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SAINT-PETERSBURG MINING UNIVERSITY

13-17 MAY 2019

SCIENTIFIC CONFERENCE ABSTRACTS

THE XV INTERNATIONAL FORUM-CONTEST OF STUDENTS AND YOUNG RESEARCHERS

TOPICAL ISSUES OF RATIONAL USE OF NATURAL RESOURCES

UNDER THE AUSPICES OF UNESCO

DEDICATED TO THE INTERNATIONAL YEAR OF THE PERIODIC TABLE OF CHEMICAL ELEMENTS

Saint-Petersburg
Mining University

XV INTERNATIONAL FORUM-CONTEST OF STUDENTS AND YOUNG RESEARCHERS "TOPICAL ISSUES OF RATIONAL USE OF NATURAL RESOURCES"

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The Volume contains works of young researchers – participants of the XV International Forum-Contest of Students and Young Researchers "Topical Issues of Rational Use of Natural Resources", which was held at St. Petersburg Mining University on May 13-17, 2019. The Volume can be of great interest for a wide range of researchers, scientists, university lecturers, specialists and managers of industrial enterprises and organisations as well as for businesspeople involved in exploration, prospecting, development and processing of minerals.

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Greeting

Mineral resources are the most important factor in economic development for most of the countries. Given the rapid growth of industry requirements, the mineral raw materials sector is confronted with a serious alternative: on the one hand, it is necessary to increase the extraction of natural resource in order to meet the constantly growing demand in mineral raw materials, and on the other hand, it is necessary to minimize the production impacts on the environment and to ensure high standards of social and economic well-being.

This issue can be solved only by searching for new approaches to the use of natural resources and by introducing the best technologies in the industry with their subsequent improvement.

The participants of the International Forum-Contest of Young Researchers «Topical Issues of Rational Use of Natural Resources» will face this particular problem in future.

Therefore, today it is necessary to maximize scientific research activity of young scientists, introduce innovative teaching methods and strengthen academic mobility, so that in the future we can have professionals, capable to solve the problem of developing innovative resource-conscious and energy-efficient technologies of production and mineral processing.

In the interests of ensuring sustainable development of society, by combining the efforts of the international academic community and by creating a high-quality institutional potential in the field of natural and engineering sciences, we will be able to eliminate the shortage in personnel in a number of specialties, which are in demand in the resource and processing industries.

The scope and international coverage of the Forum-Contest has been growing every year. Since 2018, the Forum-Contest has been held under the auspices of the International Competence Center for Mining-Engineering Education under the UNESCO auspices.

In 2019 the International Forum-Contest is held for the 15th time and is dedicated to the International Year of the Periodic Table of Chemical Elements. Traditionally, the best presentations will be selected in the categories of the Best Student and the Best Postgraduate/Young Scientist among the delegates from more than 20 countries at the break-out sessions. Considering current global trends in education, we also offer new popular formats: a case competition, TED-style presentions and master classes by the leading world experts.

We wish all the participants good luck and are looking forward to meeting them at the Mining University in St. Petersburg!

Vladimir Litvinenko,

Rector of St. Petersburg Mining University,

Chairman of the XV International Forum-Contest of Young Researchers «Topical Issues of Rational Use of Natural Resources»

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Session 1. Disruptive technologies of integrated processing of mineral hydrocarbon and technogenic

Session 2. Geotechnologies of resource extraction: current challenges and prospects

Session 3. STATE-OF-THE-ART TECHNOLOGIES OF GEOLOGICAL MAPPING, SEARCH AND PROSPECTING OF MINERAL DEPOSITS

Session 4. The latest managerial and inancing solutions for the development of mineral resources sector

Session 5. Digital and energy saving technologies in mineral resource complex

Session 6. Environment protection and sustainable nature management

Session 7. New approaches to resolving hydrocarbon sector-speciic issues

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SIZING EFFICIENCY OF FINE SIZE FRACTIONS IN VIBRATIN SCREENING

The screening of bulk materials is the most common process of mineral and natural building materials processing technologies. One of the first descriptions of multisieved vibrating screens was given in the handbook of mineral processing by prof. A.Taggart [1]. The handbook contains the drawing explaining how to sort screening from a large size grade to a small one. Multi-screen screens areused in the mining, construction and abrasive industries for the simultaneous production of material with several size grades. The first system description of the technology of vibrating screening on multi-sieves screens varying from a small to a large size grade was given by Prof. K.K. Liandov in 1948 [2]. Only later L.A. Vaisberg outlined the issue of the preliminary allocation of small particle size grades in the screening process [3,4]. However, in the mentioned above works the effect of preallotment of fine size grades on the efficiency of vibrating screening has not considered. In recent years extensive researches have been done in the field of applied mechanics of granular materials, including studies of the segregation and rheological properties of polydisperse bulk materials. These studies assume that the preliminary isolation of fine size grades can contribute to increase vibrational screening efficiency as a result of changing physical properties of bulk material.

Laboratory studies were done on Kuzbass coal sample with size grade -5+0 mm. Coal is a raw material with low specific and loose densities. Screening of material is carried out in its thick layer. The rheological factors of such mixture and its segregation have a strong influence on the screening efficiency. The experiments were performed on a vibration analyzer with orbital oscillations in a horizontal plane equipped with 200 mm sieves with square holes. The oscillation frequency of the sieves was 16,7 sec-1. The initial mass of the loaded coal sample was 400 g, which ensured the formation of a thick layer of material on the screen. Vibrational classification of the material was done in the periodic mode on a sieve with 2,5 mm holes, and also successively on sieves with 2,0 and 2,5 mm cells. In the tests with sequential classification, the material was first dispersed with a fixed time on the sieve with 2,0 mm holes, after that the fraction yield was determined, and then the oversized product was classified on the sieve with 2,5 mm holes with the same time as the test on the sieve 2,0 mm. The classification kinetics was determined in the interval experiments. Thus, the experiments simulated a continuous process of step sizing.

The experimental results showed that a consistent vibrational classification from a small to a large size grade allows a significant increase in the overall classification efficiency in size grade -2,5 mm over a reasonable period of time. The results obtained on the coal sample were verified by the tests in sequential fine dry screening of finely crushed apatite ore and copper-nickel ore of –2.0 mm size on sieves of 0.5 and 0.63 mm mesh size, demonstrating stable increase in classification efficiency by 4–5 %. The approach is beneficial for light-weight minerals that are classified only in thick material layer.

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FORMATION AND PROPERTIES OF NIOBIUM CARBIDES IN STEEL MELTS

Niobium carbides as a hard phase are bearer of superior abrasive performance. Besides, with a density not far from iron, those carbides are expected to be evenly distributed in the steel matrix. Which is necessary for viscosity measurements in near neutrally-buoyant solutions.

The incorporation of niobium was experimentally tested at high temperatures with different heating sources and crucibles, applying sheet and bulk material. Afterwards, the samples were characterized by optical microscopy, SEM/EDX and differential scanning calorimetry (DSC) in terms of NbC distribution and also melting behavior. Despite thermodynamicalmodelling suggests a high Gibbs free energy for the formation of NbC, the dissolution of niobium into the steel was rather slow, resulting in significantly long holding times. Phase diagrams were calculated using FactStage-software and later confirmed with DSC and remelting experiments. Introducing niobium to the melt and formation of NbC were successfully accomplished. The carbide distribution was not homogenous, but could be improved during the process development. During the remelting experiments a better dispersal of the NbC was also observed.

The present work is essential for validating and expanding the use of the newly developed vibrating finger viscometer, even to non-Newtonian fluid behavior. [1,2]

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INVESTIGATION OF THE INFLUENCE OF FOAMING REAGENTS OF DIFFERENT GROUP CHEMICAL COMPOSITION ON THE EFFICIENCY OF COAL FLOTATION

The relevance of this work is to improve the quality indicators of coal flotation. Increasing the output of coal concentrate and reducing the loss of organic matter of coal with flotation waste.[1]

As reagent blowing agents were investigated: “Ekofol”, Oxal “T-80”. The technical product “Ecofol” is represented by a mixture of 2-ethyl-1-hexanol, esters, isotroic alcohols and olefins ($C_{10}H_{20}$ -$C_{20}H_{40}$). Oxal “T-80” contains dioxane alcohols, formally dioxane alcohols and esters, and ethers of dioxane alcohols. [2]

As a collector reagent was used: “Flotek”. Currently used as a collector's reagent at the “Belovskaya”central processing plant , MMK-COAL. It has been established that indicators of coal flotation depend on both the collector reagent used and the blowing agent reagent used. When used as a reagent collector "Flotek" found that the highest rates are achieved in the case of use as a reagent foaming agent Oxal "T-80".With equal consumption of reagents in the amount of 2.36 kg / t and consumption of Oxal "T-80" in the amount of 0.2 kg / t, extraction of the combustible mass into the concentrate increased by 14.3% compared to the use of other foaming. When the output of the concentrate was 80.7% and its ash content was 8.0%, the ash content of the flotation waste was 60.7%, which is 20.3 higher than the use of other blowing agent reagents. The use of the “Flotek” gatherer was confirmed by high coal flotation rates in the case of using the Oxal “T-80” blowing agent. The lowest coal flotation rates were obtained when the “Ecofol” blowing agent was used as a reagent. When the concentrate yield was 67.5%, the ash content of the flotation waste was 40.4%, which indicates a significant loss of organic matter of the coals with flotation waste.[3]

The high flotation activity of the Oxal “T-80” blowing agent is explained by the content of dioxane alcohols, which, when adsorbed onto the coal surface, increase the hydrophobicity of the coal particles and their active floatability. This reagent blowing agent is recommended for use at the“Belovskaya”central processing plant, MMK-COAL.

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PROCESS TO EXTRACT HIGH PURITY NAPHTHALENE FROM THE HEAVIER GAS OIL FRACTION FROM NAPTHA CRACKERS PRODUCING ETHYLENE

The general power of pyrolysis processes in the world exceeds 130 million tons per year [1]. The process of getting light olefins is accompanied by forming about 20 percent coproducts. The use of these coproducts is a serious technical and economic problem that is associated with increased profitability of production. One of these coproducts is a heavier cut of pyrolysis gas oil (PGO). This is the mixture of different groups of hydrocarbons, greater part of them is aromatic hydrocarbons which boil above 180 Celsius degrees. Nowadays PGO use as source of boiler heater[2].Only in Russia production of PGO exceeds 325000 tons per year. Belarussian oil refining factory «Polymir» which is part of JSC «Naftan» is able to produce from 12000 up to 16000 tons of PGO yearly[3].

The aim of this work was to proposemethod of rational refining of heavier cut of pyrolysis gas oil of hydrocarbon feed. We have analysed the Belarussian PGO`s chromatography and identified more than 225 individual substances, while the containing of aromatic hydrocarbons in the PGO reaches to 67 mass percent, in particular, naphthalene up to 18 mass percent. Nowadays, naphthalene is produced from coal tar with a high content of heteroatom compounds, expensive cleaning operations are used to remove them. Hence, in our opinion, the most rational method of use of the PGO is getting the naphthalene from it. But the existing methods for the extraction of naphthalene are not used in industry because of high energy inputs, expensive catalysts, or low purity of naphthalene.

We have patented the method of extraction of naphthalene from fractions of liquid pyrolysis products of hydrocarbon feed. It includes atmospheric and then vacuum distillation of PGO with the extraction of naphthalene concentrate that is having azeotropic rectification and then it is coming for the stages of crystallization and pressing. The degree of cleanness of naphthalene corresponds to the requirements of GOST 16106 for "Naphthalene-purified", and can be used as a raw material for petrochemical synthesis.The SO «BELISA» has developed a business plan for the project of this processing station with a planning horizon for 5 years, investment costs are about $ 3.1 million, net present value (NPV) is $ 6.9 million, internal rate of return is 74%, dynamic payback period is 2.67 years, product profitability is 28%. These facts prove the rationality of investing in this project.Realization of the process of obtaining naphthalene from resin with lower costs and a higher cleanness will allow increasing the profitability of ethylene production and expanding sources of raw materials for petrochemicals.

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DEVELOPMENT OF VACUUM CARBURIZING MODES ON HE BASIS OF THE MATHEMATICAL MODEL

Significant reserves to improve the quality and reduce the mining industry opens up the use of vacuum carburizing to harden low-alloy steels used in mass production of transport systems - car gears, ship gearboxes, tracked vehicles, etc. [1, 2]. During its implementation, there is no externally and internally oxidation, the duration of saturation is reduced, the consumption of process gases is reduced, and high ecological purity is ensured. The efficiency of the new process is combined with the advantages of modern vacuum equipment [3, 4].

The result of carburization depends on a large number of technological factors. The wide range of their changes causes a large number of possible processing options, complicating the determination of the optimal carburizing regime [1, 3].

The paper developed and built a computational model of vacuum cementation of low-alloyed steel, which makes it possible to predict the distribution of carbon in the diffusion layer and evaluate its main parameters - carbon concentration on the surface, concentration gradient, effective thickness of the saturated layer.

From a comparison of the concentration curves, it follows that the calculated and experimental values of carbon concentration differ slightly. The carbon concentration on the surface in steel was 0.88%, the effective layer thickness (layer at $C \geq 0.40\%$) was 0.83 mm. The concentration gradient does not exceed 5%, which corresponds to the formation of a favorable concentration area near the surface.

Comparison of the experimental and calculated concentration curves shows their satisfactory convergence, which creates opportunities for the development of technological modes of vacuum cementation by the calculation method to improve mining equipment.

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MODELLIZATION OF SEISMIC RADIATION FROM AN EXPLOSIVE COLUMN

The aim of this study is to compare analytical results of seismic radiation from an explosive column obtained by Matlab® code with real blast measurements in order to define the efficiency of the model used. This model is replica of Blair predictive explosion-source model [1] based on pressure measurements within the blast hole, which extends his previous work about seismic radiation from a short cylindrical charge [2] comparing Heelan approximate solution [3] and a full field solution by using a scale-independent model.

The model is written in scale independent terms with the aim of having a general equation that can be used for different charge lengths and diameters. An elastic medium will be supposed characterized by the seismic waves velocities on it. In order to obtain an independent scale formulation, it will be necessary to have dimensionless variables: angular frequency of the Pwave, axial wavenumber and measuring point coordinates.

The displacement equation depends on an angular frequency, axial wavenumber, point coordinates and a transfer function composed by a source spectral function, modified Bessel functions, and shear modulus. The displacement will be calculated by using Inverse Fourier Transform, and will be calculated for the radial and axial component, in order to compose both and obtain the full waveform. The result will be dimensionless as so are the variables.

Furthermore, the displacement was calculated for a mesh of points in order to obtain a solution applicable to a real case as, for example, a blast with several boreholes drilled. The scale independent result will be transformed to scale dependent, so a comparision with real data can be carried out. The results showed that analytical and real displacement waveforms were similar, and the peaks corresponding to P-wave and S-wave were produced at the same time and similar amplitude.

The method seems to be consistent and able to give results close enough to the real case. Consequently, it has proven the validity of a scale independent model. A more developed study about the method would be very useful and precise for displacement and velocity calculations including viscoelastic attenuation.

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EFFECT OF SULPHUR ON WETTING BEHAVIOR OF CR-MN-NI STEELS ONhBN-SiC-ZrO_2-SUBSTRATES

Boron nitride is one of the non-metallic, non-oxide inorganic materials, which is currently in a development stage. Because of its superior high-thermal properties in combination with other substances (e.g. SiC and ZrO_2), this ceramic is widely used in the field of metallurgy and electronics for producing detectors, temperature resistance substancesand metal matrix composites (MMC).The present study investigates the wetting behavior of Cr-Mn-Ni-alloys with TRIP/TWIP-effects on hBN-SiC-ZrO_2-substrates in a 90 vol.% N_2/10 vol.% H_2 atmosphere. The wettingat the steel/ceramic interface has been studiedusing the sessile drop method in a temperature range of 1773 K to 1873 K.Herewith, the ceramic-steel interface is analyzed using SEM-EDX. The results present the effect of sulphuron the contact angle between the hBN-SiC-ZrO_2-substratesand the Cr-Mn-Ni-alloys.Increasing the sulphur content leads to the decrease of contact angle. Results are consideredin context ofthe chemical stability of the substrate components with regard to alloy elements.The data are essential for a newly-developed vibrating finger viscometer[1].

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MODERNIZATION OF THE PLANT FOR THE PRODUCTION OF POLYETHYLENE TO OBTAIN A COPOLYMER OF ETHYLENE WITH VINYL ACETATE IN AUTOCLAVE REACTOR

The main products of the plant "Polymir" JSC "Naftan" is high-pressure polyethylene.Ethylene can enter into copolymerization reactions with other monomers, so it is possible to obtain copolymers having special properties in comparison with polyethylene, on the available equipment of the plant. This issue is well studied for tube-type polymerization reactors, which produce ethylene copolymer with vinyl acetate in the CIS countries and the world.However, obtaining a copolymer in a reactor with a stirrer is not sufficiently developed.According to the studied literature [1,2] obtaining ethylene-vinyl acetate copolymer in an autoclave reactor has such advantages as greater flexibility and maneuverability of the copolymerization process and the resulting ethylene-vinyl acetate copolymer has a more regular structure.

To modernize the plant, calculations of the main equipment were made with the determination of the available stock in terms of productivity.For verification of the calculation was selected autoclave reactor and the heat exchanger cooling the reaction mixture.As changes in the technological scheme, installation of tanks of fresh and returning vinyl acetate, a high-pressure pump for supplying vinyl acetate to the reactor, as well as separators of high and low pressures for separating the mixture of ethylene and vinyl acetate are provided.A high-pressure separator [3] and a high-pressure vinyl acetate pump [4] are designed and selected.

The obtained calculations confirm the possibility of copolymer production with vinyl acetate content up to 14% (mass fraction) in the autoclave reactor. This will increase the range of products of the plant, because the copolymer of ethylene with vinyl acetate is in great demand due to the limited number of its manufacturers.The resulting product with a minimum investment in modernization will meet its need in the country and can be exported, since its only production in the CIS is in Russia.

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IMPROVING FLOTATION TECHNOLOGY OF COPPER-MOLYBDENUM ORES WITH THE USE OF REAGENTS BASED ON ACETYLENE ALCOHOLS

The purpose of this research is to increase efficiency of copper-molybdenum ore enrichment by flotation through the improvement of the reagent regime by adding a nonionogenicheteropolar compound at the processing plant of the joint Mongolian-Russian venture "Erdenet Mining Corporation". Despite numerous researches and achievements, the issues of selective flotation of non-ferrous ores have not lost their relevance. Sulfur-containing collectors, typically xanthates and aeroflots, commercially used in the flotation of complex and sulfide ores of non-ferrous metals do not always offer sufficiently high recovery of valuable components [1]. DK-80 (dimethylethylcarbinol) (CH3)2C(OH)–C≡CH and DMIPEK (dimethyl (isopropenylethynyl)carbinol) (CH3)2C(OH)–C≡C–C(CH3)=CH2 reagents were tested on current "Erdenet" copper-molybdenum ore production and factory collective concentrates in the laboratory. The combination of the molecules of the solidophilic acetylene and hydrophilic alcohol groups in the structure of the molecules gives them the properties of blowing agent collectors [2]. The proposed mechanism of action is that the interaction of these flotation reagents with the surface of the minerals produces a metal–alkyne π-complex [3]. The results of the studies showed that the use of collectors based on acetylenic alcohols is more effective at fractional feeding, both in the preparatory cycle and in the collective and selective flotation cycles in combination with the reagents used in the processing plant, which includes BK-901 (dialkyldithiophosphate - dialkylthionocarbamate), AERO MX-5152 (15 to 40% allyl ester of amylxanthic acid), diesel fuel "type E" and MIBC (methylisobutylcarbinol). Flotation efficiency of the "Erdenet" copper-molybdenum ore can be increased by incorporating into the main mode of flotation, reagents based on acetylene alcohols. According to the experimental results, the additional extraction into the collective Cu-Mo concentrate were +0.62% (96.49%) for copper and +5.76% (82.65%) for molybdenum. The extraction into the selective molybdenum concentrate increases by 2%. This gives the basis for the formation of proposals to improve the ore enrichment of the field Erdenetiyn-ovoo, based on a set of statistical results of further research.

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STUDY OF THE POSSIBILITIES OF SHALE GAS IN THE CANTABRIAN MASSIF

The objective of this project is the study of the possibilities of unconventional gas (shale gas) within the domains of the Cantabrian Massif (North of the Iberian Peninsula). Therefore, it has been determined, in a theoretical manner, the method of geochemical characterization, studying the occurrence (fundamentals), composition and origin of the organic matter (parameters), to evaluate the source rocks as potential shale gas generators. In such study, in order to apply the technical knowledge described in the first part of the project to the formations which would present potential to hold shale gas, it has been proceeded to make a bibliographic recompilation and analysis of the latter, studying the lithostratigraphy, tectonic, and Structural configuration, as well as hydrogeological aspects of the affected zone [1], culminating with a geochemical evaluation of the samples acquired during two campaigns held by the "InstitutoGeológico y Minero de España" (IGME) in the Cantabrian Massif. After the geochemical evaluation of the samples acquired, the Jurassic age formations have the greatest potential to hold shale gas, so we propose to carry out a new campaign of those geological formations which most promising to hold shale gas. The objective of this campaign will be complement those already carried out, so we recommend expanding the laboratory analyzes.

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STUDY OF THE EFFECT OF THE DELAYED COKING TECHNOLOGICAL PARAMETERS ON THE YIELD, QUALITY AND COMPONENT COMPOSITION OF THE DISTILLATE PRODUCTS

Nowadays, among the thermal processes of the oil refining industry, the delayed coking process has become the most widespread worldwide. This process allows to process a large variety of heavy oil residues and distillates with a high content of aromatic compounds for obtaining the additional amount of petroleum gaseous and distillate products. The distillates obtained by the delayed coking can befurther refined and used compounding ascomponents of gasoline, diesel and marine fuels [1,2].The main product of this process is acarbon-based material called petroleum coke.

Tar, being the bottom fraction of the atmospheric distillation and containing paraffins mostly, is often used as a feed of the delayed coking process. However, it was found that the most suitable feed for this process should have a high content of aromatic and polyaromatic hydrocarbons [3].In this regard the main feed used in this work was the heavy gasoil of catalytic cracking.

The quality of the distillate products obtained during the process, as well as the ways of their possible use, varies considerably depending on the operation parameters of the delayed coking. In this work, the methodology of carrying out the process of delayed coking under laboratory conditions was developed. To evaluate the influence of the operation parameters on the quality of the distillate products the following properties of these products were analyzed: density, viscosity, acid number, content ofsulfur, individual hydrocarbon content for gasoline of delayedcoking and pour point for the mixture of light and heavy gasoil of the delayed coking.

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INTENSIFICATION OF RARE EARTH ELEMENTS LIQUID EXTRACTIONSEPARATION PROCESS BY THERMO OSCILLATION EXTRACTION TECHNIQUE

A number of the works [1,2], which are carried out last decades, has suggested that it is possible to achieve higher separation of rare earth elements in nonequilibriumnonestationary conditions - the extraction process which is not allowing extractant saturation.

We have developed and constructed the facility allowing to conduct research of process in the described conditions; the experimental results received with its help.The example of an extraction of couple of Pr/Nd with acidic organophosphorusextractantP507 arepresented. For this type ofextractantskeepingthe system in an unsteady state can be carried out by temperature variations in an extractor and/or acidity in an aqueous phase. Impact on system of temperature oscillations in the range of 25-60 °C is presented on figure. Differences in speeds of saturation of an organic phase by neodymium and by praseodymium are well visible: while temperature is increasingthe concentration of neodymium in the aqueous phase decreases much more, than the concentration of praseodymium. With decreesing of the temperature neodymium passes into an aqueous phase more slowly than praseodymium. Waves of temperature oscillations promote accumulation of differences in the speed of an extraction of neodymium and praseodymium that leads to growth separation factor $\beta_{Nd/Pr}$. The second wave of a temperature oscillation substantially repeats the first one, as in the value of maximum $\beta_{Nd/Pr}$, and in value of pH in the points of thetemperature minimum andmaximum.

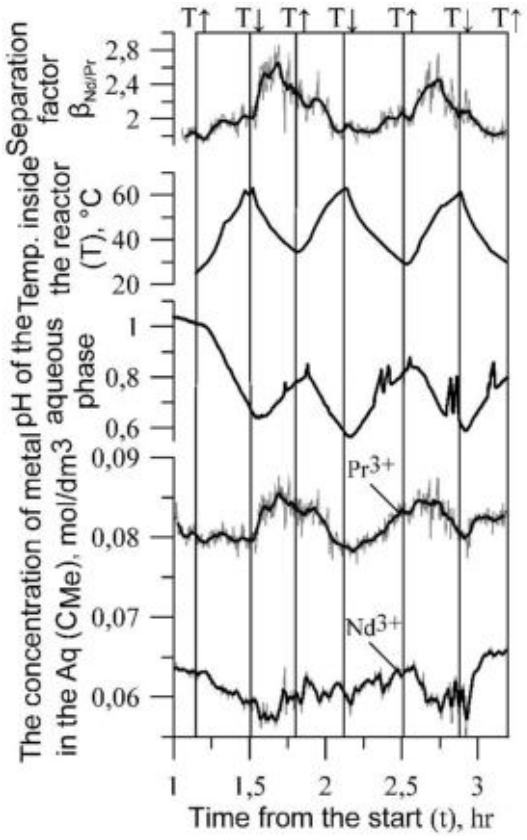

Figure – Temporal profiles of the process main parameters

In an experiment the increaseof value $\beta_{Nd/Pr}$ by 65% from 1,7 to 2,8 is registered.

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FACTORS AFFECTING ON THE EXTRACTION OF ALUMINA FROM KAOLIN ORE USING LIME-SINTER PROCESS

Currently most of the world's commercial alumina is produced by the Bayer process using bauxite as raw material. However, bauxite production is concentrated in a limited number of countries rich in bauxite ores and now the bauxite is not readily available to meet the global increasing of the industrial demand for the alumina production [1].

This globally increasing demand of aluminum raises the interest in developing alternative technologies to produce alumina from non-bauxitic sources and low grade aluminium ores, with the intention that these technologies will lead to a significant reduction in the consumption of bauxite and alumina transportation costs [1,2].

Clay is one of the numerous aluminous raw materials, consisting mainly of Aluminosilicatesminerals that are distributed on a large scale in the world.Among the different clays, kaolin seems to be a moreattractive candidate for alumina production alternative to bauxite, due to its high aluminum content [3].

Pyro-and hydrometallurgicalextraction of alumina from the kaolin ore excavated from the Irkutsk region, Russia using lime-sinter process was investigated. The kaolin-limestone charge was sintered to obtain the ($12CaO.7Al_2O_3$)phase suitable for the alumina extraction [4].

The best recovery of alumina about 87% was obtained at 1360°C sintering temperature for 1h., 5 MaP briquetting pressure and using 120g/l Na_2CO_3 solution at 70^0C for 30 minutes.

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INFLUENCE OF ULTRASOUND ON THE PROCESS OF FLOTATION ENRICHMENT OF POTASSIUM MINERAL

The study of the flotation concentration of potash ores and other minerals in saturated solutions is an extremely urgent task [1]. On the one hand, there is currently a tendency to reduce the quality of sylvinite ores, which leads to the need to optimize existing methods and technologies for their enrichment, on the other hand, understanding the mechanisms of the processes occurring with different phases in concentrated salt solutions, allows us to get closer to solving practical problems associated with the flotation of ores in seawater [2-3]. Such a transition will allow rational use of constantly decreasing freshwater resources. The aim of the present work was to study the use of ultrasonic treatment of the process of separation of hydrophilic particles (by the example of halite) from air bubbles to increase the selectivity of separation of water-soluble minerals (KCl-NaCl) with similar physicochemical properties during flotation. The studies were carried out at the Georesources Laboratory (UMR 7359 CNRS) of the University of Lorraine (France) on samples of sylvinite ore from the Verkhnekamskoye field, taken as a core from the Palashersky wells. The results of the experiments showed that for small classes (size of 0.1-0.25 mm), KCl extraction does not depend on the ultrasonic treatment method and its power. However, in the process of the combined action of ultrasound during conditioning with reagents and then during flotation, there is a decrease in NaCl extraction by 5%. One of the reasons for this effect is ultrasonic vibrations, which can contribute to the selective separation of mineral particles from bubbles in accordance with the degree of hydrophobic properties of the surface of minerals.

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IMPROVING EFFICIENCY OF GRAVITY SEPARATION OF FINE IRON ORE MATERIALS USING COMPUTER MODELLING

At present, as the most part of the richest ores which can be easily processed has beendepleted the problem of separation of fine-disseminated ores with complex material composition arises. This problem requires the research and development of technologies and devices for processing of fine fractions of materials including gravity separation [1]. In particular at the processing plant of JSC "Olkon" the jigging separation of a non-magnetic fraction of primary magnetic separation does not provide acceptable content and recovery of hematite in concentratebecause the most part of hematitefineparticles with diameter less than 0.2 mm are lost with tailings. When processing hematite ores it is often not possible to achieve requirediron content in the concentrate and the loss of the valuable mineral with tailings reaches 60%.

Computer modelling of spiral separation of the tailings of primary magnetic separationwas carried out using computational fluid dynamics (CFD) to determine the possibility of the useof spiral separators.The simulation results showed the advantage of spiral separators compared to the jigging machines due to the more efficient separation of fine fractions of the feed.The highest indicatorsof separation were achieved using spiral separator with a low inclined profile of the surface. A rough concentrate was produced with content and recovery of hematite of about 70%, and the loss of the valuable mineral with tailings did not exceed 10%,when processing the material with 10%content of hematite.

Industrial tests of spiral separation of the tailings of primary magnetic separation were carried out at the processing plant. The resultsof the tests were consistent with the simulation data and confirmed the feasibility of the use of spiral separators instead of jigging machines. When processing feed containing from 2% to 21% of hematite iron, a rough concentrate was produced with content from 28% to 58% and recovery from 48% to 91% of hematite iron.The average recovery of hematite in the tailings was 13%according to the results of the tests.Further processing of the rough concentrate and middlingswith the use of spiral separators and shaking tables provides concentrate containing about 56% of hematite iron and the through recoveryof hematite of about 75%.

Thus, studies were conducted aimed at increasing the efficiency of gravity separation of fine fraction of tailings of primary magnetic separation at JSC "Olkon". The feasibility of replacement of jigging machines with spiral separators was confirmed using computer modeling. The technology of further processing of products produced at the first stage of spiral separation was developed. In the future, large scale testsare planned with the use of spiral separatorsat the plant.

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PREPARATION AND ANALYSIS OF NEEDLE COKE BY THE DELAYED COKING PROCESS

The process of delayed coking tends to be the most profitable among the secondary thermo-destructive processes of deep oil refining. Delayed coking is an important direction in oil refining for Russia. Special attention should be paid to the production of needle coke, which now is entirely imported to Russia from the USA, China and the UK.

During the study, a laboratory unit for delayed coking of hydrocarbon and carbon-containing raw materials DCU-1was developed. This research facility is located at the Department of Chemical Technology and Processing of Utilities at the Mining University [1].

In this work two types ofraw materials were used as a feed of the process: tar (vacuum residue of fuel oil) and heavy gasoil of catalytic cracking (highly aromatic distillate fraction obtained during the process of catalytic cracking of hydrotreated vacuum gasoil). Raw materials were selected from industrial plants refineries in Russia [2, 3].

During the study, a series of experiments was carried out with a change in the operation temperature or pressure. The process temperature varied in the range of 480-505 ° C, and the pressure varied from atmospheric to 0.55 MPa. The following products were obtained: petroleum coke, distillates (gasoline fraction, mixture of light and heavy gasoils), hydrocarbon gas.

During the delayed coking of heavy gasoil catalytic crackingthe petroleum needle coke, which is a special type of carbon material characterized by developed anisotropy of structure, was obtained. The study of the of calcinated petroleum coke microstructure was carried out according to the GOST 26132-84. Samples correspond to 5.0–5.5 points according to the control scale of microstructures, which is typicallly for needle coke with a fine-needled structure. The real density of the needle coke samples was determined and constituted 2.10-2.15 g/cm^3.

When conducting experiments, there was a tendency of increase in the yield of coke with increasing pressure of the process. The total amount of distillates produced reduced. This is reflected mostly in the yield of the gasoil mixture, which is used as component of marine fuels.

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PERSPECTIVE DIRECTIONS OF COMPLEX PROCESSING OF RESIDUAL PRODUCT OF THE PROCESS «UNICRACKING»

The residual product of the process of hydrocracking of vacuum gasoil, received by technology "Unicracking", is a complex mixture of high boiling compounds consisting of mainly paraffin and naphthen hydrocarbons with ultra low sulfur content. This product can be used not only as a component of low-sulfur fuel oil, but also as a raw material for the production of lower olefins[1], which are the raw material base of the modern petrochemical industry; obtaining base oils corresponding to group III according to API classification[2]; and greases[3].

One of the perspective directionof complex processing to refining residual product of the process "Untracking" is to obtain white oils. These oils can be used both for technical purposes and in medicine, pharmacology and cosmetology. The most important indicators of the quality of white oils, in addition to kinematic viscosity, density and flash point, are: pour point, color and content of aromatic hydrocarbons. White oils should be a colorless, buttery, clear, non-fluorescent, odorless and tasteless liquid.

To make white oils the residual product of the process "Unicracking" must be subjected to dewaxing and deep cleaning. The traditional method of producing white oils is sulfuric acid purification of oil fractions. But this method is not effective for the purification of the studied raw materials. White oils can be obtained by deep hydrogenation of the residual product of the hydrocracking process [4]. However, the implementation of this technology requires large investments.

One of the most effective and relatively simple ways to obtain white oils from the residual product of the hydrocracking process is the adsorption purification method. As an adsorbent, it is proposed to use modified bleaching clays, which allow to improve the color and reduce the content of aromatic hydrocarbons in the studied product. The possibility of adsorbent regeneration was studied.

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GREEN METHOD OF RARE EARTH METALS EXTRACTION

Rare earth metals are widely used in several high-tech industries, so now they became strategically important raw materials [1]. These days consumption of the rare earth reflects the level of technology development in the country. However, far from all countries have even small natural resources of the rare earth. Many countries have to buy REM from China, since this Asian country is almost a monopolist in this field in recent years. Russia has its own rare earth resources, so our country has a unique opportunity of restoring rare earth production and fulfilling both domestic needsand world market demands.

In this research it was suggested to use wet-processed phosphoric acid (WPA) as a raw material for recovering rare earth. WPA is an intermediate stage in the production of phosphate fertilizers from apatite ore [2].In this way, there is no need to buildnew mining and processing enterprise, because REM can be recovered by introducing a stage of rare earth by-product extraction.

Liquidextraction REM withdi-2-ethylhexylphosphoricacid has been studied for a long time in our department, proving to be effective when used for recovery and separation of REM. However, liquid extraction method has its disadvantages. For example, it requires high volumes of toxic extractants and inflammable solvents, which inevitably pollute the environment [3]. Therefore, a decision was make a switch to solid-phase extraction in this work. This method combines the properties of both extractionand sorption processes, and allows to avoid the disadvantages of liquid extraction, being more eco-friendly.

During this work there were determined several important characteristics of TVEX-D2EHPA such as the equilibration time in the extraction system; extractiondegreeofyttriumdependency on the stirring velocity, process temperature and phosphoric acid concentration; sorption capacityof TVEX for yttrium; the reextraction stage with the use of sulfuric acid.

Overall, the forecasts for implementing TVEX-D2EHPA are quite positive, since solid-phase extraction does not yield in terms of equilibriumdegreeofextraction indicators to those of liquid-phase one. Apart from that, solid-phase extraction allows to a great extent separate competitiveferricionsfromtargetREM. For this reason, the study should be taken further to determine theothers characteristics of TVEX-D2EHPA.

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RESEARCH OF THE PHOTOELECTRODES PREPARED FROM CERAMIC NANOWIRES

In DSSC systems, one of the most important elements determining the efficiency of cells is the photoanode [1-3].The purpose of the work include the produced photoanodes from nanowires which gives the opportunity to obtain significant surface area while maintaining the highest possible electron transport and low electron recombination. The innovation of the subject is based on the use of the previously non utilizing form of photoanode material and the determination of its impact on the efficiency of the cells.

The produced photoanodes have beed deposited on substrates in form of glass tiles with a fluorine doped tin oxide (FTO) layer. Nanowires materials have been applied with use doctor blade techniques on a glass/FTO substrate and heated at the temperature of 300-400◦C in order to remove residues after deposition by the doctor blading method. On the thus prepared surface the N719 dye was embedded.

The structure and surface morphology of the created films, have been determined by atomic force microscope (AFM) and scanning electron microscope (SEM). By use AFM were taken topographic studies with the quantification of the expansion of the surface of the anode.

Investigations of optical properties of individual photovoltaic cell layers were made using the UV-Vis spectrophotometer equipped with a xenon lamp with a wavelength range from 190 to 1110 nm. Absorbance A of layers deposited on a glass/FTO measured before and after dye deposition

The research component of nanowires as photoanodes component is a promising direction for the development of DSSC. Both topographic and surface morphology confirm the expansion of the surface of free photoanodes. Absorbance studies confirm the deposition of dye and its effect on absorbance of radiation

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EFFECT OF HOT ROLLING ON THE MICROSTRUCTURE, MA PHASE FORMATION AND MECHANICAL PROPERTIES OF PIPELINE STEELS

When the pipelines are installed in permafrost ground or in seismic activity areas, where ground movement causes large deformation and strain, they must have sufficient deformability and high strength to prevent local destruction and ensure safety [1]. One of the key technologies for improving deformability is strain-based design. One such type is the bainitic or ferrite-bainitic microstructure with constituents of the martensite-austenite phase (MA) [2, 3]. For understanding the formation process of this type of microstructure with MA phase and its effect on mechanical properties, two kinds of pipeline steels distinguished by the content of carbon and molybdenum were produced by the pilot plant test with varying rolling temperature and accelerated cooling rate. The material thus produced was compared in aspect of the microstructures, MA phase morphology and mechanical properties. Results showed that applying of the low finishing rolling temperature promotes the refinement of MA phase. Increase in the cooling rate leads to the increase in the amount of the MA phase and its refinement. Alloying with molybdenum promote bainitic microstructure nucleation and reduce grain size and M/A-constituents. All these factors lead to a slight improvement in mechanical properties.

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TO THE QUESTION OF THE INITIALIZATION THE KINETIC MODELS OF BLACK-SHALE RAW MATERIALS FLOTATION

The study of flotation kinetics is one of important tasks in the theory and practice of modern mineral processing. The most commonly used model to predict kinetic data of the process is the first order exponential equation (K. F. Beloglazov model), but in practice data there is almost always a significant difference with calculated data [1]. Kimpell, Kelsall, Gamma and Fully mixed model and their modifications found the most widespread and usage. These models formed the basis of specialized computer package list: HCS Chemistry, JKSimFloat, MODSIM^{TM}, USIM PAC^{TM}, etc. Among alternative approaches, the integral method of experimental data processing shows good convergence results and the selection of type of regression dependence using which contain a database of models [2, 3].

This research attempts to develop an algorithm for initializing the type of kinetic model of flotation. To do this, the experiments of flotation enrichment of black-shale raw materials were carried out, the data on the extraction of the ash product were subjected to statistical processing. The coefficient of determination was chosen as a criterion for selecting the optimal function.

According to the results of the research, it was found that the use of an integral method of data processing allows to achieve fairly accurate results of forecasting (R^2 is about 0,9). The highest accuracy using automated regression processing showed the Hoerl model. The shape of the curve has no pronounced kinks and kinks between the points and corresponds to the physical nature of the real process.

The best results were achieved with the use of modified Kelsall model. The coefficient for this model was chosen by using the Levenberg-Marquardt algorithm. This algorithm has significant advantages before the “classical” optimization methods: the method of the steepest descent and Newton’s method because these methods are based on arbitrary functions. Meanwhile, the Levenberg-Marquardt algorithm is a nonlinear least squares method and has the greatest chance of finding a global extremum and very high convergence rate. In this research finding the coefficients of the model with using this algorithm was carried out by using the developed algorithm in MathLab program.

As a result of the study was deweloped the algorithm of calculation which allows to find the most common kinetic model. Among the advantages of this approach can be notad its high arruracy in the definition of the constants, the ability to add new models and the ability to use it on free software.

Scientific advisors of this research are Dr. Prof. Alexandrova Tatyana Nikolaevna and candidate of technical science, associate professor RomashevArtyomOlegovich.

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EFFECTIVENESS OF A TWO-STAGE PRE-TREATMENT TECHNOLOGY OF BACTERIAL AND PRESSURE OXIDATION FOR HIGH-SULFUR REFRACTORY GOLD CONCENTRATES PROCESSING

A decreasing quality of mineral resources has resulted in a need to develop highly effective technologies for low-grade materials processing. Refractory gold ores, which form a significant part of world gold deposits, cannot be processed feasibly by direct cyanidation since fine-grained gold is “locked” in sulfide minerals, typically pyrite (FeS_2) and arsenopyrite (FeAsS) [1]. In order to enhance gold recovery, pre-treatment is needed prior to cyanidation to destroy a crystal lattice of minerals and make dispersed gold accessible for the leaching solution [2]. One of the promising methods for treating such materials is pressure oxidation (POX), which allows to reach high rates of gold recovery within 1-1.5 hours. However, its efficiency may be lowered while treating certain types of materials. For instance, high content of sulfur in an autoclave feed (>6%) results in excessive heat release, that may lead to the necessity to dilute pulp with quench water, thus increasing a liquid-to-solid ratio and sizes of the autoclaves [3], ultimately influencing capital and maintenance costs. Thus, studies should be aimed at the selection of the most appropriate technique for treating refractory gold materials with a high S content.

A prospective approach in this field is a combination of bacterial and pressure oxidation. At the first stage, sulfide minerals are oxidized by the means of bacteria to decrease a sulfur content and make it acceptable for the treatment in autoclaves. Then, the bio-residue is treated in autoclaves to complete the oxidation and prepare the residue for subsequent cyanidation.

The object of investigations was a flotation concentrate with 21.5% S and 55.5 g/t Au. Bacterial oxidation was conducted in three stirred tank reactors connected in series at 40 with aeration. The air supplied to the first reactor was enriched with CO_2. Pressure oxidation of the concentrate and the residue of bacterial oxidation was conducted in a titanium Parr autoclave of the volume 1.9 l with an agitator and oxygen supply at 220 .

The results have shown, that although a two-stage technology requires more time than a single-stage POX and allows to recover gold at almost the same level, bacterial treatment prior to POX significantly reduces S content in the autoclave feed and decreases a liquid-to-solid ratio by more than 2 times, thus avoiding a need to dilute the pulp with quench water. Therefore, gold recovery rate can be improved with lower equipment, operation and maintenance costs.

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RECYCLING OF TECHNOGENIC RAW MATERIALS OF METALLURGICAL ENTERPRISES

Montanuniversitat We offer a unique technology for the destruction of high-stable emulsions. The technology allows to solve the problem of formation and accumulation of lubricating-coolant fluid purification and decomposition slime of metallurgical enterprises. This technology allows to receive commercial product from waste.

The development of the metallurgical industry and related fields of technology and economy takes place in the terms of constantly increasing demand for environmental standards of enterprises. The problem of formation of lubricating-coolant fluid purification and decomposition slime, etc., which are highly-stability water-oil emulsions is relevant, their formation and accumulation provide not only an environmental hazard but also causes a direct and an indirect economic loss to enterprises.

All considered types waste are highly resistant water-oil and water-hydrocarbon emulsions, which are characterized by a low efficiency of conventional dehydration techniques based on aqueous phase sedimentation. On the average, such wastes contain 2-5% wt. of solids, 30-50% wt. of water and 30-50% wt. of hydrocarbon phase.

The increased stability of such emulsions is determined by the following factors:

- close densities of water and hydrocarbon phases;
- a high concentration of manmade emulsifiers
- the presence of inorganic presence of inorganic substances (mechanical impurities)

Method based on evaporation of the water phase of these emulsions can be alternative methods of dehydration of such waste. But serious problem arises when emulsion is heated. Water droplets tend to coalesce at elevated temperatures, and subsequently precipitate as a water phase on a heating surface. With the accumulation of a critical mass of water on the heating surface the process of boiling is destabilized, overheating of globules of water leads to the over throw of emulsion, which makes dehydration process impossible. There are various techniques that are based on the evaporation of water.

As the primary method we have proposed the method of thermomechanical dehydration of liquid oil waste. This method implies that the evaporation of the water phase takes place under mechanical action that prevents the coalescence of water droplets and their accumulation on the heated surface.

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THE NEW TYPE OF HYDROTREATMENT CATALYSTS IMPLEMENTATION

Current natural energy producing materials are one of the main sources of energy, which are globally used. However, nowadays, the quality deterioration of going into processing crude oil (weighting and sulfur concentration inclining) is observed. The sulfur content in the final petroleum products reduction is achieved by mean of hydrocatalytic purification units [1].The specific character of the sulfur removal process and the variety of products, which undergo sulfur purification, considerably complicate the catalysts development due to different chemical properties and structure [2]. High-porous catalysts are possible solution due to desirable to reduce molecular sizes matching. Therefore, it was decided to obtain laboratory-batch samples of high-porous hydrodesulfurization catalysts and carriers.

The main requirements for these chemicals concern mechanical properties and pore size distribution [3]. The carrier pelletsproduction was mad by means ofchurned paste extrusion. As raw material pseudoboehmite-phase of alumina was applied due high-strength properties of this material. As peptizing agent nitrogen acid was used. The specific surface area was determined by the BET method by the nitrogen (or argon) isotherm at liquid nitrogen temperature (-196^{o}C).

In order to further implementation of obtained carriers, the laboratory batch was compared with industrial hydrodesulfurization catalysts in terms of physical properties satisfaction. The optimal approach was applied and parameters, such as peptizing agent and extrusion conditions, was set to achieve required pore sizes. However, the industrial implementation on this stage is impossible due to the absence of catalytic properties. The metal impregnation isrequired.

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THE INFLUENCE OF ADJUVANTS TO THE UNEVENNESS OF TRANSVERSE DISTRIBUTION OF LIQUID ACCORDING TO SELECTED SPRAYER OPERATING PARAMETERS

The quality and effectiveness are two basic criteria spraying. The quality of the treatment is determined on the basis of three indicators: unevenness of the precipitation and spraying of the liquid, the degree of coverage of the sprayed objects and the application of the liquid. The most important factors for the quality of spraying is: working speed, liquid utility pressure, liquid dose per hectare, nozzle used, temperature, wind speed, atmospheric pressure, adjuvant addition, characteristics of the sprayed objects (1, 2, 3, 4, 5).

The paper presents the research of the process of the sprayed liquid fall for the choose types of air-injector and standard nozzles, working in variable conditions and parameters of spraying. The aim of the study was to determine the unneveness of transverse distribution of the liquid. The research was conducted in field conditions, at the Institute of Agricultural Engineering, Wrocław University of Environmental and Life Sciences on stand test, which basic element was grooved table.

It was found that the distribution of unneveness transverse sprayed liquid was addicted to of constructional solutions tested spray nozzles and the speed of wind. It was also noted that with the increase of speed wind was a decrease volume of the liquid measured on the grooved table by a phenomenon of drift. This negative phenomenon can be minimized by the use of appropriate adjuvants.

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THE DEVELOPMENT OF DIGITAL TECHNOLOGIES IN THE MINERAL RESOURCE COMPLEX

Modern economy requires new effective tools for better competitiveness of the national industrial complex. Industrial digitalization increases efficiency and improves interaction of industrial enterprises.The mineral resource complex is susceptible to the introduction of digital technologies that help to use available resources more effectively.

The basic global technological trendsin the sphere of industrial digital transformation include the installation of smart sensors; the introduction of robotic machines for cutting down labor costs, minimizing the lack of qualified personnel, reducing mining-related diseases; improved logistics due to automated verification and data exchange; the automation and integration of production processes into a unified information system in order to reduce the duration of the production cycle, to increase sales and reduce production costs due to faster coordination, transmission and verification of information. Mineral resource industrial complex can benefit from the introduction of internet technologies.

The potential benefits from using digital technologies in the mineral resource complex are as follows: the introduction of remote control and equipment autonomy technologies, minimizing the lack of qualified personnel, increasing production safety, reducing ecological and social risks, the integration of sales and production planning, the reducing of unproductive mine operations, remote access to information, productivity growth, longer life of assets and equipment, etc. At the same time the extension of the use of digital technologies can lead to new risks, for example, in the sphere of information security.

Digital transformation influences greatly all the production and sales processes.Digital mine provides more efficient measuring, automating and collecting more accurate data; applied analytics is used for making important economic decisions; mobile technologies are necessary for increasing the number of robotic transport means and reducing staffing requirements. Digitallogistics provides inventory monitoring, better analysis of stock balance, load automation and cargo tracking. Digital organization helps to use digital technologies for company's efficiency based on financial growth, staff interaction, social interaction for identification of benefits [1].

Mineral resource enterprises should consider new technical and technological trends, improve business processes and reduce production costs. This needs industrial modernization based on introduction of digital technologies that will help companies provide profit and keep high level of safety [2].

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AN INNOVATIVE TECHNOLOGY TO PROCESS MAN-MADE ZINC CONTAINING WASTES

There are more than 100 billion tons of solid technogenic wastes in the dumps and stockpiles on the territory of the Russian Federation [1]: sludge, dust, oiled scale etc. Storage and warehousing of technogenic wastes is associated with catastrophic effects on the environment. Huge areas are removed from agricultural turnover. Valuable components of the wastes are irretrievably lost. Groundwater is polluted. Companies are required to spend a lot of money on landfill content and sludge storage tanks.

Often, man-made waste contains a number of useful components, the concentration of which in the waste exceeds the content in existing and newly developed fields. It indicates of their raw values and feasibility of using. The development of new technologies opens up opportunities of converting huge amount of man-made waste into valuable raw materials. In ferrous metallurgy one of the unsolved problems is zinc-containing wastes. For example, in dusts and sludges the zinc content can reach 30% [2].

The most promising areas in the processing of man-made wastes are liquid-phase technologies, the main advantages of which are: high specific performance, low energy costs, high recovery ratio of useful components in commercial products, low capital costs, low cost of the final products [3].

To solve the problem of zinc-containing materials utilization the bubbling technology has been developed with the complete selective extraction of useful components into commercial products. The new technology is mutable in relation to the existing requirements of a particular source of waste and consumers of processed products. The first pilot plant was successfully launched in Mtsensk, Russia.

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STUDY OF NON-SULFIDE FLOTATION PROCESSES

The relevance of this study lies in the effective extraction of useful components through the applying and improvement of technological solutions, namely in improving the quality of iron ore concentrates.

The growing demand of the iron ore world market for high-grade low-silica pellets suitable not only for blast-furnace production, but also for the technology of direct metallization led to an increase in the number of beneficiation plants using the flotation method of enrichment of magnetite concentrates.

The research`s aim is studying the influence of aminoreagents on the process of non-sulfide flotation of ferruginous quartzites.

The aim of the research is to develop and substantiate a scheme for processing ores of oxidized ferruginous quartzites to intensify the process of flotation separation of iron ore concentrate after the stage of magnetic separation [1].

The object of the study was monomineralic silica and ferruginous quartzites from the Mikhailovsky deposit (concentrate obtained after magnetic enrichment). Reagents for carrying out laboratory experiments on flotation separation were selected aminoreagents: cationic collectors (Lilaflot, Tomamin), aminoethanoic acid.

The main point was to use the ability of silica to form complexes with cationic reagents. The applying of aminoethanoic acid in the process of ore preparation was carried out in order to increase the chemisorption of the cationic collector on the surface of the mineral.

Laboratory experiments were carried out in this work, which included ore preparation and flotation concentration of mineral raw materials. Samples of ferruginous quartzites and flotation separation products were studied using precision methods: X-ray fluorescence analysis, IR spectroscopy, laser diffraction to determine the particle size distribution of the samples.

It was established that applied aminoethanoic acid in the grinding process acts as a surfactant, helping to reduce the strength properties of the material (Rehbinder effect [2]). Physical – chemical activation at this stage allows subsequently a greater amount of silicon dioxide to pass into the aqueous phase in the form of “silicic acid”, which leads to improved chemisorption of the ‘collector mineral’ in flotation.

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ELEVATION OF GOLD-BEARING SULPHIDE FLOTATION EFFICIENCY

Nowadays because of increasing demand on precious metals, industry all over the world faces problem of precious metals deposits depleting, what makes implicating refractory ores processing an urgent issue. For effective gold recovery from that kind of ores it is necessary to achieve selective extraction of gold-bearing sulphide minerals for further refinement [1].

Selective recovery by flotation is possible with oxidants appliance due to surface properties adjustment by oxidation [2]. For evaluation of efficiency of that process optimal range of redox potential amount for pyrite recovery was defined by thermodynamics method. In that area of eH-potential functional connection between pyrite monofraction recovery and redox potential value was determined. Furthermore we described a correlation between pyrite flotation recovery and the effect of bubble surface area flux [3].

Sulphide flotation with using oxidants is more efficient in range of eH-potential specific for border area of sulphat-ions existence, what could be explained by oxidation intensification of transitional ions on minerals surface, what redound aligning of flotation properties. Absence of correlation between bubble surface area fluxvalue and recovery in concentrate and high relative values in flotation with oxidants testifies that oxidant and oxygen act similarly in influence on sulphides minerals floatability, what could be used in cases of low values of bubble surface area flux.

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POLYMER-MODIFIER FOR THE ROAD BITUMEN MANUFACTURE OF THE FOURTH GENERATION

In the recent years, two contradictory trends have been observed in the production of road bitumen by the method of air oxidation. On the one hand, road bitumen consumers require the manufacturer to improve the quality of road bitumen. The reason for this is the growth of the vehicle fleet and increasing load on the road bed [1, 2]. On the other hand, the deepening of oil refining at oil refineries changes the ratio of the main components in tar and creates significant difficulties in obtaining high quality commercial bitumen by direct air oxidation [3, 4]. From a technological and economic point of view, it is advisable to obtain polymer bitumen compositions in order to improve the operational properties of bitumen for road construction.

The aim of this study is developing a polymer-bitumen composition based on oil road bitumen and a polymer modifier. The latter is obtained from petrochemical waste of polymer production, which differs by the use of cheaper and more accessible components compared to industrially used analogs.

To bring the main indicators of the quality of road bitumen to modern standards' requirements, it is proposed to use a thermally prepared combined additive with a concentration of up to 3% by weight. The cost of raw components of the combined additive is equal to the cost of the commercial road bitumen itself. For industrial implementation it is proposed to use a 1% combined additive obtained by mixing 1 part of plasticizer and 2 parts of polymer production waste. This will bring the main quality indicators of road bitumen of the BND 70/100 (petroleum road bitumen) in the line with the requirements of modern standards.

The proposed polymer-bitumen composition differs from industrially used analogs by the use of cheaper and more accessible components, and in terms of its basic performance indicators it approaches the requirements for modified road bitumens, ensuring their reliable operation in asphalt concrete mixtures.

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TERNARY CARBIDES IN THE IRON CARBON SILICON SYSTEM

The properties of alloys are strongly influenced by precipitations. These precipitations can be intermetallic phases. In one of the most used alloy systems the ternary system of iron carbon and silicon there is a diversity of such intermetallic phases. Of special interest are the ternary carbides in this system. This presentation is a summery from the history of their discovery up to the results of modern investigations and our modern knowledge about these ternary carbides. In every time there were only a few groups of researchers, who worked on this topic. It began with British engineers and chemists [1] and was in mainly parts investigated by Soviet and Russian scientists [2, 3].

First described were carbides including silicon in the ternary iron carbon silicon system in the heart of a blast furnace [1]. First attempts to clearly identify that there is a phase which is not cementite consisted of experiment with heat tinting [4]. It could be clearly identified that there is a new and till then unknown phase. Also a possible mechanism of precipitation will be described [3].

With more modern methods like X-ray diffraction and scanning and transmission electron microscopy it was possible to get further data of the structure and chemical composition of the carbides. Also new methods in production of these precipitations were attempted [2]. So a variety of carbides in this system were found.

In this presentation the historical way of discovery of the carbides with description of the different technologies is shown as well as the results of this studies and introducing in the different carbides. Also there will be shown microscopic pictures of the carbides.

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DISINTEGRATION OF MOUNTAIN BREEDS

Disintegration - this process of mechanical grinding of solids can be represented by crushing or grinding. When crushing or grinding pieces of solid materials, a lot of mechanical energy is expended, therefore it is necessary to choose the grinding method as correctly as possible [1].

A method of rock disintegration is proposed using highly swirling high-speed water flows with high pressure, which form a disc-shaped water knife. [2]. Developed an installation for the application of this method. The high energy of the jet, in this installation, is formed due to the centrifugal force of the jet flowing from the rapidly rotating (up to 50,000 rpm) rotor.

The disintegrator can be designed for grinding rocks with dimensions of no more than 30 mm. The diameter of the rotor 300 mm. The performance of the disintegrator due to the new method can be increased by 1.5-3 compared with traditional mechanical crushers and their analogues. This will be very noticeable in the electricity consumed for the production of 1 ton of rock, as well as increased wear resistance and, consequently, the resource of this installation [3].

The installation allows you to get from 1 ton of waste mining plants up to 3 grams of gold and several grams of rare earth metals. The breed is crushed less than 10 microns from which further useful metals are extracted by the traditional method.

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STERILIZATION OF NANOFIBER BIOMASS CARRIERS FOR BIOTECHNOLOGY APPLICATIONS

In the last decade, nanomaterials have gained a lot of attention as providing new options and potentials in many areas. Since nanofibers have a very high specific surface area, they are promising tool applicable in various fields, particularly in biomedical and environmental applications. For most of such applications, sterility of nanofibers is a critical factor to avoid possible negative contamination. For example, the nanofiber carriers used for the colonization of pure microbial culture have to be microorganism-free, and its structure must not be affected after the sterilization.

In this study, nanofiber biomass carriers were sterilized using 3 various physical and 4 chemical methods. Physical methods implied steam, ultraviolet irradiation and ultrasound. Chemical methods were as follow: absolute ethanol, a solution of chlorine dioxide, hydrogen peroxide and ozone.

Two types of the nanofiber layer based on polyurethane, which showed in previous experiments very good biocompatibility, were prepared by the needleless electrospinning from a free liquid surface. DC and AC high voltage source were used for nanofibers preparation. The impact of sterilization method on the nanofiber layer was examined by optical and scanning electron microscopy. The efficiency of sterilization was assessed by cultivation methods on the plate count agars and molecular-genetic methods, namely using a qPCR analysis.

Nanofiber carriers sterilized by steam exhibited the highest efficiency of sterilization. The most significant damage of the nanofiber layer on the support thread was observed after the sterilization by steam and ozone. Results of cultivation and molecular-genetic methods also indicated that both nanofibers prepared using DC as well as AC electrospinning are partly antimicrobial already after their production. It was probably caused by the reagents used for the polymerization of polyurethane during its production. This effect will be subjected to chemical analysis in detail to detect potential antimicrobial agents. Further sterilization methods will be also texted in order to find the most efficient method or rather combination of methods, including the ambient conditions.

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RECYCLED POLYETHYLENE TEREPHTHALATE – FLY ASH POLYMER COMPOSITE MATERIAL

Reinforcing effect of mineral fillers for polymers has been recognized since the last few decades. Improving the mechanical, electrical, thermal, optical and processing properties of the polymer with the addition of filler materials has become a very popular research interest to make a composite material [1].

Developing low-cost composite materials with improved properties has been one of the primary challenges in a number of industrial applications. To achieve this goal, researchers implemented cost-effective processing methods and developed novel material systems involving low-cost fillers.

Utilization of fly ash as a filler in polymer composites has received increased attention recently, particularly for price-driven/high volume applications. Incorporation of fly ash offers several advantages: it is the best way of disposing of fly ash, and as it is cheap and plentifully available, it decreases the overall cost of composites [1-4].

The possibility of filling recycled polyethylene terephthalatewith fly ash was studied to make polymer composite material (PCM). To enhance the adhesive interaction between the phases of the composite, a method was used to change the acid-base properties of the filler surface by treating its surface with solutions of sulfuric and nitric acids. For this case the distribution of adsorption centers on the surface of components of PCM wasstated.

Concentration of fly ash filler was varied from 55 up to 75 % byweight. Compression and flexural strength, density, water adsorption, thermal characteristics of PCM were tested.

Treatment of fly ash filler to theoretically improve its adhesion characteristics to the PET polymeric matrix improves the overall properties of the PCM, especially compressive strength and density. The highest value of strength characteristics of samples with fly ash filler has PCM with 65% filler concentration.

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SOLVENT EXTRACTION OF STRATEGIC METALS – NEW INSIGHTS INTO THE SEPARATION OF RHENIUM AND MOLYBDENUM

Rhenium is a very scarce element. Its abundance in the earth's crust is in the order of magnitude of gold. As an alloy component of highly-heat resistant alloys that can be used in the construction of turbines, rhenium faces increasing demand by the aerospace industry and the energy sector [1].

In its primary deposits as well as in secondary raw materials, rhenium is typically found in combination with molybdenum. Within the context of solvent extraction from aqueous solutions, it was found that the selectivity of amine extractants towards rhenium is improved significantly by the addition of certain organophosphorus compounds. Even though the influence of those Lewisbases on the selectivity of amines towards certain metals has been a known fact for a long time, the underlying mechanism still remains controversial [2, 3, 4].

We herein employ FTIR-studies and for the first time two-dimensional NMR-spectroscopy in order to understand the molecular interactions responsible for the selective liquid-liquid extraction of anionic metal species from sulfuric leaching solutions.

The present study underlines the importance of hydrogen bonds for the selective transfer of anionic species from aqueous leaching solutions. Results of the selective re-extraction from the organic phase (figure 1) can now be understood in connection with newly discovered spectroscopic evidence for the mechanism of the separation process (figure 2). The derived supramolecular concepts are applicable to the separation of many other industrial metals, like vanadium, gold or platinum group metals.

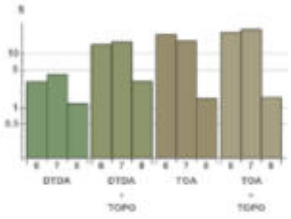

Fig.1: Selectivity of extractants

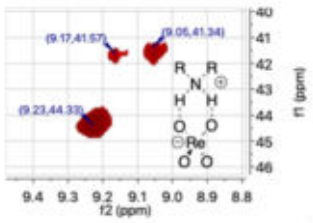

Fig.2: 1H/15N 2D-NMR-spectrum.

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INTENSIFYING PULVERIZED COAL COMBUSTION IN BLAST FURNACE

Replacement of metallurgical coke by pulverized coal (PC) injected in blast furnace (BF) tuyeres is a major economical challenge due to the high price of coke and unfavorable effect of its production for the environment. The first in Europe commercial complex for PC preparation and injection was built in 1980 at Donetsk Metallurgical Plant. At present in the world more than 90 % of pig iron are smelted with PC injection [1]. The effective use of expensive PC injection complexes can be attained when consumption rate of coal gets to maximum.

The main factors which hinder the rise of PC quantity being injected into the hearth of furnaces is the maintenance of its complete gasification within the raceway and smooth operation of a furnace due to change of heat, slag-formation and gas dynamic conditions. Burning of carbon in solid fuel is a heterogeneous process. Theoretical and experimental research of PC burning process under conditions of raceway have been carried out. Methods and designs for intensifying PC combustion in BF have been developed. Among them there are effect of coal composition, size of PC particles, temperature and enriching blast with oxygen. Recommendations to coal grinding and method of complex compensation for the changes in technological regime of BF operation have been developed. Laboratory and industrial tests have shown the possibility of considerable increase of PC combustion degree under high PC consumption [2].Research of pulverized coal burning has been carried out with sampling of materials from blast furnace dust, sludge and slag. Unburned pulverized coal and coke particles in blast furnace dust, sludge and slag were investigated by means of microscopic and chemical analysis.

Technical, economic and ecological parameters of BF operation when injecting various brands of PC has been examined.Quality of a grinding of coal and uniformity of distribution on tuyeres have been investigated. The tuyere design with PC injection has been developed. Research of the maintenance of carbon in slag, top dust, sludge at work of the furnaces with application of PC injection have confirmed practical absence of a gain of the maintenance in them of carbon, in particular, as coal, that testifies to a high degree of gasification of PC carbon in the hearth.Proposed technology will allow to improve environment situation in industrial regions due to reduction of coke production, improveits quality and quantity of injected PC.

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RATIONAL PROCESSING OF POTASH ORES OF PETRIKOV DEPOSIT

The results of the complex of laboratory studies of ore for the development of technological scheme of enrichment of silvinite ores of Petrikov Deposit with a high content of magnesium chloride (up to 1,6%).

The literature sources analysis results on the influence of the increased content of magnesium chloride in the saturated salt solutions and their high temperature (>30 °C) on the sylvine flotation process from the potash ores were used while researching the potash ores beneficiation rate of the Petrikov deposit.

On the two formed technological ore samples of the Petrikov deposit with a mass fraction of $MgCl_2$ – 1,6% and 2,0% there was held a set of experimental researches in order to investigate the beneficiation rate of this ore under the conditions of normal temperatures – 23 °C increased ones– 32 °C and high temperatures – 38 °C of the saturated salt solutions.

It is stated that the increase in $MgCl_2$ content in ore from 1,6% to 2,0%, and also temperatures of the saturated salt solution to 38 °C, leads to the essential decrease of the key technological indicators of the flotation, even at the higher specific consumption of the reagents.The reagent modes to carry out the floatation process of sylvine from the ore with a mass fraction of $MgCl_2$ 1,6% and 2,0% under the conditions of different medium temperatures were held and recommended.

The researches results of core ore samples on the beneficiation rate were the basis for the develop of technological scheme for the enrichment of silvinite ore of thePetrikov deposit with a mass fraction of KCl – 24,0% and $MgCl_2$ – no more than1,6% to obtain technological extraction of 87,5%.

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THE MICROSTRUCTURE AND TRIBOLOGICAL PROPERTIES OF CRCN LOW-FRICTION THIN FILM

Metal materials are still the most commonly used materials for moving parts of mechanical assemblies in various industries, including mining. Due to the friction phenomenonmany adverse reactions that effectively reduce their efficiency and life occure. To counteract this phenomenon, the lubricant layer is mainly used. However, due to the environmental reasons and difficulties in its removal, it is possible to use low friction coatings [1, 2]. These coatings, due to their characteristics, can be used in harsh environments such as. high temperatures, vacuum, or ones with higher corrosion risk.

Thin films based on chromium belong to hard ceramic coatings. CrCN coatings have good chemical resistance and tribological properties. The carbon addition to the popular CrN, allows to achieve better properties such as hardness, the coefficient of friction or adhesion [3]. These coatings can be deposited to elements working at elevated temperatures or in water (including saltwater) as well as cutting tools, henceforth allowing for very vast array of applications.

The aim of this work was to investigate structural and tribological properties of CrCN coating deposited by arc PVD method on the X6CrNiMoTi17-12-2 austenitic steel substrate. It is important to effectively examine low-friction coatings, by tribological and structural tests, in order to determine the phenomena which allow to reduce friction, which is necessary for their effective use in industry.

The AFM and SEM tests of the CrCN thin films allowed to determine their topography characteristic for the deposition method. Moreover it allowed for the roughness parameters assessment. Adhesion tests revealed decent values of critical loads, while suggesting that an additional layer between the coating and the substrate would improve these results. Under the technically dry friction conditions, the friction coefficient was 0.63.

Research of this type low friction coatings helps the industry to develop adequate friction protection for difficult working conditions. Moreover they are a good starting point for future research on modern complex low-friction layers.

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ANALYZING THE MORPHOLOGY OF STAINLESS STEEL POWDER MANUFACTURED VIA INERT GAS ATOMIZATION

Inert gas atomization is a powder production method that allows the manufacturing of spherical shaped particles of micron size. The choice of an effective application of this powder depends on the powder properties, one of the most important of which is morphology [1]. Therefore, it is essential to control parameters of the process in a way that the manufactured powder satisfies the requirements of the modern powder manufacturing techniques. As was established, chemical composition of the sprayed alloy can affect the final quality of the powder by varying the physical properties of the melt, such as density, surface tension and kinematic viscosity [2].

Within the framework of project CRC 799, four atomization experiments are conducted producing stainless steel powders with different nitrogen content [3]. The obtained powders are investigated with regard to morphological aspects such as particle shape, defects present, and particle porosity. The analysis is conducted on cross-section samples via scanning-electron microscopy (SEM). All investigated samples reveal similar defects and shape irregularities independent from the nitrogen content. Additionally, the phenomenon of large pores formation is discussed in correlation with the spraying gas art (Ar or N2). These pores are presumably formed by argon gas bubbles that remained inside the particles [4]. Therefore, the large pores are present for all the samples due to the implementation of argon as the spraying gas. To the contrary, the reference powder sprayed with nitrogen does not demonstrate this phenomenon. The obtained results are relevant in the context of basic powder properties and their dependence on the nitrogen content.

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APPLICATION OF SONOCHEMICAL METHOD FOR PRODUCING Cu-Zn-Al CATALYSTS FOR METHANOL SYNTHESIS

The development and introduction of new resource and energy saving technologies is becoming one of the trends in the development of chemical enterprises. Most of the chemical processes involved in the petrochemical and oil refining complex are catalytic. The development of catalysis and catalytic technologies largely determine the competitiveness of petrochemical products on the market [1]. Methanol is one of the main products of the chemical industry, as it is a raw material for the production of a number of chemicals [2]. The choice of the direction of research is due to the fact that by 2027 the global demand for methanol can reach 135 million tons, and the annual growth will be about 5.5%. The market for catalysts for methanol synthesis is occupied by three major manufacturing companies: “HaldorTopsoe” (Denmark), “Perstorp” (Sweden), “Clariant” (Switzerland) [3]. Currently, there are no technologies for producing Cu-Zn-Al catalysts for methanol synthesis in Russia. The aim of the work is to obtain a copper-zink-aluminum catalyst for methanol synthesis by ultrasonic treatment (using a sonochemical method), and also to compare the catalytic properties of the obtained laboratory sample with the properties of an industrial analogue.

Micrographs and data on energy dispersive analysis of the composition were obtained using a Vega 3 TESCAN microscope, and the morphology of the samples was studied from the images obtained. X-ray phase analysis was performed on a DRON-3M diffractometer. The content of components in the industrial sample and the catalyst obtained by ultrasonic treatment, practically does not differ from each other. By treating the adsorption-desorption isotherms of nitrogen, it was found that there are no micro- and macropores in the Cu-Zn-Al catalyst, but only a mesoporous structure. The studied sample obtained by the sonochemical method has a more developed specific surface area compared with the industrial analogue: 104.3 ± 1.5 m^2/g and 84.0 ± 0.5 m^2/g, respectively.

Thus, the Cu-Zn-Al catalyst obtained by the sonochemical method is not inferior in its characteristics to the industrial design, and in some cases surpasses them. The results of the research work can be used to conduct experimental and technological work aimed at establishing the production of catalysts for methanol synthesis.

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USING SIMULATION TO SUBSTANTIATION OF EFFECTIVE TECHNOLOGICAL SOLUTIONS FOR GOLD SUSPENSIONS BENEFICIATION

The relevance of this study provedby the fact that the reserves of easily-rich gold-bearing ores are being depleted [1]. Refractory ores, characterized by a fine dissemination of the valuable component in sulfide minerals, the presence of chemical gold depressants, and the content of sorptionally active carbonaceous material are increasingly involved in processing.

In this regard, the task of developing effective technological solutions for the beneficiation of ores is relevant and has scientific and practical significance in modern economic conditions. One of the methods for developing such technological solutions is the use of a computational experiment, which reduces labor costs, as well as research time, by avoiding natural modeling [2].

The paper considers approaches to the mathematical modeling of the enrichment processes of gold-bearing pulp. A model of gravitational sedimentation of gold-quartz pulp was obtained, which makes it possible to estimate the sedimentation rate of particles using the Lyashchenko method [3], and also to reveal the character of the influence of various factors on the sedimentation process.

With the help of ANSYS software, the classification process in a hydrocyclone was considered. The optimal operating parameters of the hydrocyclone, necessary for obtaining in the overflow product 90% of a particle size less than 0.074 mm, are substantiated. Using the JKSimFloat software package, the flotation process was optimized by varying parameters such as the bubble surface area flux and the residence time of the pulp in the flotation cell to maximize the extraction of valuable components in the concentrate.

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MINING AS A RESOURCE OF CIRCULAR ECONOMY

The circular economy decouples growth from natural resource consumption. In a world with increasingly constrained resources and many environmental challenges, the balance of supply and demand will shift for key commodities. This will have fundamental impacts across the mining and metals value chain. Products are designed for high performance and durability, and the use of raw materials is optimised. VeggiHap started to convert wasted raw materials to food products that reached out to consumers. But saw that there are more ways of using different raw materials for our purpose.

On the whole, metals are infinitely recyclable, while their inherent durability, strength and anticorrosive properties help to enhance the longevity of products in which they're used. The high value of many metals and minerals also incentivises the recovery of such materials at the end of a product's life cycle, and hence there are many methods in place to facilitate their re-use and recycling. Therefore, VeggiHap proposes a framework where the conservation of nonrenewable resources is a core concern. The first part establishes a set of material flow indicators relevant to a mine project. The second part considers the entire mine's life cycle, in particular, the consequences of interruptions in activities on material losses.

Mining as an industry creates much in the way of waste – from rock and emissions to water treatment sludge and mine water – and this too can be reused, either within the production chain or re-purposed elsewhere. It is unreasonable to think that society will not need any metal resources from mining activities in the short, medium, or longer term.

VeggiHap will design a coordinating upstream and downstream activity to recover precious materials in the most cost-effective way. At the end of a product's life cycle, the resources used to create it are, where possible, recovered, recycled or re-purposed, creating a responsible, restorative and regenerative cycle that 'designs out' unnecessary waste.

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DESIGN OF A HEAT EXCHANGER OF TUBES AND SHELL (1-2) FOR A CHEMICAL PLANT ASSOCIATED WITH A PYROMETALURGICAL FOUNDRY

The aim of this study is to combine fundamentals heat transfer for heat exchangers with calculations derived from research and approved codes such as TEMA and ASME. The practical problem to solve is to cool sulphuric acid to a specific flow of the same one and to size the equipment for this purpose. Heat exchangers are a fundamental element in any type of industry that requires the optimization of the energy produced to be transferred along the production chain or processes. After the passage of the first decade of the new century, the minimum energy consumption on the part of the industrial sector has been seen as a priority objective. The heat exchangers play a fundamental role to be one of the most used equipment for that purpose, managing to eliminate both cooling systems and systems that increase the temperature of fluids of high power consumption. This is achieved by passing fluids of different temperatures through the opposite sides of a material, as all materials have conductivity properties; the hot fluid transfers the heat to the lower temperature fluid. In summary, the objective of this article is to create a heat exchanger, taking into account the necessary and sufficient design restrictions. At the same time, the justified study of the materials to be used in the design.

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ELECTROSPINNING OF COMPOSITE NANOFIBERS WITH GRAPHENE OXIDE ADDITION IN WATER FILTRATION

Due to the dynamicindustrialization and development of the industry, more and moredifficult to removeimpurities in the form of heavy metal ions, dyes as well as drugs and hormonesgetinto the water [1]. Traditionalmethods of watertreatment do not meetexpectations, thereforemoreeffectivemethods of waterfiltrationarestillsoughtafter [2]. In the last decade nanofibrous membranes obtained by electrospinning from the solution have attracted the attention of manyscientists. Electrospinning techinqueis cheap and simple way of nanofibrous membranes obtaining [3, 4].

The aim of this paper was to prepare polyacrylonitrile polymer nanofibers (PAN) and composite PAN nanofibers with the addition of graphene oxide (GO) via electrospinning from the solution. By changing the configuration of the distance between the nozzle and collector (10 and 20 cm) and maintaining the remaining parameters (solution flow rate and potential difference between the electrodes), four samples in the form of nanofibrous mats were made.

In order to identify the structure and morphology of the material, X-ray microanalysis (EDX) and scanning electron microscopy (SEM) and Fourier-Transform Infrared Spectroscopy (FTIR) were performed. In addition, the structure of graphene oxide microparticles was investigated by a Raman spectrometer. The polymer nanofibres PAN for both the distances between the nozzle and the collector show no structural defects and presented same diameter over the entire length of the fiber. Nanofibers with the addition of GO obtained at both distances between the electrodes, showed defects in the form of beads.Electrospunned mats due to its high surface area are considered to be useful in water filtration.

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DETERMINATION OF THE COMPONENT COMPOSITION AND PROPERTIES OF ENVIRONMENTALLY FRIENDLY RESIDUAL MARINE FUELS

From January 1, 2020, the International Marine Organization tightens the quality requirements for marine fuels, therefore the content of sulfur compounds in marine fuels should be less than 0.5wt. %.Thus, there is a need for a composition of residual marine fuel (RMF) which meets the requirements of Russian (GOST 32510-2013) and international (ISO 8217: 2017) standards. One of the economically viable methods of obtaining environmentally friendly RMFis the indirect hydroconversion, which constitutes the selective compounding of sulfur and low-sulfur components [1-3].

The properties of residual petroleum fractions, heavy distillates and middle distillates were explored. In this work their individual hydrocarbon content was also quantified and analyzed. Based on the obtained data about the properties of petroleum fractions, 12 samples of RMF were developed, their main characteristics, such as viscosity, density, calculated aromatization index, mass fraction of sulfur, acid number, totalsedimentaged and pour point were determined. It was found that all samples obtained had a sulfur content of less than or equal to 0.5 wt. %, which meets the future requirements of the International Maritime Organization.

The obtained data about the quality of the samples were analyzed with the requirements of GOST 32510-2013 (ISO 8217:2017). Samples that do not meet the requirements for the parameter oftotalsedimentagedwere excluded. A method for describing the stability of the fuel system of marine fuel from their component and hydrocarbon composition using a three-component phase diagramwas developed.

Thus, it was established in the work that it is possible to obtain a stable environmentally friendly residua marinel fuel based on two-component and three-component mixtures by an indirect hydroconversion process. To stabilize a two-component mixture consisting mainly of asphaltenes and paraffins, it is necessary to introduce a third component, with a high content of aromatic hydrocarbons.

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ACTIVITY OF THE CATALYST OBTAINED BYINTEGRATED PROCESSING OF HIGH-MAGNESIA SIDERITES

The principles of the integrated processing of high-magnesia side rites have been developed and tested inenlarged laboratory experiments. These principles allow one to increase the level of using these ores inmetallurgy and to obtain additional products [1]. It is established that a porous oxide material forms at the stage of roasting high-magnesia siderites accordingly to the patented scheme [2]. This material has an extended surfaceand imperfect crystal lattice so it can be regarded as a ready-to-use catalyst. The catalytic activity of the material obtained was investigated in the reactions of steam conversion of ethanol and conversion of carbon dioxide by hydrogen.

The main products of the catalytic conversion of ethanol by steam in the temperaturerange of 470 - 550 0C are hydrogen and acetone. The yields of these products on the catalyst being investigated are comparable with the yields on the CoO/MgO- and Cu/CeO2 catalysts, while the conversion of ethanol is even higher (up to 97.4%).

It is established that the catalyst obtained by the integrated processing of high-magnesia siderites demonstrate high activity in the water gas shift reaction at a temperature of 820 0C. The possible reagent flow rate can be as high as 3800 h-1. When activity of the catalyst is reduced it can be agglomerated for further use in the blast furnace process.

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RATIONAL PROCESSING OF STALE INDUSTRIAL BENEFICIATION WASTES OF IRON ORES APPLYING THE ROMELT PROCESS

The purpose of this research is the development of a technology for processing the concentration tailings of hematite ores at Kamysh-Burun operation plan into an iron-bearing product using the ROMELT process. In the concentration and metallurgical processing of iron ores, substantial amounts of waste are generated (tailings, slimes, slags, metallurgical dust, etc.) that can be converted into a commercial product if properly processed [1]. The iron content of the dumped waste varies between 10 and 35%. Iron is mainly held in slightly magnetic hematite and non-magnetic minerals [2]. High-gradient permanent magnet separators, cationic flotation, and pyrometallurgical processes are used to achieve high economic performance of iron-bearing waste processing [3]. In the concentration and metallurgical processing of iron ores, substantial amounts of waste are generated (tailings, slimes, slags, metallurgical dust, etc.) that can be converted into a commercial product if is properly processed. Using Mossbauer spectroscopy, it has been shown that the iron minerals in the studied samples are technogenic varieties of iron hydroxides. The most suitable technology is the magnetic roasting process, since iron hydroxides are easily transformed into a magnetic, easily recoverable form. The advantages have been shown of two-stage magnetic separation in a strong field in polygradient separators. Concentrating this feed with magnetic methods makes it possible to increase the iron content to 20-21 %. Magnetic concentration of the deeper layers results in iron-bearing concentrates with a total iron content of up to 58% at a phosphorus content of about 2%. Reducing the phosphorus content is possible by blending the top and bottom layers of the material at a ratio of 1:1. Thus, it is possible to process the material accumulated in the slime storage facility using the ROMELT process combined with preliminary three-stage magnetic concentration and disposal of tailings with the permissible iron content of less than 5%. Smelter wastes will be slags suitable for use as an input in the building materials industry. The dumped waste of Kamysh-Burun operation should be pretreated before smelting using the ROMELT process using a gravity wash process to separate the size class -0.4 mm followed by additional blending to leach the phosphor content in the concentrate. Smelting will result in a metal product (pig iron) and slags suitable for use as an input in the building materials industry.

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NEW ROAD CONSTRUCTION CONCEPT FOR FAR NORTH MINING

The region of Far North is rich of underground resources. However, severe weather conditions and wetlands complicate the construction processes of roads for resource extraction sites. Manufacturers follow innovative technologies in order to improve the road construction. Due to necessity of road construction features improving there is a problem of nanotechnologies developing and researches resulting as roads building and maintenance cost decreasing. One of the way to solve this problem is floating roads construction made from lightweight foam-concrete segmented structures using the technology of step-by-step assembly and topological self-linking [1].

Considered road construction is defined as follows. Segmented construction is the bitumen-impregnated road base covered with geotextile and asphalt concrete layer as the final road surface. The key point of this constructional solution is to use materials with a given internal architecture named «archimats» and assembling technology based on the method of small-sized blocks topological self-sealing. The main difference between this class of materials and structures made from them is non-monolithic design. A good example of the geometry of such segments is osteomorphic blocks whose self-linking is provided by the convex-concave shaped contacting surfaces. It is impossible to extract any of each segments after the structure is assembled. Resistance to destruction of construction is increases due to its mosaic-like structure. This shaping method is ideal for creating structures made of hybrid materials and allows to create a single structure from heterogeneous materials taken in any mixing proportions [2].

The development of experimental design segments was carried out by computer-aided desing systems such as AutoCAD which was using for developing, researching and building models of topological self-linking blocks [1]. Designed prototype of block was assembled further in a three-layer canvas fixed at the edges. Assemblies of these blocks were checked for mechanic features of a deformable solid in the ANSYS. Aerated concrete and polystyrene foam used in road construction were selected as the most suitable for comparative experiments. The results of calculations showed the advantage of segmented structures over monolithic constructions.

One of the distinguishing features of segmented structures made using the method of topological self-linking is to maintain their performance under load in case of part of the blocks are destroyed. In order to research and confirm new technology's features developing and theoretical substantiation of a new constructive solution of a road design is provided. Laboratory testing of prototypes in order to technological solutions search and design optimization are processing.

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HEAVY OIL AQUATHERMOLYSIS IN SUBCRITICAL AND SUPERCRITICAL WATER

This work describes a comparison of subcritical and supercritical water effects on it.

The impact on oil of water in a subcritical state at a temperature of 360°C and a pressure of 21 MPa leads to a maximum decrease in the content of asphaltenes in the liquid product - by 53% rel. in comparison with the original oil, which is caused by the fact that subcritical water is not only an agent that reduces the partial pressure of petroleum hydrocarbons, preventing condensation and coke formation reactions, but also a reagent involved in transformation reactions. During the transition to the subcritical state, water has an ionization constant three orders of magnitude higher than under normal conditions and is able to play the role of a hydrogen proton donor, participating in the hydrogenation reactions of, first of all, heteroatomic compounds of oil — resins and asphaltenes, as well as semi-products of their thermal destruction during aquathermolysis. The experiment with the use of supercritical water (420°C, 24 MPa) is characterized by a large decrease in density (to 0.7162, which is 27% relative lower than the original oil) with a naturally resulting decrease in the content of the fraction boiling at 350°C and above (13.4% rel. compared with the original oil). The increase in the fractional content of nk-200°C is 2.5 times and the increase in the content of paraffin-naphthenic hydrocarbons by 67% rel. compared with the original oil, as well as a decrease in the content of aromatic hydrocarbons by 60% rel., resins by 45% rel. and asphaltenes by 28.5% rel. are the result of the destruction of high-molecular polycondensated compounds of oil with the separation of peripheral alkyl substituents.

As a result of experimental work, the selective action of water in various states of aggregation on the conversion of petroleum hydrocarbons was established.

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MECHATRONIC COMPLEXES OF THE COAL ENRICHMENT WITH POWER REMOVAL OF COMPONENTS

In recent years, mineral exploitation has been accompanied by a decrease in the quality of the primary raw materials, especially in the extraction of coal due to an increase in the ash content and the degree of grinding of the mass. The wet coal enrichment methods, which are widely used in the world, require in the process the involvement of a significant amount of water and energy and form a large amount of waste. And that is why the problem of creating and implementing resource-efficient methods of enrichment of small and middle classes of coal in the conditions of geotechnical enterprises is particularly acute. Creating of a compact and energy-efficient equipment for the coal enrichment , which can be used in the conditions of geotechnical enterprises, will significantly reduce transportation costs for delivery to the mineral processing plants.

Among the methods of the dry enrichment of the mass, which consists of several components with different friction coefficients, a dry method of the coal preparation in friction should be noted [1-3]. The well- known offered schemes with the friction enrichment have not been widely used for a number of reasons. The main disadvantage of the existing friction enrichment schemes is difficulty of the interaction process of the mass components during their movement. As a result, almost the same trajectory of the movement and low speed of the particles of components. Also the disadvantages include the complexity of production of the working bodies for the concentrating machines.

To create a new resource-saving coal enrichment technology should be used segregation processes , which are based on the use of tribological properties of shared components with the creation of high-speed working bodies to guarantee the necessary performance. The presented machines were successfully tested at the «Pavlogradugol» geotechnical enterprises and they confirmed the high technical and economic indicators. Each of the created machines is designed to sort the masses of various sizes, and together they form a highly efficient complex of the coal enrichment with high quality indicators of the output product.

The established dependences of the pressure distributions in the zones of action of the working bodies on the mass make it possible to establish the main energy-power parameters of mechatronic systems and to carry out strength calculations.

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METHOD TO REDUCE FREEZING AND IMPROVE DUST SUPPRESSION WHEN RECEIVING AND TRANSPORTING PETCOKE

Petcoke may be combusted as fuel in industrial and power generating plants[1].Coke fines may be easier to burn as a fuel. The creation of coke dust, associated with the presence of coke fines, is a major cause of environmental problems. It results also in loss of productivity [2].An emission control technique that is commonly used at petcoke storage locations is the application of water to storage piles, but freezing temperatures may require additional practices to mitigate fugitive dust. Treating piles with anti-dust chemical agents prior to the arrival of subfreezing conditions is the following practices are mitigation strategies for wintertime conditions [3, 4].

The input analysis of raw materials was performed in the laboratory of the Department of Technology and Equipment of Oil and Gas Processing. Compounding of light vacuum gas oil with high-molecular oil residues was performed on a laboratory setup. For the obtained prophylactic agents assumed viscosity at 50°C (GOST 6258), pour point (GOST 20287), flash point (GOST 6356), determination of water content (GOST 2477), determination mechanical admixtures (GOST 6370) and copper strip test (GOST 6321) were determined.

A prophylactic agent for dust suppression and reducing losses from blowing petcoke upon receipt, as well as against the freezing of coke, sticking during transportation at negative temperatures has been developed on the basis of residual refined products. The process of freezing and sticking to the surface of the gondola cars when watering coal and applying anti-freezing agent is simulated at a temperature of minus 25°C. The sequence of modeling the process of freezing and sticking of coal to the walls of gondola cars.

It is established that the proposed prophylactic agents do not exhibit corrosion aggressiveness with respect to metal surfaces, do not contain mechanical impurities and water. Samples have sufficiently high flash points that meet fire safety requirements. Also samples are characterized by low pour points allowing them to be used at ambient temperatures below minus 40°C. The proposed samples are not inferior in performance properties to the analogue "Niogrin-PS 35S" and cheaper than it more than three times. Prophylactic agents can be effectively used as prophylactic agents against freezing, sticking, for dust suppression and reducing losses from blowing petroleum coke and coal.

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DEVELOPMENT OF AN AIR-CLASSIFIER FOR THE CLASSIFICATION OF CRUSHED AGGREGATES

In the course of the processing of aggregates, e.g. for use in asphalt production, aggregates are being comminuted. The aggregate product is often crushed to sands with a grain size range of 0µm to 5000µm. In the crushing process, as well as in conveying processes, a part of the natural stone product is inevitably crushed to a grain size of below 63 µm. This grain size range is called rock filler. In natural stone sands this filler content can be more than 20%. A high filler content results in a high pore content during asphalt production, as the fine material triggers a sponge effect. This high pore content favors the weathering of the asphalt during frost-thaw cycles by the penetration of water into the pore spaces. In order to avoid this disadvantage as far as possible, the filler content of the aggregate sand used for asphalt production should be less than 10% (normally approx. 7%). However, no further filler should be removed from the aggregate product beyond this limit, as this filler content can be sold as a product without any loss in quality.

After the introduction, this paper will give an overview about the state the art and show that the current processing possess the disadvantages of being too large in size, while being too low in production.

The third part of the paper will illustrate the functionality of the system. The aim of the system design is toeffectively reduce the filler content, while being small enough in size to be e.g. integrated at belt transfer stations. To realize this, the machine utilizes a dispersing unit. This dispersing unit is a novelty in contrast to other state of the art equipment. It is used to generate the necessary airflow as well as to disperse agglomerated grains. This combined effect allows the classifier to handle larger mass flows while remaining energy-efficient at the same time.

The fourth part describes the current state of experiments include the testing of several parameters on the classification efficiency. Such parameters concern the settings of the dispersing unit, the airflow, the size of the classification zone and the amount of material input.

This report finally concludes by summarizing the recent developments and giving an outlook on further developments for an industrial application.

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DEVELOPMENT OF ACOUSTIC EMISSION METHOD OF ASSESSMENT OF THE RISK OF SPONTANEOUS COMBUSTION AND THE REDUCTION OF CONSUMER PROPERTIES OF COAL UNDER THE INFLUENCE OF CLIMATIC FACTORS

Most of the coal producers in Russia are concentrated in the regions classified as permafrost and seasonal frost zones. Frosty weathering which is characteristic of these zones leads to the development in the coal of a grid of cracks acting as channels for the migration of air oxygen into the coal substance. With the increase in the number of such channels, the rate of replacement of inert gas medium initially contained in the coal material by the oxygen-air increases. Oxidation processes are activated in the areas of coal exposure in the massif and in stacks located in open areas. This is accompanied by a decrease in the consumer properties of coal products (for example, calorific value), as well as an increase in the risks of their spontaneous combustion.

Traditional methods of studying the state of coal are marginally usable for its express control and monitoring due to the low speed of data acquisition and processing, the high labor intensity of measurements, the need for cumbersome and requiring special conditions equipment, etc. This precludes using of traditional methods in the field. Accordingly, in order to promptly obtain information about the state of coal and to determine optimal measures to reduce the risks of its spontaneous combustion, as well as to determine the storage period, it is necessary to develop new methods of control.

In this paper we propose an innovative express method of thermal acoustic emission control of coal products suitable for implementation directly at coal mining and storage sites. The methodological approaches have been developed that allow during the work shift to both take measurements and perform processing and interpretation of the results. It allows to monitor on an operative basis the impact of the process of frost weathering on coal, to track and to predict the deterioration of its consumer properties. It also allows to choose the optimal plan of preventive measures in order to ensure the long-term preservation of consumer properties of coal, to identify at the initial stages the areas of development of destructive processes and to prevent their transformation into the sources of spontaneous combustion.

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STRENGTHENING AND SOFTENING BEHAVIOR OF THE MAGNESIUM ALLOY MG-6.8Y-2.5ZN-0.5AL

Abstract

Mg-Y-Zn alloys containing LPSO-Phases (Long Period Stacking Ordered) have received tremendous attention in the last decade due to their extraordinary mechanical properties. The basal plane of LPSO structure is equal to the (0001) of α-Mg, however, the stacking sequence is elongated along the c-axis compared to pure magnesium, for example an 18R structure with a stacking sequence of ABABCACACABCBCBCABA or a 14H structure with a stacking sequence of ABABCACACACBABA [1].

Previous studies have shown that the property and characteristics of LPSO structures and their interface with magnesium matrix could affect the prevailing mechanisms during the forming process [2]. The strengthening and softening behavior of Mg-6.8Y-2.5Zn-0.5Al alloy is characterized based on flow curves accompanied with microstructural analysis. The hot forming behavior of Mg-6.8Y-2.5Zn-0.5Al alloy is investigated through plain strain compression tests at temperatures from 300°C to 500°C, with an equivalent strain rate of 0.1s-1 and equivalent strain of 1.0.

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DEVELOPMENT OF A SELF-MOVING MODEL OF INDUSTRIAL IOT COMPLEX OF UNDERGROUND SCANNING

The work is devoted to the study of the capabilities of the hardware-software platform Arduino to create a prototype of a self-propelled scanning device underground space.

The aim of the work is to simulate a self – moving scanner of underground space within the framework of the industrial IoT concept based on the Arduino software and hardware complex. The algorithm of the model motion, scanning of underground space in one plane is described. Solved problems of motion, positioning, collecting and processing data, constructing the digital space. It is concluded that it is necessary to create a prototype of a self-moving 3D scanner.

The implemented prototype fits into the concept of industry 4.0 [1], which involves the construction of “smart mines” through continuous monitoring of process parameters using various sensors. Prototyping systems for collecting and processing information from sensors requires a hardware and software platform. The platform should meet the requirements of low cost, prevalence, scalability and ease of development. At the same time, such a platform should support modern digital transformation technologies, such as wireless communication, cloud technologies, the Internet of things, etc. Such requirements are satisfied by the hardware and software platform Arduino [2].

As a result of the work lasting more than a year, a prototype of a self-moving ultrasonic scanner was built. The prototype determines its position on the plane relative to the boundaries of the studied room (tunnel or mine model), which allows it to move along the conditional middle line. During the movement, the scanning of the surrounding tunnel and the formation of an array of data on the coordinates of the points of reflection of the ultrasonic wave is performed. The received information is transmitted to the computer with the installed program to convert the array of measurements into a tunnel plan. To build a horizontal section of the tunnel plan, the MathCAD program was selected.

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APPROBATION AND IMPROVEMENT OF INTERNATIONAL METHODOLOGY FOR ASSESSING THE RISKS OF EMERGENCY SITUATIONS ON LINEAR PIPELINES

Evaluation of the risk of an accident at any hazardous production facility (HPF) is an essential element of ensuring industrial safety. [1] In the course of constantly occurring changes in science, the development of technology and the environmental knowledge base, the developed methodology for quantitative and qualitative analysis of technogenic risk, used, among other things, to manage the technical condition and integrity of the linear part of trunk pipelines (LP TP) needs to be refined and continuous update.

Practice shows that the use of quantitative methods of analysis often gives the values of risk indicators, the accuracy of which for complex technical systems is small.[2] The objects of the transport system of the fuel and energy complex of Russia are functioning and are planning to be deployed in conditions of the development of virtually all known dangerous geological, hydrological and other natural processes, as well as anthropogenic and technological.[3] These processes are characterized by a variety of impacts on the linear part of trunk pipelines, which lead to an increase in the frequency of accidents. For an accurate analysis of the risk of an emergency at the LP TP, it is advisable to take the values of the coefficients reflecting the impact of factors taking into account Russian realities. On this basis, with a strong impact, it is necessary to increase the coefficient, and with a slight effect - to decrease.

At the stage of identifying hazards, qualitative analysis methods are used, based on a well-thought-out procedure, special aids (questionnaires, forms, questionnaires, instructions), and practical experience of the executors. Ignoring incidents is unacceptable, since it is their totality that is the basis of major accidents. In order to prevent exposure to hazardous situations at the facilities of the fuel and energy complex, the Check-List album questionnaire, adapted to Russian realities, is proposed. The structural elements of this risk assessment method include general questions that are in an affirmative form, taking into account the full possibility of assessing the specific proportion of factors affecting the integrity of the LP TP. The proposed methodological approaches to assessing the risk of operating the TP can be used to create a unified automatic database for predicting and recording incidents and accidents at fuel and energy complex facilities, followed by writing a program.

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INTEGRATION OF MICROPLASMA SENSOR CES INTO OIL AND GAS INDUSTRY AND MINING INDUSTRY

The microplasma sensor CES developed by a plasma research group at the Saint Petersburg Mining University is a multifunctional device with unique characteristics that allowto use it in various industries. The mining industry is not exception. With the help of the CES detector, which is based on the method of electron collisional spectroscopy, it becomes possible to do drilling and blasting operations and make an aeroecological map. The sensor registers the concentrations of the specified molecules in the air and compares it with the established normal values. Such an approach to drilling and blasting operations reduces the risk of emergency and allows the sensor CES to become a portable personal protective device for stuff at a hazardous industrial mining facility.

By now, the following results were achieved in the framework of scientific research.

A schematic diagram of the VUV photoionization detector has been developed with a source of ultraviolet photons as a miniature gas-discharge tube; this tube has been made with MgF_2 end window and has been filled with Kr-He mixture to generate the resonance radiation of krypton on the 116.48 nm atomic lines (10.64 eV) and 123.58 nm (10.03 eV); a cylindrical cathode and an anode have been mounted inside a 16 mm glass bottle, the radiation has been discharged through the end of the anode; discharge voltage has been 450 V, burner voltage has been 220 B, discharge current has been 3 mA, consumed power has been less than 1 W. Operating modes have been selected, namely in the gas-discharge chamber there has been an inert gas under pressure from 102 Pa to atmospheric one, the discharge voltage has been 300-500 V, the current has been about 10 mA.

Based on the microcontroller ADuC 841 a model of a microprocessor system has been manufactured and assembled; it has controlled the power system for the discharge ignition in a constant mode on a high-voltage DC-DC converter, block of step-by-step digital scanning of the delayed voltage in the range 0-5 V with a scanning step of 0.01 V, an ADC that provided digitization of the photocurrent with a frequency of up to 300 kHz and averaging the samples obtained. The software for the ADuC-841 microcontroller has been developed in the Assembler language, that provided an opportunity for the operator to determine the scan limits of the cathode voltage, the scanning step, the duration of the photocurrent measurement interval at each scan step and the number of repetitions of the photocurrent.

The grafen coating of the electrodes have become an innovation, that made it possible to reduce the work function of electrons to 1 eV.

The proposed CES method has allowed us to develop an individually portable gas analyzer with a retail price of about $800, while comparison CES detector with the cheapest gas analyzers that have a similar technical complexity shows that this price will look very attractive.

Further development of this study involves a reduction in dimensions and an increase in the accuracy of the device.

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A FEASIBILITY STUDY FOR THE QUALITY OF ORE OF ERDENET OPEN PIT MINING

A number of scientists has been investigating the opportunities to improve effectiveness of mining-spike processes and resolution of ore quality.

It seems to seek the weakness of the “Erdentiin Ovoo” copper-molybdenum mining concentrators, due to various reasons such those mutual dependence of main process of digging, loading, transporting, crushing and enrichment, content of averages, supply of ores, loss of mining regimes, increase of metal waste, permissible toxicity balance sheet. Moreover, establishment of ore tactical warehouses and rationalization of management can be possibility ways that increases of technical works, reducing their own cost of production, minimize inefficient costs, stabilizing ore volume and content, and controlling toxicity balance.

A crucial result of this study displayed that the method and strategy warehouse can be established to manage quality of ores in the copper-molybdenum, ore grades and following millimeters of all stages of process.

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IMPROVING THE EFFICIENCY OF OPERATION OF CAREER CAR DUMP TRACKS.BODY MODERNIZATION

The durability of the body of a dump truck depends on its design, as well as the peculiarities of the process of unloading rocks from the body.

On dump trucks of leading world manufacturers, a tipping bucket body is used. The disadvantage of this design is the increased wear of the inner walls of the body when unloading abrasive rock.

Body dump truck of bucket type with a protective visor is known , in which the bottom is made of rubber with a thickness of 50-60 mm, supported by interchangeable transverse polypropylene ropes attached to the sides of the body. Also tipping bodies of bucket-type mining dump trucks with a protective visor are known, in which the inner walls of the bottom and side boards are lined with metal or rubber sheets.

The wear of the inner walls of the body when unloading abrasive rock can be significantly reduced due to the fact that the inner walls of the sides and the bottom are made corrugated.

The authors have developed two ways to improve the process of unloading rocks from the body: changing the shape of the bottom of the body in therear open wall; increasing the intensity of movement of the cargo along the bottom by reducing friction.

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MULTIVARIATE EVALUATION OF THE STATE OF "ARRAY - FOUNDATION" IN THE SIMULATION SOFTWARE PLAXIS

Important tasks in the construction of facilities is to prevent emergency situations, which is laid at the initial stages of design and in the analysis of the geotechnical conditions of the area.

Very relevant is the task of assessing the natural stress-strain state of an array of rocky soils and determining the choice of technical solutions. The purpose of this work was to simulate the stress-strain state with different schematization options and then compare the results.Methods of modeling in the study of engineering and geological processes require the simplification of natural conditions to create a design scheme.Many deposits of the Quaternary period - the upper technogenic deposition of sand with the index tQ, and the lower ones numbered 1, 2, 3 with the geological index aQ4 are represented by the sand of light gray, fine-grained, loose, partly mixed with fine gravel and pebbles.The studied massif is composed of sandy soils; it is classified as non-uniform due to the strongly different physicomechanical properties.

Next, a schematization of the analyzed array was performed.Itwas made in two versions.

1. With the maximum degree of compliance with the geological structure of the array while maintaining heterogeneity;

2.With the transition to a layered structure of the array of soils with smooth linear boundaries.

The foundation draft was calculated in two cases. The first of them is a detailed geological section, the second - the geological structure was simplified to a layered environment with even boundaries located at certain angles to the horizon.

Naturally, the decisive question remains the matching of the correspondence of the time spent on the simulation of the model to the accuracy of the result. Also for modeling the stress-strain state an important role is played by the accuracy of the data obtained during engineering geological surveys and the obtained values of the physical and mechanical properties of soils.

According to the obtained results, it can be concluded that the schematization of natural conditions for the considered soil massif influences the obtained results not more than 3.6%.

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EVALUATION OF HYDROCARBON POTENTIAL OF EASTERN KAMCHATKA BY THE RESULTS OF MODERN GEOLOGYCAL-GEOPHYSICAL RESEARCHES

The purpose of providing hydrocarbon raw materials to such a remote region as the Kamchatka has always been relevant. In the 80s of the last century four small gas fields were discovered in Western Kamchatka, other hydrocarbon sources haven`t been identified here. Taking into account the limited amount of proven gas reserves of these fields and the growing energy needs of the region every year, the problem of preparing new volumes of reserves is still extremely topical, which requires detailed exploration and previous regional exploration.

A large amount of geological researches has been carried out on the land and offshore of the Kamchatka over the past decade. On the land of Eastern Kamchatka, two parametric wells were drilled – Liginmynskaya (2012) and Ust-Kamchatskaya (2017). In the period from 2012 to 2017, comprehensive geological and geophysical researches were carried out in the Bering sea, covering the Khatyr, Anadyr, Olyutor and Ilpin sedimentary basins, and also on the offshore of the East Kamchatka basin and the Northern part of the Kuril Islands in the Pacific ocean.

The complicated geological structure of the region was established by the results of two wells drilling. Uncovered section of Liginmynskaya well differs sharply from the project section. As the result, the Cenozoic cover is not fully explore. According to the results of studies of the Ust- Kamchatskaya well, layers with increased filtration and capacitive properties were located, which indicates the presence of possible reservoirs over here. [1, 2].

By results of geological and geophysical researches on the offshore the average thickness of a sedimentary cover reaches 4 km, and in some depressions it is more than 6 km. The possible focuses of hydrocarbon generating were determined, and the anomalies ΔF (fluid factor) and AVO-anomalies indicate the presence of hydrocarbon reservoirs. About 200 local objects are allocated, some of which are marked by favorable conditions of accumulation and preservation of deposits [3].

To create a single model of the geological structure of the region, it is necessary to conduct general studies in order to link the results of land and sea researches with the subsequent allocation of zones of possible oil and gas accumulation. The lack of objective grounds for the transition from the regional stage to the search stage today makes Eastern Kamchatka not too attractive for potential subsoil users. However, it should be noted that a significant amount of research gives every reason to suppose the presence of oil and gas systems. A thorough analysis and generalization of all available geological and geophysical data will help to allocate the priority objects of licensing, which should eventually lead to the discovery of hydrocarbon deposits here.

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EVALUATION OF BLAST-INDUCED GROUND VIBRATIONS IMPACT ON OVERHEAD ELECTRICITY POWER LNES

The evaluation of blasting operations influence on the stability of constructions of various types situated on the border quarry territories is considered to be a crucial task for mining enterprises. At the moment, the development of some deposits is complicated due to the proximity of the overhead electricity power lines to the excavation front or when they are a part of the electricity supply system of a quarry. The following enterprises face with such a problem: Afanasevskoye deposit of cement raw materials (HV line 110 kV), Borshevskoye deposit of construction materials at Kaluga region (VL line 35 kV), Olimpiadinskoye deposit at Krasnoyarsk area (VL line6 kV), etc. There is a set of studies devoted to various aspects of electricity power lines supports behavior under various types of loading including the combinations of climatic loads, the rupture of insulators or cables [1,2], vibrations due to earthquakes, structural behavior of spun-cast poles, steel and polymer with the prestressed reinforcement, dynamic performance of the supports.

The dynamic blast-induced loading of such type of a construction may cause the build-up of oscillations exceeding maximum allowable amplitudes provoking jump-up of a construction as well as each cycle of dynamic loading results in occurring of the residual deflections of a pole which may consequently lead to the loss of stability. The objective of the performed studies was to determine the reaction of a pole under blast-induced loading.

The time-history analysis on the basis of SimuliaAbaqus simulation platform was applied [3]. As the result, the three-dimensional model was created; the application of the model during dynamic analysis allowed to calculate the values of maximum and residual deflections of a pole (HV line 110 kV) as well as the values of build-up oscillations under blasting loading. The main parameters of seismic waves influencing on the value of the residual deflection of a pole and its build-up oscillations was found to be the amplitude and number of delay groups in case of waves superposition. Also the issue of soil characteristics influence on the dynamic behavior of the pole was considered in the study. The scientific novelty of the obtained results consists in evaluation of the values of maximum and residual deflections of a high voltage pole of 110 kV subjected to the blast-induced ground vibrations with various parameters.

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AUTOMATED GEODESIC MONITORING OF METROPOLITAN STRUCTURES DURING THE COLLECTOR

In modern, dynamically developing megacities, one of the important factors in the constructionand renovation of various buildings and structures is the laying of new or transferring existingengineering services. Particular attention is paid to the production of this type of work in the historic part of the city, in which the buildings and structures in use were built more than 60 years ago. During the period of operation, from the moment of completion of the construction to the present, deformations have accumulated in the structural elements of the structures, which have weakened the structural structures of these buildings and structures to varying degrees. [3] This report examines the work on monitoring the building structures of the Moscow Metro facilities, performed by employees of Triada-Holding CJSC, during the shield tunneling of the collector tunnel under the current double track distillation tunnel of the Sokolnicheskaya line from art. "Library. Lenin" to Art. "Kropotkinskaya". The collector route crosses the double-track distillation tunnel perpendicularly, the centerline of the metro route is located at PK15 + 15.7 of the collector route. [1]

Performed work on the shield sinking are unfavorable factors affecting the objects of the metro.

To solve this problem, a monitoring project was developed and agreed upon, including the installation of an automated geodetic monitoring system. In addition to the automated geodetic measurements, it was decided to perform periodic manual geodetic and visual observations of the height displacements of the deformation marks. [2]

As a result of the complex of automated and manual measurements of the negative impact of work on strengthening the soil massif and driving the collector tunnel on the structures of the Kropotkinskaya distillery tunnel, the Lenin Library was not recorded. Structures are in working condition and can be operated in a regular mode. Conducting automated observations in the future is not required.

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MINIMIZING THE SEISMIC EFFECTS OF BLASTING WORKS ON THE ENVIRONMENT IN THE MINING OF RAW MATERIALS

Vibrations caused by blasting works effects not only on buildings but also on the inside environment of the buildings. If these buildings are situated in the surroundings of quarries, the citizens can feel these vibrations negatively. With suitable milliseconds timing interval, it is possible to lower the intensity of vibrations at the levels that the citizens will not feel negative effects inside buildings.

Experiments confirmed theoretical assumptions that lowering the intensity of vibrations under 2 mm/s, the citizens are not complaining about vibrations. The results of the experiments were confirmed in the practice of blasting work. Systematic measurement of seismic effects in blasting is an inherent part in detecting adverse effects on the surrounding environment. On the basis of the measured values, we are able, if necessary, to carry out operational measures to optimize blasting performance.

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THE APPLICATION OF SIMILARITY THEORY ELEMENTS IN GEODESY

The aim of this work is to draw an attention of specialists to the potential usefulness of thesimilarity theoryin solving various geodetic problems.Using the theory of similarity provides an opportunity to solve several practical geodetic problemsin a completely new way. Asit is possible in geometry to determine the height of the tree or the width of the river using the theory of similarity of triangles, and in geodesy as well (in other science also), there is a possibilitytocalculate the values of measured parameterswithout equalizationeven if they contain a systematic or input values errors.

The concept of similarity theory can be extended to any physical phenomena, but it is very important to ensure that system's parameters where the phenomena occur are unchanged or factors which are affecting changes of the system are considered. It should be mentioned that parameterswhich are considered in such phenomena must be homogeneous (having the same physical meaning and the same dimension), and the phenomena themselves have a strict mathematical description and considered at similar points at similar time. In other words,the value of the parameter in one system will correspond to the value in another system.

According to one of the theorems of this theory, the similarity of two physical phenomena means the similarity of all parameters which are characterizing the phenomena under consideration. The ratio of these values is given by the following equation (1):

$$\frac{P_i}{R_i} = m_i \,, \qquad (1)$$

Pi, Ri - similar parameters, mi- similarity index, or scale of similar parameters.

The similarity index does not depend on coordinates or time. In this case, each physical quantity has its own similarity index andthey are different from the others.Thus, using dimensionless quantities allows to get rid of systematic errors which is linear relative to the measured value.

This technology has been used in order to solve following tasks: determining the coordinates of a point from three-point resection, determination of object deformations using linear measurements along profile lines, calculating rectangular coordinates using the technique of traversing.The most significant result was obtained by solving the problem of deformation monitoring. It was found that this technology completely ignores the quality of positioning of the initial points, and deformation marks.For instance, in our example they were obviously erroneous more than 1.5 m.Nevertheless, the calculated displacement was correct, and it is the most importantthing in the study of deformation processes.

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ULAPh (ULTRA LOW ALTITUDE PHOTOGRAMMETRY) AS AN ALTERNATIVE PHOTOGRAMMETRIC METHOD OF ARCHAEOLOGICAL DOCUMENTATION

This paper concerns research work aimed at developing DTMs and orthomosaics of archaeological sites without using aerial photographs from UAVs (Unmanned Aerial Vehicles) [1]. It is widely known that comprehensive documentation of these places before the beginning of its archaeological exploration is a particularly significant assignment. Authors present the comprehensive methodology of conducting surveys and the outcome of the research aimed at determining the accuracy of photogrammetric products. Moreover, the optimisation of the photogrammetric control network as well as the quantity of photos is outlined.

There were two archaeological sites in South Jordan under investigation: the Roman fort in Dajaniya and the ancient city of Tuwaneh. These places were the main research objectives of the BARI - Buildings ARcheology Inventory project. Highly restrictive legislation in Jordan turned out to be a trigger for replacement widespread airborne drones – there were no permission to import and operate UAV. Therefore, the alternative method was enforced: all the essential data were collected using a GoPro camera mounted on boom. This technique was named 'ULAPh' which stands for Ultra Low Altitude Photogrammetry.

Authors conducted comprehensive analyses consisting in determining the accuracy of twelve different datasets. Each of them differ in the quantity of stations, taken photos as well as control points. The reference variant consisted of about 600 stations with 8 photos taken from each station and 51 photogrammetric control points. The most important issue was to choose the most appropriate parameters while maintaining desired accuracy and moderate workload. The second significant issue in this article was a comparison between DTMs derived from different methods: ULAPh, laser scanning as well as classic close range photogrammetry. The reference measurement was executed with FARO FocusM70 laser scanner and classic close range photogrammetry.

ULAPh, as a photogrammetric method of archaeological documentation, allows to obtain satisfactory accuracy and can successfully replace aerial photographs from UAVs. However, the method applied is time-consuming and for that reason not suitable for exploring larger area. Moreover, the optimal overlapping of photos should be ensured.

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THE EMBANKMENT FORMATION FOR CONVEYOR UNDER HARSH CONDITIONS

The development of the unique Udokan copper mining of strategic importance is complicated by avalanche hazard of the territory, permafrost, high (10 points) seismicity of the area, and mudflowspresence.

The most problematic issue under these conditions is to ensure safety of dumps and embankments for transport facilities – conveyor highways andsections of which are crossed by the mountain riversvalleys. The embankment baseis frozen soils with high strength in the period of negative temperatures and ability to convertinto a high plasticity state in summertime. In this regard, there is a need to develop special measures [1] aimed at ensuring the stability of the embankment under conditions of special combinations of loads and impacts.

Studies of a number of scientists [2] justified the increase in stability due to the concave shape of the mining structures plan, creating additional resistance to the displacement of the sliding wedge by forces of lateral expansion. The condition has been taken as a basis for calculation of the retaining prism created in the form of an artificial ridge in the landslide circus [3] for the 'clamping' of the landslide-prone area. In general, the stability factor of the 'clamped' area is determined by the formula [2]:

$$n = \frac{\sum 1/2(U_i + U_{i+1})a_i + F_1 + F_n}{\sum 1/2(T_i + T_{i+1})a_i} \quad (1)$$

where U_i, $T_i$are holding and shear forces on individual profiles defined by the usual way; $a_i$is the distance between two adjacent profiles.

Holding forces on the side of one side edge

$$F = C\ tg^2\varepsilon \sum h_i l_i cosa_i + \frac{1}{2}\gamma\ tg\varphi\ tg^2\varepsilon \sum h_i^2 l_i cosa_i \quad (2)$$

The proposed method makes it possible to establish the required parameters of the retaining prism by calculation, thatallows to providethe embankment stability and proper operation of the ore delivery conveyor installed under conditions of the rough terrain and sharp fluctuations in air temperature.

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CHALLENGES OF MODERN ARCHEOLOGY

One of the greatest challenges of modern archeology is the development of more and more effective methods of documentation of archaeological sites.This is a key issue due to the progressive destruction of sites in the face of human and nonhuman agents. In this paper the study results on establishing a methodology of documentation based on modern technologies like 3D laser scanning and photogrammetry were presented. The research was performed as part of BARI (Buildings ARcheology Inventory) Project. The measurement campaign took place on the 2-16 November 2018 in Jordan. The survey was carried out by 9 geodesists from AGH University of Science and Technology in Krakow and 4 archaeologists from the Jagiellonian University. Objects of measurements were remains of the Roman fortress in Dajaniya and the ancient city of Tuwaneh. Tuwaneh was the city where the influences of the most important cultures of the Middle East intersected: the Romans, the Greeks and the Nabataeans.

During the field measurements a number of measurement techniquessuch as: short-range photogrammetry and terrestrial laser scanningwere used. To achieve this goal, among others, Faro Freestyle,Faro M70 laser scanner,GoPro sports cameras, non-metric cameras, and spherical cameras were used.In turn, the GNSS receivers and the total station were used for georeferencing purposes. The receivers operated in RTK mode with their own base station and in the tested RTX mode.The collected data allowed the elaboration of archaeological documentation and data visualization in the form of three-dimensional models of archaeological objects that provided a spatial database.

As result of the conducted research, the methodology of non-invasive archeological documentation was developed using advanced and developmental spatial data acquisition techniques ensuring efficiency, preciseness, completeness of results and safety of measured objects.The accuracy of the obtained products allows further analysis by a team of archaeologists. What's more, the collected data will be a reference when monitoring the progress of archaeological work on the researched sites and will allow monitoring the activity of thieves on the site of excavations.

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GEOMETRICAL MODEL OF THE HEAD-ZONE OF DEVELOPMENT HEADING TO AIR FLOW CFD SIMLUATION

Ensuring appropriate ventilation conditions in excavations are significant in underground mines. The underground excavations are being ventilated by using circulation system of ventilation, which is provided by main fans. For development headings (blind headings) the air is being provided by separate ventilation systems. The effective ventilation systems have special meaning for development heading, where auxiliary ventilation systems are used. During mining activity in the face zone of development heading (using roadheader or continuous miner) are produced a huge amount of dust, which part of them is suspended in air. In gassy mines during mining activity are also emitted methane, which has bad influence of safety.

Technical safety measures gains significance at the underground workplace, where occurs natural threats. In the paper are presented the geometrical model of the head-zone of development heading with auxiliary ventilation. Model will have been using to conduct the computer air flow analysis. The scope of those analysis will be concentrated on the reduction propagation of dust and maximize the efficiency of ventilation. Model of the excavation with each necessary equipment were prepared according to the polish mining law [1] and the methods applied in Polish mining.

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GEOMECHANICAL MODEL DEVELOPMENT FOR THE EFFECTIVE ROCK MASS STATE MANAGEMENT IN CONDITIONSOF THE OLENIY RUCHEY DEPOSIT UNDERGROUND MINING

The Oleniy ruchey deposit is located in southeast part of the Khibiny massif, from the northeast adjoins the Nyorkpakh depositandrelatedto Nyorkpakhk, Suoluayv and Koashkar mountains. One of the major geomechanical factors defining excavations stability and structural elements stability on the Oleniy ruchey deposit mining method is the high rock mass tectonic stress [1,2]. Due to the absent of the persistent useful mineral concentration in the ore bodies, mining is focused on stopes creation with a trend of pillar size decrease. The aim of the research was evaluation of the rock mass stress-strain state (SSS) in the pillars between stopes taking into account influence of the nearest fault structures and tectonic stresses.

The analysis of therock mass SSS can be carried by using numerical methods, in particular the finite element method (FEM). FEM is the program complex SigmaGT calculation basis allowing to model the rock mass SSS in three-dimensional definition [3]. Influence of mining operations with a trend of pillar reduction on creation of stress concentration areas can be revealed by creation of several forecast modelvariants. Creation of a number of models with various configurations of mining will allow to reveal the most probable dynamic manifestation rock-pressure areas.

For stress-strain state evaluation on the excavation contour, it is necessary to create the local models of both the strike and crosscut directions. As the boundary conditions of the refined model, the nodal displacements resulting from the deposit model nodal displacements interpolation should be calculated. Three-dimensional model will allow to evaluate the effect of a fault structure to the stress vectors direction relative to the excavation roof.

The developed model corresponds to data of in-situ measurements and excavations visual inspection results by level of calculated stresses. Predicted SSS calculations have shown that high concentrations of compressive stresses in the pillar between the stopes do not occur. Dynamic rock-pressure manifestations are most probable in the pillars between the stopes and the fault structure.

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STUDY OF VOLUME EXPANSION OF THE CONCRETE MIXTURE FOR LINING VERTICAL SHAFTS

Vertical shafts are the most complex technical facilities of mining companies, both in terms of their construction and in terms of exploitation [1]. The vast majority of vertical shaftsare fixed with monolithic quick setting concrete, which provides high technical and economic parameters in their construction. The high quality of the work and the observance of the fastening technology should ensure full contact of the reinforcement of monolithic concrete with rocks, to have filled joints between separate sections and to ensure uniformity of the structure, to have no breakages, cracks and other deformations [2].

The parameters of the monolithic concrete reinforcement in the area of technological seams during the construction of vertical shafts of mines according to a combined pipeline scheme are substantiated to improve the technical and economic indicators of their construction and operation due to the sealing of the joints of the concrete crepe with the use of cements expanding into the composition of the concrete mixture to provide the necessary support in the place of the technological seam, which helps to split old concrete with new ones.

In the course of the study, a computer simulation of the interaction of crepes and rock massif in the area of technological joints was performed to increase the strength and stability of the anchorage, laboratory studies of concrete specimens based on expanding slag-portland cement [3] were carried out, which allowed the development of technological regulations for the combined technology of penetration and fastening of vertical shafts.

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THE ANALYSIS OF INTERBED STABILITY WITH MATHEMATICAL MODELING METHODS

The issue of interbed sustainability is actual when «chamber – pillar – interbed» system sustainability period is considered as a whole. With the interbed fracture the height of the pillar increases, that accordingly leads to its degree loading increase and sustainability period decrease. Consequently, both factors, influencing the interbed behavior, and influence of its state on the whole geomechanical system are considered. Nowadays, there is little experience in interbed instrumental observations at Upper-Kama Potassium Salt Deposit [1], but still, the mechanism of interbed behavior as layered structure is identified.

In order to investigate the interbed behavior the complex analysis of mathematical modeling and instrumental observations results are used. Stress-strain state calculation of the interbed is carried out by finite element method in «ANSYS» based on specific rheological model [2], that allows considering separately primary, secondary and tertiary creep deformations. Besides, this model takes into account salt fracture and softening processes [3]. Modeling results achieved are compared with the results of interbed instrumental observations. Calibration of the model parameters is done.

In the conclusion, contingency modeling is done on the basis of obtained results. Diverse graphs of interbed breaking were obtained. With the help of these graphs interbed behavior can be predicted for the certain mine and technical conditions.

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IMPROVING THE EFFICIENCY OF OPERATION OF CAREER CAR DUMP TRACKS. INCREASING THE LIFE OF TIRES

Life time of tires o dump trucks depends on their design and materials used, as well as the conditions and modes of operation of machines.

The analysis shows that the destruction of the layers of the cord and the metal tracker of tires occurs during their long-term operation with a significant excess from the nominal capacity, with increased hardness and abrasiveness of the rocks of the mining field, poor quality of technological roads and areas for loading and unloading of the rock, with the intensity of machine maneuvers in laden condition with extremely small turning radii, as well as severe climatic conditions at the quarry.

As the main directions of increasing the life of tires dump trucks can be identified as follows:

- applying modern synthetic materials with high strength, elasticity and adhesion in combination with steel cord in the design of large tires;
- equipping machines with automatic load weight sensors in the body;
- controlling and managing the internal air pressure in the tires, as well as the temperature in the tire elements during the movement of the vehicle;
- formation of optimal technological routes taking into account the reduction of maneuvers of vehicles in a laden state with extremely small turning radii;
- modernization of unloading dump trucks at the crushing and screening plants;
- development of recommendations for optimization of operating modes of machines, taking into account the climatic conditions at the quarry.

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ASSESSMENT OF METHODS MICROCLIMATE CONTROL IN RUSSIAN OIL MINES

In the Russian Federation, high-viscosity oil and bitumen are produced by underground method through wells drilled from mine workings into an oil-bearing formation. Reducing the viscosity of the oil, ensuring its flow into the well, is achieved by heating the rock mass with steam. The intense thermal action on the oil reservoir leads to the formation around the mine workings, which are used for drilling wells and withdrawal of oil, artificial thermal anomalies that affect the thermal conditions of these workings [1].

As shown by experimental data, the air temperature in the workings - the drilling galleries from which oil recovery takes place, can exceed 30^0C.

The thermodynamic parameters of the mine air are influenced by a significant number of factors, among which thedeposit openingand development systems of the oil deposit, the intensity of oil production and the amount of air supplied to the mine workings can be distinguished [2].

A method for calculating temperatures in the workings of mines has been proposed, on the basis of which thermal calculations of mine workings have been carried out.

Comparison of the results of calculations with the data of field measurements is carried out [3].

The efficiency of using different methods for normalizing the thermal conditions were assessed: an increase in the amount of air, the use of thermally insulated air ducts to deliver air to workplaces, the sale of air through special wells, thermal insulation of the surface of rocks, thermal insulation of the ways of oil transportation to the surface, artificial air cooling [4].

The substantiation of the possibility of providing upper-air safety, in terms of the thermodynamic parameters of air, with increasing length of the drilling gallery from 280-300 m to 1000 m is given.

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GROUND FREEZING – A GENERAL OVERVIEW

Soil freezing is a process in which the soil or the water in the soil is artificially frozen in order to increase the bearing capacity of the subsoil and/or to shield water. The frozen frost body is a water impermeable element with improved static properties. Soil freezing needs to be taken into accounts when extraction resources in areas where permafrost is present or when constructing accesses to underground mine workings like shafts.

This report will present the two state of the art ground freezing methods and lists their advantages.Freezing takes place through vertically or horizontally inserted freezing pipes in the ground. A refrigerant is fed into these freezing tubes. Heat is extracted from the ground by the temperature difference between the refrigerant and the surrounding rock. Either brine or liquid nitrogen is used as the cooling material.Since the first ground freezing in a mine in Wales was carried out around 1862, the process has been continuously further developed.Starting with shaft construction, where water-bearing layers had to be penetrated, the process was adapted to engineering and tunnel construction a few decades ago. Soil freezing, however, does not compete with conventional methods such as sheet piling or groundwater lowering funnels, but acts as an extension of conventional construction methods.A modern field of application is, for example, the freezing of pollutants in the subsurface in order to prevent their spread.

The advantages of ground freezing are not only the absence of pollutants, but also the comparatively simple installation to support construction measures.In summary, it can be said that the frost body reacts sensitively to inhomogeneities in the soil during its freezing phase, therefore it is important to carry out detailed soil investigations in advance. The plant can then be dimensioned using static and thermal calculations.

The frost body can be used both for stabilisation, for improving the strength properties as well as for trapping or freezing pollutants. Soil freezing is therefore a versatile addition to civil engineering. Due to the different processes, soil freezing can be well adapted to the conditions. Since the end of the 19th century, the soil freezing process has been continuously developed and adapted to new problems. New, still little researched areas of application, especially in environmental technology and in dealing with contaminated sites, show that this process is far from complete.

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IMPROVING THE EFFICIENCY OF DUST SUPPRESSION ON THE BASIS OF THE PULSATING VENTILATION

The pulsating ventilation mode proved the effectiveness of increasing the mixing properties of the air flow with low turbulence (low flow rates, near-wall spaces, niches, chambers, etc.) using the example of dynamically active gases (coal mine methane)[1]. The development of the scientific grounds and practical application of this mode for operating in colloidal systems (harmful and hazardous aerosols) in the metals and mining industry at the initial stage of research while transferring the experience to the other industries with clarification of the rational parameters seems promising [2].

At the initial stage, it is practical to study a laboratory model, which will allow you to get an initial understanding of the patterns of mass transfer under aerosol conditions, as well as to perform the research task in an economical way [3]. In particular, it is expected to obtain the physical confirmation of the effect of pulsating ventilation on the increase in the efficiency of sedimentation of soaring dust by irrigation.

This hypothesis is based on the fact that an increase in the turbulence of the air flow allows to increase the number of collisions of dust particles soaring in the air and introduced into this stream artificially during the process of fogging of water droplets or surfactants. Therefore the process is expected to decrease their concentration which will improve working conditions in the industry.

Further development of this method will be based on the industrial experiments which are necessary to obtain the statistical material for refining mathematical dependencies and, on the basis of them, to develop a methodology while taking into account rational parameters of the mass transfer for the specified conditions.

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METROLOGICAL CONTROL OF ELECTRONIC TOTAL STATIONS

Currently, the majority of surveying works use electronic surveying instruments. Their serviceability is reflected in the results of surveying shooting and the accuracy of the tasks, so the problem of metrological control of electronic total stations plays an important role in the initial stage of mining. At the moment, there is a method of checking electronic total stations according to ISO standards, but the impact of the shapes and sizes of polygons on the objectivity of the test results by this method has not been elucidated.

A series of surveys were carried out with artificially introduced errors in the goniometer and anallacticparts of the total station, after which their analysis was carried out to identify the dependence of the test results on the geometric parameters of the polygon.

Errors in distance measuring part were introduced by a change of regular prisms (offset), because the device was measuring distance in accordance with the passport value. Errors in the goniometer part were introduced by shifting the line of sight, thereby simulating the incorrect operation of the goniometer part of the total station.

The sensitivity of different configurations of polygons to rangefinder, goniometer and program errors in the total station operation was studied to identify the most optimal of them – the most sensitive to the above errors.

As a result of the research, the obtuse-angle shape of the polygon with side lengths exceeding 100 m is the most sensitive of those studied during the simplified test procedure, so it's use is recommended to obtain the most accurate results in the metrological control of total stations. Similar studies will be carried out with the further development of scientific work to create a complete methodology. At the moment, the program is being carried out to simplify the processing of the received data.

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REMOTE MONITORING OF GAS DYNAMIC PHENOMENON AT COAL MINES WITH APPLICATION OF MULTISPECTRAL INFRARED CAMERAS

The problem of ensuring the safety and efficiency of mining operations is relevant. This problem has been solved only partiallydespite the existence of many regulatory documents and methodology for predicting the nature and intensity of gas release in mines.

Therefore, it is important to use innovative methods for analyzing the physical, mechanical and chemical processes occurring in the bottom-hole part of the array.

This paper shows the possibility of using infrared cameras in the mining industry, namely, their theoretical and practical use in mines, in places of direct mining operations.

It is known that all objects emit an electromagnetic field whose spectral density is determined by Planck's formula. It is necessary to take into account that the radiation of each component of the gas mixture in mines is observed in a certain spectral range. The use of such multispectral infrared cameras allows not only to identify each gas, but also to determine its concentration, temperature and flow rate. A special set of rotating light filtershas a fast rotation mechanism that allows measurements in real time and all information are recorded in digital form.

Thus, full information about the immediate situation of mass emission and gas-kinetic processes in methane-air mixture can be obtained by measuring during the development of coal seam when measuring methane flow, its concentration and gas temperature in real time [1]. Therefore, the use of multispectral cameras is a promising method for remote monitoring of gas-dynamic phenomena in coal mines.

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ROCK SLOPE STABILITY BY GEOMECHANICAL CLASSIFICATION

The assessment of slope stability in rock poses a particular challenge in geotechnical engineering. Especially in surface mining, in dams or alongside roads, slope stability needs to be maintained not to damage and harm personnel, infrastructure or equipment. This research paper deals with methods to determine slope stability and to recommend rock support. It should give an overview about the basics of slope stability, possible failure mechanisms and classification systems which allow to make a slope stability assessment based on basic data derivable in the field and in the laboratory on the basis of structural geological investigations and core drilling sampling.

The second chapter of the report illustrates the basics of slope stability such as the force equilibrium that needs to be maintained, as well as possible failure modes such as planar, circular, toppling or wedge failures.

To estimate the slope stability as well as the shear strength parameters, it is not representative nor permitted solely to a few rock samples. The whole rock mass needs to be evaluated, especially by considering structural geology, as slope failures often occur alongside joints. For this rating systemsfor rock masses have been developed. The most relevant of these systems for the determination of slope stability is the rock mass rating (RMR) system, which is presented in the third chapter.

The fourth chapter introduces theslope mass rating, which adjusts the RMR system by four factors. The first three factors, which will be multiplied and subtracted from the RMR, describe the joint orientations and the fourth factor, which will be added to the RMR, considers the influence of the excavation method. The fits three factors depend on joint orientation, specifically on parallelism between joints and slope, dip of joints and probability pf joints to “day-light”. The fourth factor relates to the excavation method. Based on the SMR different slope mass classes can be determined. The classes differ from very bad to very good for each 20 points of SMR. The total SMR is 100. For each SMR class, a failure probability and an estimate about a likely failure scenario can be made. In addition a support recommendation can be given.

Based on this systems this report will summarize by illustrating the way to determine slope stability on the basis of the introduced geotechnical classification systems.

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USING OF THE PILLARLESS TECHNOLOGIES DURING THE MINING OF COAL SEAMS LIABLE TO SPONTANEOUS COMBUSTION

Spontaneous combustion of coal is one of the most important problems for modern coal mines [1]. The source of ignition could cause explosion of methane and coal dust. Accidents connected with spontaneous combustion of coal can cause significant economic damage to coal mining companies [2]. This is due to the current high level of concentration of mining. Analysis of accidents connected with spontaneous combustion of coal, shows that the wide range of means of prevention of endogenous fires existing today does not provide the safety of mining coal seams prone to spontaneous combustion and spontaneous combustion centers continue to occur in the mines [3]. The catastrophic results that methane explosions potentially have from spontaneous combustion, indicate that improvement of using technologies is required.

Analysis of the existing coal mines in Russia shows that despite the variety of mining and geological conditions, now mainly flat layers of coal are worked. In most cases mining system by long poles with the preparation of the dual workings is used. When implementing this technology, the coal pillars between workings are left in mined-out space, and they allow to manage outgassing on the extraction area effectively. This makes it possible to provide a high load on the working face [4]. However, research of the mechanism of formation of source of spontaneous combustion in coal mines shows that the pillars in mined-out space is a major cause of accidents.

For safe mining of coal seams, prone to spontaneous combustion, it is necessary to use the pillarless technology. To save the advantages of coal pillars, working of the neighboring extraction columns should be considered in the complex and divided into two stages. At the first stage, pillar performs its functions of gas management and protection of mine workings. At the second stage, during the transition of mining operations to the neighboring extraction column, the pillar should be worked out on the same line with the mining face. For isolation of extraction pillar and safe ventilation of the stalled lava it is necessary to form an artificial strip of non-combustible materials on the border of the excavation of the pillars.

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IMPROVEMENT OF THE PREDICTION METHOD OF EARTH SURFACE DEFORMATION EFFECT ON UNDERGROUND GAS PIPELINES

Pipeline deformations can vary considerably along the lengths in the conditions of multiple undermining. The existing method of gas pipelines strength calculations (taking into account the influence of mine workings) allows to determine the maximum stresses for the entire section of semi-troughs. It is also impossible to determine points where the stress value starts and finishes to exceed the maximum allowable value. This situation often makes it necessary to open the entire pipeline within the borders of the displacement trough, and it requires significant financial and human resources.

In case when gas pipeline crosses the whole territory of displacement trough, stress propagation pattern for the gas pipeline is similar to the horizontal (relative) deformation propagation pattern within the borders of displacement trough where pipe is. According to this, we can use a sinusoid of the pipe stress changes to determine point where stress value exceeds the allowable value. During the calculation it is neccesary to take into account that the pipe outside the trough is rigidly fixed. This leads to the fact that pipe stresses related to undermingoccure at a distance of several tens of meters from the displacement trough boundary.

Also during this kind of calculations it is necessary to take into account the effect of old pipe openings on the position of the maximum stress point. The value of such effect depends on the age of opening and it can vary from one to tens of meters.

The use of patterns like this makes it possible to develop the prediction of the earth surface deformation effect on underground pipelines. This makes it possible not only to reduce the costs which are necessary for the gas pipelines stability on undermined territories, but also to increase safety.

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NEW METHOD WORKING OF DOLOTS FOR BOREHOLES DRILLING DURING THE MINING OPERATIONS

Roller drilling, which has found widespread use in the mining and petroleum industries, has drawbacks due to the limited structural stiffness and high level of vibrations. To eliminate this drawback, single cone bits [1] were used, the peculiarity of which is the presence of one roller cutter mounted on a rigid, cantilever pin. Thus, a single pin chisel with a vertical pin [2], when drilling wells with a diameter of 215.9 mm, showed the best results [3] compared to a three-beat bit. This experience is advisable to use when drilling small diameter wells and boreholes.

The authors have proposed a new way of drilling a bit, which provides for the transfer of axial force directly to the roller cutter and the transformation of the bit case rotational force into the forces of an impact of the drill bit head in another plane.

Comparative tests of the Sh-76 and tricone chisel were carried out on the drilling bench and showed an increase in the drilling rate of 1.9 times, a decrease in the level of vibrations by 5 times, compared with the tricone bit with the same operating parameters. The direction of further research is the substantiation of effective parameters of a bit with a diameter of 42 mm or less.

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RESEARCH OF THE CHARACTERISTICS OF THE BACKFILL MATERIALFOR UNDERGROUND POTASH MINING

Analysis of global salt mining experience shows that the main problems in the development of potash mines are high losses of mineral resources and an increased risk of water inflow through the technological discontinuitiesin water-blocking stratum. These problems canbesolved by implementing backfill into the mining process.

The main aim of the work is to model salt pillars'deformation process and to study how backfilling of the adjacent rooms with crushed salt influences this process.

As the result of the laboratory experiment, relations between shrinkage ratio of backfilling material (crushed salt) and applied pressure wereobtained. Then these relations were used as the initial data for finite-element simulation. The computer model of the stress-and-strain state of a salt pillar was built for different filling ratios of adjacent rooms.According to the results of the simulation, the minimum filling ratio, which ensures pillar's long-term strength and stability, is 0.75.

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NUMERICAL CALCULATIONS OF EVACUATION THE EMPLOYEES AND STUDENTS OF THE FACULTY OF MINING AND GEOENGINEERING OF THE AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

In a case of fire danger in the building the most important issue is fast and efficient evacuation of people. The false alarms are used to estimate the time of evacuation of people and find out how the evacuation process is going, Due to development of new computer programs the evacuation process is increasingly often foreseen with the numerical calculations.

The main purpose of this study is to present and evaluate the results of numerical calculations of evacuation the employees and students of the Faculty of Mining and Geoengineering of the AGH University of Science and Technology.

In this study presented so-called safe evacuation criterion [1] and components of the total evacuation time [2].

The software used for this study is PathFinder program. For the numerical calculations it is necessary to specify simulation environment(rooms, doors, stairs, ramps, etc.) and to create the personal profiles. For this aim it is requisite to define individual traits of each personal profile (speed, shoulders width and the assumed response time [3]).

Due to this numerical calculation the time of evacuation of individual people was determined and the relationship between evacuation time and specific factors was found (distance from evacuation door, number of people and objects in the room, etc.)

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ROCK SLOPE STABILITY BY GEOMECHANICAL CLASSIFICATION

The assessment of slope stability in rock poses a particular challenge in geotechnical engineering. Especially in surface mining, in dams or alongside roads, slope stability needs to be maintained not to damage and harm personnel, infrastructure or equipment. This research paper deals with methods to determine slope stability and to recommend rock support. It should give an overview about the basics of slope stability, possible failure mechanisms and classification systems which allow to make a slope stability assessment based on basic data derivable in the field and in the laboratory on the basis of structural geological investigations and core drilling sampling.

The second chapter of the report illustrates the basics of slope stability such as the force equilibrium that needs to be maintained, as well as possible failure modes such as planar, circular, toppling or wedge failures.

To estimate the slope stability as well as the shear strength parameters, it is not representative nor permitted solely to a few rock samples. The whole rock mass needs to be evaluated, especially by considering structural geology, as slope failures often occur alongside joints. For this rating systems for rock masses have been developed. The most relevant of these systems for the determination of slope stability is the rock mass rating (RMR) system, which is presented in the third chapter.

The fourth chapter introduces theslope mass rating, which adjusts the RMR system by four factors. The first three factors, which will be multiplied and subtracted from the RMR, describe the joint orientations and the fourth factor, which will be added to the RMR, considers the influence of the excavation method. The fits three factors depend on joint orientation, specifically on parallelism between joints and slope, dip of joints and probability pf joints to “day-light”. The fourth factor relates to the excavation method. Based on the SMR different slope mass classes can be determined. The classes differ from very bad to very good for each 20 points of SMR. The total SMR is 100. For each SMR class, a failure probability and an estimate about a likely failure scenario can be made. In addition a support recommendation can be given.

Based on this systems this report will summarize by illustrating the way to determine slope stability on the basis of the introduced geotechnical classification systems

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THE USAGE OF CONTOUR BLASTING METHODS TO ACHIEVE THE INTENDED SHAPE OF THE SLOPE

Research on reducing the impact of blasting works on the adjacent rock formation has been conducted for many years. It is often alleged that good over break control can not be expected in all geological structure [3]. This is sueis mainly related to hard rocks, ie. granite, basalt and sandstone. The article analyzes and describes the possibilities of using contour blasting methods in the limestone mine, so in rocks of medium and low mechanical properties. Additionally, the possibility of using a specialized computer program, which support the desing of blasting works, was analyzed.

The aim of the articleis to present contour blasting methods that will allow to excavate the remaining rock and obtain a targeted shape of slope. The data used in the papercomes from the limestone mine. At first, a description of the selected slope is presented. This will allow to choose the right parameters needed at a laterstage. Next part of the paper describes a main purpose of contour blasting and a detailed description, which includes characteristic features and parameters. Four selected examples of known method sare precisely detailed. Then, on the basis of the blasting documentation, examples of blast works parameters are proposed. As the conclusion of the article, contour effects obtained by blasting works at the quarry are presented. At the end the O-Pitblast software capabilities, in the design of blasting, arepresented.

All types of contour blasting methods have one commono bjective: to reduce crushing, fracturing and overbreak of the remaining rock by reduction and better distribution the energy delivered in the rock mass by expolsives charges [1]. The effect of blasting with the use of contour blasting methods depends on the type of rock mass, iephysical and mechanical properties, geological conditions, occurance of disturbances, discontinuities, cracks, fractures, etc [2]. Preciserecognition of these features will allow to achieve the intended purpose: minimize undesirable damages and cracks, and to ensure a smooth contour beyond the perimeter and high stability [3].

All described methods are still developed and areprimarily based on the experience and research. Carefully design will allow to find the appropriate solution. It is very important to make trial blasting, but also to use good support software as O-Pitblast program. Due to the large number of functions it supports and facilitates the process of designing and foreacasting effects.

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IMPROVING THE EFFICIENCY OF OPERATION OF CAREER CAR DUMP TRACKS. MODERNIZING THE VARIABLE TRANSMISSION

The reliability of the main transmission mechanisms of the dump trucks largely depends on the load of the machine with the rock mass, as well as on the profile of the technological roads.

On modern dump trucks of the BelAZ series with a carrying capacity of up to 90 tons, a hydromechanical transmission (GMP) is used, and larger vehicles (120-450 tons) are equipped with an electromechanical transmission.

Hydromechanical transmission includes a torque converter (GT) and a gearbox (CAT). Two types of gearboxes can be installed on machines of the same series: a four-shaft gearbox with permanent toothed gear wheels in pairs and individual friction clutches; gearboxes with four-stage planetary gears, individual friction clutches and brakes.

As a result of the analysis of failures of the GMP dump trucks, the authors found that the design parameters of friction with the leading elements of gearboxes had a significant impact on their reliability and operational efficiency. Repeated gear changes during one trip of the car in the laden condition are accompanied by intense slipping of the drive disks relative to the slaves and, as a result, they have a negative effect on the thermal regime of the working fluid in the crankcase. Therefore, preference should be given to clutches with a larger diameter and fewer discs.

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KEY ISSUES FOR THE SUPPORT DESIGN IN A DEEP SUBLEVEL STOPING OPERATION UNDER DIFFICULT GEOLOGICAL CONDITIONS

A sublevel stoping system with backfill is applied to extract a mineral deposit at depths of approximatively 900 m. In the current layout longitudinal panel pillars separate neighbouring stopes. Massive inter-panel pillars divide individual mining panels. The role of panel and inter-panel pillars is to ensure the integrity of weak shale layers in the immediate hangingwall. These shales protect the deposit from water-bearing limestone formations and therefore disturbance of the shale must be kept to a minimum. However, ongoing monitoring of pillar and backfill behaviour indicates that panel pillars do not carry significant loads. For this reason panel pillars are going to be extracted in a second step in an experimental section of the mine. To compensate the local roof support of panel pillars it is necessary to adopt the roof and hangingwall support design.

Local and regional geological conditions drive mainly the support design in the considered mine. The rock mass properties vary over short distances due to several tectonic events in the past. Moreover support design must ensure the integrity of the weak shale layers in order to protect the mine from water-bearing limestone formations situated above. For this reason the geological conditions are considered being critical for the success of the test section and a careful planning is mandatory.

The adopted support design comprises the installation of friction bolts for local support and cable bolts for regional support. For the design of the friction bolts in the drifts the Q system after Barton et al. [1] and after Barton and Grimstad [2] is applied. The cable bolt layout is designed after the modified stability graph method [3] and the cable bolt density is estimated after Potvin and Milne [4]. Additionally we conducted numerical simulations with Phase 2 and compare the results with the empirical design methods. The cable bolt design after the modified stability graph method yields a very dens cable bolt pattern, which we consider to be uneconomic. Instead we modify the cable bolt design by means of numerical simulations. The cable bolt density derived by simulations is significantly lower. In order to examine the functionality and performance of the newly designed support system a detailed monitoring programme will be set up.

To sum it up, empirical design criteria provide reasonable results for a preliminary support design. However, the encountered complex geological conditions require additional planning efforts, which are conducted by means of numerical simulations. A comprehensive monitoring programme will be set up to evaluate the support design.

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POSSIBILITIES OF APPLICATION OF SPOIL CONTAINER IN COAL MINE

The current market situation of mine coal, mining plants have problems of technical and economic challenges. Rising production costs and competition on the market in the form of increasing raw material imports force mining management to reduce costs, increase efficiency, reduce equipment failure and reduce employment.

The article presents problems and potential solution in mine coal. In many mining plants due to geological and mining conditions is carried out below the level of accessibility. This model of the mine enforces maintaining a very complex series of belt conveyor, often consisting of 7 or even 10 conveyor belts. Within of working conveyors a failure or an unplanned stoppage of one of them causes the entire production chain to be suspended. One solution to increase production efficiency is to reduce or eliminate stoppages. The application an underground storage of spoil is a solution of this problem. The system of underground spoil storage consisting of belt feeders and tanks can act as a buffer that takes transported spoil from sidewalks or mining walls in the event of failure of the main haulage [1-3].

The underground spoil container allows to limit the downtime of exploitation of sidewalks or walls during failure of the main runway. The possibility of using a tank in the face excavations drilled in gangue allows selective collection and transport of spoil on the Mechanical Coal Processing Plant without contaminating the useful mineral, thereby improving its quality. The improvement of the quality of extracted ore allows to reduce expenditures for enrichment and to obtain a product of higher quality, increasing final financial results [1-3].

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STUDY OF INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITY ON THERMAL CONDUCTIVITY OF GEOTHERMAL INJECTION GROUTS

The study is focused on the issue of filling boreholes used in application of heat pump in the ground - water system and also boreholes used for storage of heat in underground reservoirs. In closed-loop vertical geothermal systems, the material that fills the gap between the borehole wall and PE collector tubes is an essential element of the entire system. When using geothermal energy by heat pumps, the material is called an injection grout. Its function is, among other thing, ensure effective heat transfer between the rock mass and heat transfer medium flowing in PEpipes of the collector.

The subject of research is the influence of time, temperature and relative humidity the tested samples of injection grout on their thermal conductivity. At the conference, there are presented the results of the basic phase of the research, where the main task of the study was to monitor the measured values of thermal conductivity at various temperatures (-5 ° C, 5 ° C, 20 ° C), simulating the conditions of temperature variation at different depths, caused by climatic, geological and technical influences. After this initial measurement, identical samples were then placed in a climatic chamber where they were exposed to 45 - 85 °C under two relative humidity states, namely 40 % and 60 %. Based on the obtained results, it is possible to propose optimal injection grouts for filling boreholes for heat pumps (tested temperatures -5, 5 and 20 ° C) and boreholes for storage of heat in underground reservoirs (tested temperatures 45 - 85 ° C).

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THE ESTIMATION OF THEROCK MASS STRESS STATE OF THE ZHDANOVSKOE DEPOSIT, JSC "KOLA MMC"

The Zdanovskoe deposit is apart of the Pechenga ore field and located at the North-East of Murmansk region. The deposit is developed by the underground mine "Severny", which is owned by the JSC "KolaMMC". There are several factors that affect mining conditions, such as: increase dintensity of mining, a large depth of working sand the applying of the open stoping mining method [1]. So, the issue of studying of the rock mass stress state of the Zhdanovskoe deposit isimportant. The study on the Zhdanovskoe deposit has been carried out by several researchers over the years. The researchers have determined that the rocks of the deposit are strong and capable to accumulate elastic energy, which may be released as dynamic failure under certain conditions and affects the safety of mining. In the article [2] it was noted that the vertical stresses are dominant.The researchers in work [3] have noticed that the value of horizontal stresses is higher than the value of vertical stresses about 30%.

In this work considers the Central ore body, which is the largest sheet like ore body of the Zhdanovskoe deposit with a maximum thickness of 90 meters and average angle of 51º. At the first stage of study visual observations of excavations and numerical modelling were carried out.

As a result of visual observation, it has been found that the main failure is located on the roof or on the coupling of roof and wall. Mainly the failures were observed in the excavations which were located in the zone of bearing pressure.The sings of a rock pressure in the dynamic form of excavation failure have been indicated in deep horizons.

The 2D numerical model of stopes in the Centralore body was developed to estimate the rock mass stress state. The modelling was performed by using a finite element method in elastic conditions. Two types of the field stress were considered: gravity and gravity-tectonic. Comparison of the visual observation sand numerical modelling results showed that the hypothesis of tectonic stresses with value shigher than vertical was the best explanation for excavation failure in the Zhdanovskoe deposit. The assumption of tectonic stresses was confirmed by thein-situstudies results of the rock mass stress statein the Zhdanovskoe deposit [4]. Therefore, it has been found that significant horizontal stresses exist in the rock mass and that phenomenon may affect the stability of excavation and mining safety.

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SOME INSIGHTS INTO THE EXTRACTION OF PLACER GOLD IN GERMAN GRAVEL AND SAND DEPOSITS

Germany is a primary producer of raw materials like lignite, salt and a wide variety of construction materials. In recent times there are efforts to separate heavy minerals as byproducts of the gravel and sand industry. Among them placer gold belongs to the most valuable constituents and induces endeavors to separate it economically [1]. The presentation delivers a short overview of the current placer gold extraction in Germany.
Public knowledge about placer gold extraction in Germany is sparse. There are four plants, where gold production is regulated by official permissions. But at many other places hobby gold miners have installed mats or carpets, which allow extraction of a part of the placer gold. The efficiency is mostly low because of long time between cleanups, a lot of manual work, inadequate processing variables (fluid flow, inclination of sluices etc.). The German gold production by these simple methods in 2017 was estimated at about 25 kg [2]. Compared to gold produced from "real" gold deposits (with gold as prime product) this may appear negligible. But special importance deserves the fact, that this amount was extracted economically from matter with a grade of 3 – 10 ppb. Applying some experiences of the extraction technologies for gold from the low-grade German gold bearing gravel deposits to other world-wide gold deposits of placer type could help to significantly improve the efficiency of their utilization.
This applies especially for a (semi)automatically working sluice with a short cycle time (one hour) where the mean gold content is about 3 ppb [3]. In contrary to that, batch-operated gold extraction – predominantly by sluices – in most German gravel deposits works with cleanups in the range of days or weeks. One reason for that situation is the cumbersome manual replacement of the heavy carpets or mats in the sluices. But because of lowering ability of sluices to store heavy minerals by rising feeding times this means a more or less loss of gold.
Automatically working gold extraction technologies on the one hand could improve this situation. On the other hand installation of such a device would require an official permission. Until now especially small companies shy away from this step and prefer the easier way to get at least a part of the gold by concealed activities of private persons.
Therefore in future a more professional, increasingly automated by-product extraction of placer gold and possibly other valuable heavy minerals will be probably executed preferentially in bigger enterprises with a portfolio of own gravel and sand deposits, a better financial and personal background and competent experiences in the cooperation with state authorities. Especially at international enterprises the export of these technologies and knowledge into other countries and adaption to deposits of different gold grades may act as a driver for the better utilization of natural resources.

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NUMERICAL SIMULATION OF OVERPRESSURE PROPAGATION OF METHANE/AIR EXPLOSION IN NATURAL GAS COMPARTMENT USING FLACS

With the rapid development of China's urbanization in recent years, the urban utility tunnels have been vigorously promoted by government, which have been constructed more than 2,000 kilometers since 2016. Urban utility tunnels include natural gas compartment, comprehensive compartment, high voltage compartment and drainage compartment, which have become an important approach to solve the problem of the layout of various pipelines and facilities in the city. However, in natural gas compartment, the leakage of natural gas pipeline would result in a certain hazardous zone where explosion might occur and lead to serious consequences. Therefore, it is of great significance to investigate overpressure propagation of explosion and the explosion prevention of natural gas compartment in urban utility tunnels.According to existing studies, Canto-Perello et al. sorted out the hazards involved in the operation space of the urban utility tunnels and analyzed the risk of the major threats to the urban utility tunnels [1]. Zhang et al analyzed the fire risk types and characteristics of urban utility tunnels [2]. Li et al studied the propagation characteristics of premixed gas flame under different blocking rates [3]. Most of the previous researches focus on gas combustion and explosion in ordinary tunnel without taking complex obstaclesand ventilation conditions into consideration. However, natural gas compartment is equipped with several facilities and dynamic ventilation exists in natural gas compartment which has a great impact on the explosion process.

The CFD software FLACS was used for the simulation of methane-air explosion, investigating distribution of overpressure with Navier-Stokes equations and the propagation characters of flame. The complex barriers of facilities were set and the dynamic ventilation were realized by the leakage model. To study the characteristics of methane overpressure in different lengthsof fire compartment, the 100m, 200m and 300m long fire compartments were investigated for simulation. The effects of different ignition positions on methane-air explosion overpressure werestudied bycomparing the data of five samplepoints innatural gas compartment.

The results show that the flame profile changes regularly, which mainly contains five stages (semicircle flame, irregular flame, plane flame, inverted triangle flame, irregular flame). The overpressure was in the range of 8.81 bar - 25.17 bar with the consideration of multi-facilities and dynamic ventilation in utility tunnel. The maximum overpressure change of the five monitor points with five different ignition positions were basically symmetrical to about 100 meters.In addition,the change ofaverage overpressure at the five monitor points of the fire compartments were:100m>200m>300m.

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ASSESMENT OF THE CONDITIONS OF THE UNDERMINEDWATER-RESISTANT ROCKSAT POTENTIALLY DANGEROUS AREAS OF THE POTASH-MAGNESIUM SALT DEPOSIT

The development of potash-magnesium deposits in Russia by underground mining iscarried out by pillar-and-room systemwith supportingroof on non-yielding pillars. This mining method is characterized by high losses, however, it is necessary to preserve the integrity of the water-proof stratum and reduce the risk of water and brines inflow into the mined-out space.

Geological surveying observations at themining fields of potassium-magnesium deposits allow to determinepotentially hazardous areas of the breakthrough of brines and water. In the course of this work, some of these potentially hazardous areas were considered, and the condition of the water-proof stratum within their limits was evaluated on the basis of the criterion of curvature of the upper boundary of the water-proof stratum. Researches show that the curvature of the water-proof stratum at the considered sites exceeds the allowable values.

In this paper, possible reasons that lead to the formation of hazardous states of the water-proof stratumare formulated: destruction of the edges of interchamber pillars, collapse of the roof andinterbedroof in the chambers, which lead to the change in the shape ratio of the pillars and reduction of their carrying capacity.

To reduce the possibility (risks) of these processes and the formation of water-conducting channels, a full backfill of mining rooms is recommended.

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APPLICATIONS OF MODERN METHODS FOR BLAST WORKS IN THE CONDITIONS AT THE «DUKAT» MINE

The development of the application of modern technologies in the field of blasting operations is ongoing. The main trends towards their improvement are aimed at improving security, stability and, of course, quality. Despite this, open pit mining surpasses blasting in underground conditions due to many technological factors. Thus, the process of modernization and re-equipment of the complex of blasting operations is much faster. [1,2].

Using the example of the gold and silver mine “Dukat”, a set of measures to improve the explosive works and modern explosive materials and explosives was considered.All this is aimed at improving the quality of underground mining and compliance with global safety trends.

In particular, experimental industrial work on the use of a safer and more stable emulsion explosive, instead of the widespread “Granulit-MP” and granulite “Igdanit-P”, both in the course of tunneling works and in cleaning blasting.Also, the use of electronic initiation systems that allow minimizing the errors of programming the slowdown time, as well as being the safest method of blasting operations to date [3].

According to the results of the experimental-industrial works, it can be concluded that the emulsion explosive makes it possible to better maintain the contour array of the ore body, by varying the final charge density, thereby mitigating the effect of the contour charge. In turn, the use of an electronic initiation system, it is possible to reduce the dilution of the mineral during the selective penetration of ore drifts due to more accurate programming and minimal error of the used detonators..

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ANALYSIS OF DEFORMATION VELOCITES OF EARTH’S SURFACE WITH SPATIAL SCALE EFFECT

For evaluating geodynamic state of the different degree of tectonic activity of the areas required correct assessment of crustal deformation. One of the methods of studying the destruction of the earth's crust is the formulation of observations by global navigation satellite systems (GNSS). The useful of GNSS observations of modern crustal movements allows to collect the most reliable data at different scale levels (local or regional). Analysis of data on the deformation of the earth's surface allows to obtain fundamental knowledge about the geodynamic regime of the studied region or local area, and to assess the engineering state of natural and technical systems.

The purpose of this study – the development and testing of methods for analyzing the rate of deformation of the earth's surface, taking into account the large-scale effect for localgeodynamic polygons. The tasks of the work included: creating a catalog of strain rate data; performing analysis of deformations taking into account their spatial scalability; evaluation of prospects for the application of the results. The effect of reducing the strain rates and their derivatives with increasing the distance between the observation points was studied.

The paper presents the procedure of calculations described the observed distribution and the regression dependence of the strain rate. On the basis of the revealed generalized dependences it is possible to estimate a priori the deformation regime at the geodynamic polygon (either to specify the degree of tectonic activity, or to predict abnormally possible deformations). Estimates of strain distribution for specific intervals of distances between observation points allow to calculate the number (in percentage) of strain rates in a certain interval of their values. And thus it is possible to judge which of the strain rates are abnormal and which are characteristic of the study area.

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THE RISK OF FATIGUE AND DISTRACTION IN MINING OPERATION

Imagine yourself as a responsible person, an engineer and/or shift supervisor in the mining industry. Maybe you are already. Are there risks you can think of, that you are sure of existing, but you cannot tell how imminent they are or how often they occur? In the beginning of this thesis there has been the goal to showcast a problem, that everybody knows and experiences during every day; yet, only a few take care of in their daily routine and safety strategy: Fatigue. But also the topics of distraction, wearing Personal Protective Equipment (PPE) and general safe behavior have been within the focus of this thesis combined with an industry internship. The term "risk" is hard to showcast to people. Every individual calculates risk different. During the research the aim has been, to use safety standards in engineering risk calculation and prevention as well as models of work safety to explain the real risk of an accident happening because of a fatigued operator. Models found, to mention the most important are:

- Permanent load model (LAURIG) [1]
- NOHL risk matrix [2]
- Tripod Model (REASON) [3]

Together with the Zeppelin Baumaschinen GmbH, the contract dealer for Caterpillar Inc. equipment in Germany, a collaboration was formed to use a technical device and change management tools to engage fatigue events in real operation.
During the thesis, different models have been created, to make the explanation of the risk and the single components visible. Data have been checked to make the risks comparable. A real industry partner was found to check the prevention system directly. That all taken care of, fatigue, distraction and conflict with not wearing proper PPE has been reduced. Operators have been schooled in safer behaviour. [4]

Finally, fatigue and risky behaviour can be overcome through understanding. Making the risk visible and creating an understanding is the key to changing operators and supervisors behaviour. Documents for schooling have been created. The aim and target, to help a responsible person to create a safer mine site can be achieved through deeper understanding and the data gathered through a pilot project.

Safe production is always linked to working safety; through prevention and education one can safe investment and benefit.

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GEOTECHNICAL MONITORING OF FOUNDATIONS OF FOUNDATIONS AND CONSTRUCTIONS OF CONSTRUCTIONS ON THE OBJECT MINING AND ASSOCIATED INFRASTRUCTURE ON THE SOUTHERN-ORIENTED SCRONE OF VEDUCHI

The purpose of geotechnical monitoring is to ensure the safety of construction and operational reliability of newly constructed facilities, timely detection of unacceptable deviations in the behavior of newly constructed structures and their bases from design data, development of measures to prevent and eliminate possible negative consequences, as well as preservation of the natural environment.

The main tasks of geotechnical monitoring were:

• systematic fixation of changes in the controlled parameters of structures of structures and the geological environment;

• timely detection of deviations of the monitored parameters of the structures of the constructed object and its base from the specified design values;

• analysis of the degree of danger of the detected deviations of the monitored parameters and determination of the causes of their occurrence;

• preparation of recommendations for the development of measures to prevent and eliminate the identified negative reasons for which they are caused.

Observation network of geotechnical monitoring - installation of devices for monitoring changes in monitored parameters: ground bench markers, wall deformation marks, geodesic marks (film).

To identify the parameters of the movements, and the deformation of buildings and structures, an observational network was created at the facility, and highly accurate geometric leveling of class II of enhanced accuracy was carried out. 6 soil and bench marks and sedimentary marks were laid, to determine the planned coordinates of the bench marks, high-precision satellite measurements were carried out using the relative definition method in the “static” mode.

According to the results of 12 measurement cycles, no unacceptable strain values were detected on buildings and structures. Observations of the foundation slump during the operation of the Veduchi VTRC are made in accordance with the requirements of the PTE: in the first two years of operation - twice a year;in the future, until the basement sediment stabilizes, once a year;after stabilization the sediment (1 mm per year or less) - once every 5 years.

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THE TECHNOLOGY OF DEVELOPMENT OF THIN DEPOSITS OF DIAMOND SANDS IN THE PERMAFROST ZONE ON THE EXAMPLE OF THE SOLUR-EAST DEPOSIT

Diamond is an absolutely indispensable material in the most diverse branches of human activity, ranging from the jewelry and manufacturing industries to the electronic and space industries. All this is due to its unique properties: hardness and wear resistance, high thermal conductivity and optical transparency, high refractive index and strong dispersion, chemical and radiation resistance.

To meet large and very pure diamonds - a rarity. Therefore, the main directions of development of diamonds at present are the introduction of new cost-effective technology options for mining alluvial and small kimberlite deposits, preserving the value of diamonds and more fully extracting them from the field, ensuring environmental safety for the environment through the reclamation of disturbed lands in the development of placers. [1] The field under consideration is located in the permafrost region, the horizontal thickness of the overburden rocks is 25 times the horizontal thickness of the useful stratum.

After analyzing various methods of extraction under the conditions of the SolurVostochny field, a non-explosive, resource-saving, low-cost technology with preliminary thawing of the useful stratum was proposed, which will increase productivity, ensure maximum extraction and environmental safety, and increase occupational safety. [2] Technical and economic calculation and practice of layer-by-layer excavation using mobile equipment (rippers and scrapers) confirm the high efficiency of the field development technology in the permafrost zone, which allows to improve the quality of raw materials and minimize its losses.

In the course of the research done, the influence of the water column on the soil thawing efficiency was determined, the destructibility of rocks was estimated by the seismic wave velocity, and the regularity of the bulldozer's performance on the seismic wave propagation velocity was revealed. [3]

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SOFTWARE AND HARDWARE SYSTEM FOR MEASURING MICRO MOVEMENTS DURING LABORATORY AND GEOMECHANICAL RESEARCH

Strain, magnetic, capacitive, and induction displacement sensors are widely used [1–3]. Accuracy and reliability are inductive sensors of transformer type LVDT [2], the cost of which is high, which limits the scope of their application. Thus, this modern level of development of microelectronics is the main task of developing universal precision microprocessor LVDT sensors and building an automated information-measuring system on their basis.

The authors have developed wireless LVDT sensors with satisfactory accuracy characteristics. Particular attention is paid to the design of the sensitive element of the object of study and circuit design of the microprocessor unit. The basis of the analog part of the processing unit of each LVDT sensor is: a low-pass filter, a controlled current source, amplifiers and band-pass filters, as well as a synchronous detection circuit. The power of radio transmitters is regulated depending on the conditions of use. Interpretation of the data is carried out in the main window developed by the authors of the program.

The proposed approach to the measurement of microdisplacements and the developed automated system for recording the results of an experiment enable the researcher to instantly interpret the data obtained. The next stage of research will be the adaptation of the obtained measurement tools to natural conditions.

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FEATURES OF DRILLING AN INCLINED WELL AT THE SOUTH-WESTERN END OF THE OCTOBER STRUCTURE

The accumulated factual material in the drilling of directional wells in the complex geological conditions of the Hankal heat and power water field will later be the basis for the design and construction of directional wells for water, oil and gas fields in the complex geological structure of the Terek-Sunzhensk oil and gas region.

The project provided for the drilling of 1 production well and 1 injection well. The purpose of drilling is exploitation. Purpose No. 1 DGT was the extraction of thermal waters; No. 2 NGT was intended for injecting thermal waters. Both were planned as directional, borehole number 1 DHT with a maximum design zenith angle of the wellbore 10.0 °, No. 2 NGT with a zenith angle of the borehole 45.0 °. The choice of well design was based on objective geological factors, which include stratigraphy and section tectonics, thickness of rocks with different permeability, strength, porosity, the presence of fluid-containing rocks and reservoir pressure. Well construction No.2 of NGT: - the direction with a diameter of 426.0 mm is lowered to a depth of 10 m in order to overlap the zones of absorption and unstable rocks of the Quaternary sediments, prevent erosion of the mouth, and related complications with further deepening of the well under the conductor.

- the production string with a diameter of 244.5 mm is lowered into the interval of 0-875m, serves to separate the aquifers of the Apsheron and Akchagyl longlines and isolate them from other horizons of the geological well section. Designed to supply the production of water to the surface for the needs of the heating system. The operational column (mesh filter) with a diameter of 177.8 mm is lowered in the interval of 875-1045 m in order to ensure reliable overlapping and operation of the productive horizon.

- when drilling the injection well No. 2 of NGT, the shift of the point of entry into the roof of the project horizon of the XIII st layer from the vertical is equal to 443 m.

More common gets directional drilling. It became possible to extract on an industrial scale oil, previously considered non-removable, due to low power and low permeability of the reservoir. Horizontal wells end up in the reservoir above the bottom water, which allows to extend the period of anhydrous exploitation of fields.

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CONTROLLING THE ACTION OF THE EXPLOSION OF THE BOREHOLE CHARGE DURING THE BREAKING OF FERRUGINOUS QUARTZITES

In connection with the intensification of iron ore mining by open method and the transition to the high ledges, it became necessary to develop such a method of controlling the action of the explosion of the downhole charge of the explosive, in which the crushed rock mass had a given granulometric composition, providing the necessary performance of mining equipment, and the sole of the ledge did not exceed. The solution to this problem is devoted to scientific works G.P.Demiduka, M. G. Novozhilova, N. V. Melnikova[1,2,3].

The study used numerical simulation of the explosion, based on the finite element method. The stages of creating a computational model are described, which consist of the construction ofgeometric patterns, the creation of a finite-element computational grid, as well as the establishment ofinitial and boundary conditions. The Johnson-Holmquist state equation was used as a rock strengthmodel. In order to verify the results of numerical calculations, laboratory tests were performed on aphysical model made of a slab of jaspilites in compliance of the similarity criteria. The dependence is shown of the radial acceleration of the ore body on time to verify the numerical model. On the basis of theverified model, fracture zones and equivalent stress fields were obtained when blasting for variousborehole charge structures [4].

The pilot scale tests conducted within the quarry of Rubikon LLC in the area of the Ilmenioki deposit. Detonation pressure was calculated based on the measured values of detonation velocity. Dependences of detonation pressure on explosives' detonation velocity are shown in this paper. The paper presents a comparison of explosive fragmentation results for various designs of borehole charges made using photoplanimetric analysis. It was established that a quality elaboration of the bench bottom is achieved by blasting the blocks, and the degree of fragmentation is maintained within the specified limits when using a combined design that uses different types of explosives separated by a graded inert gap.

The conclusion is made concerning the efficiency of an explosive impact on a massif of various structures for solving the task of elaborating the high bench bottom. The greatest effect on the development of the bottom was achieved when placing parts of the combined charge in the ratio of 0.3:0.7 of the bench height.

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EVALUATION OF A ONE-DAY AVERAGE METHANE CONCENTRATIONS FORECAST AT THE OUTLET FROM THE LONGWALL VENTILATION REGION AS TOOL OF SUPPORTING SELECTION OF METHANE PREVENTION MEASURES

One of the most common and dangerous hazard in coal mines is methane hazard. Magnitude of this threat in the longwall depends on many factors. Such factors are the geological structure, concomitance threats, reallocation of roof supports and position of shearer, pressure distrubution, daily longwall advance, applied ventilation system and others [4]. Methane concentrations and physical atmosphere parameters measurement and monitoring are made by telemetric systems and manually. This data could be utilized for preparing methane concentration forecasts and researching unusual events [1,3]. Prepared forecast results has been made using autoregressive one-day average and maximum methane concentration forecast models developed in Silesian University of Technology[2]. In both presented autoregresive models, prognosis are performed based on linear equations with parameters estimated for each day of the week. As decriptive variable was used preceding day average methane concentration.

As input data for research were used continuous methane measurement results and daily exploitation volumes from the one of Silesian coal mine longwalls and covers 152 days. One-day average methane concentrations forecast due to the low absolute and relative errors can be applied as a supporting tool for selection of short-term methane prevention measures. This measures includes: increasing air volumetric flow rate through longwall and the proper selection of auxiliary ventilation devices at longwall and tailgate crossing, such as ductless jet fans in the zone of an intense methane outflow, ventilation screens directing the air current in the longwall towards the goaf. Mine ventilation department can also apply organizational prevention measures, such as delaying reallocation of roof supports in the upper section of longwall until shearer reaches proper distance from tailgate. Another way to reduce methane concentrations can be also increasing the underpressure in the methane drainage boreholes or limiting daily exploitation volume.

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REAL-TIME GNSS PRECISION POSITIONING WITH RTX TRIMBLE TECHNOLOGY IN ARCHAEOLOGICAL WORKS

This paper concerns the results of using Trimble RTX (Real Time eXtended) technology in the geodetic works supporting archaeological researches. The studies were carried out as a part of the projects BARI 2017 and 2018 conducted by students scientific association "KNG Daltha" (AGH University of Science and Technology). The main goals of the expeditions were connected with popularization and protection of archaeological remains that are a part of the cultural heritage. Modern geodetic measurement technologies including precise satellite positioning were used to manage this. Therefore, Trimble RTX technology was tested in two different environments - in one of the warmest regions of the Mediterranean – Cyprus and in the desert conditions of Jordan.

The RTX technology has been constantly developing for several years by the Trimble company [1]. The operation of RTX technology is based on a worldwide network of over one hundred tracking stations observing GPS, GNSS, GLONASS, Beidou, Galileo and QZSS satellites [2, 3]. Thus, there is no need to use the network of ground reference stations. Data from tracking stations distributed in different parts of the globe are collected and transmitted via the internet to Trimble operation centers and then calculated. The precise satellite corrections can be obtained on a global scale in two ways: through a satellite (receiver need to be equipped with L-Band antenna) or via the Internet. As a result, the coordinates of surveying points in the global coordinate system are obtained in real time. Thanks to accurate corrections of satellite orbit and satellite clock as well as other information supporting more accurate positioning, the RTX technology can achieve, as manufacturer provides, 2 cm horizontal accuracy and 5 cm vertical accuracy (RMSE).

In this paper, authors focus on the usefulness of RTX technology and describe the main objectives of using satellite measurements at diverse archaeological sites. During the measurements Spectra SP60 GNSS receiver was used. The receiver is equipped with a modern L-Band antenna, thanks to which, it is possible to get the Trimble CenterPoint RTX corrections in real time. Additionally, accuracy verification of measurements performing with Spectra Precision SP60 was performed.To determine the accuracy of the positioning two measuring test networks were established at Kato Paphos Archaeological Park in Cyprus and one test network surrounding the Dajanyia fort in Ma'an province of Jordan. Networks were particularly located to allow the measurements of points both in very good conditions and partially obscured horizons. The analysis confirms that the accuracy of the receiver at the open horizon are within the limits of the error declared by Trimble (4 cm in 2017 and 2 cm in 2018).

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GEOTHERMAL RESOURCES OF THE NORTHERN CAUCASUS

Geothermal energy is the physical heat of the deep layers of the earth, which are characterized by significantly higher temperatures than the air temperature at the surface. Carriers of such energy are thermal waters, steam and water mixtures. More than 80 countries of the world use geothermal energy in different ways. In 60 countries mastered their industrial use. Such countries as Iceland, Germany, Turkey, France, USA, Japan and others achieved the greatest success in the development of geothermal energy. Russia has significant reserves of geothermal resources. About 65 deposits of thermal waters and 5 deposits of steam-water mixture are discovered here. They are located in the North Caucasus and the Far East. In the North Caucasus, 52 deposits of thermal waters have been discovered, for which 74.3% of the balance reserves of the entire country have been explored.

Geothermal features of the region are closely related to its deep structure, since a significant amount of heat is released during tectonic movements. Of great importance in the formation of temperature regime are regional faults, cutting the complex of sedimentary rocks to the basement. According to them, high-temperature waters can be carried to the surface and create geothermal anomalies (high temperatures in the arches of the developing anticlinal folds, in fractured and adjacent areas).

In general, the region of Ciscaucasia is characterized by a high-temperature regime. At a depth of cut of 1000 m, the highest temperatures in the Western Ciscaucasia (60-65 ° C) are recorded on the Adygei ledge. To the northeast, the band of observed elevated temperatures passes through the Stavropol uplift (Panarina, 1980). In the Central Ciscaucasia, temperatures (67-75 ° C) are noted in the East-Stavropol depression in the region of Georgievsk (74 ° C) and reach 72-85 ° C in North-Nagutskaya area. Within the Terek-Sunzhensk Oblast (Eastern Ciscaucasia), temperatures have values of 65 ° C (Gudermeskaya Square) and 53 ° C (Zakan Square), Khankal fields (100 °). [1]

It should be noted that, in spite of the large amount of exploration carried out in the North Caucasus, the quality of the reports submitted based on the results of the work was not sufficient for their submission to the GKZ level and approval of operating reserves. A number of explored (prospected) fields have been in operation for 10 or more years, but the necessary monitoring observations are not carried out, which does not allow for the approval of operating reserves in terms of field exploitation experience. Obviously, the terms of licensing agreements do not contribute to increasing the exploration of exploited deposits.

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ARCHAEOLOGICAL DOCUMENTATION QUALITY DEPENDING ON GROUND CONTROL POINTS (GCP) SURVEYING TECHNIQUE, TYPE OF UNMANNED AERIAL VEHICLE (UAV) AND SENSOR

Nowadays exploration of archeological sites may be conducted with the latest surveying techniques, which allow obtaining large amounts of digital data in a relatively short time. One of these techniques is close range photogrammetry with application of UAV [1], where the type of used unmanned aerial vehicle (UAV) and ground control points (GCP) surveying technique affect on products quality at most. In order to achieve the highest level of accuracy of the georeferencing process of photogrammetric products, different techniques are used for determining coordinates of GCPs [2]. This dependency has been analysed in presented paper.

The research was conducted on the Błędów Desert (Poland). The coordinates of GCPs were measured by GNSS receiver working in RTN mode, which provides the accuracy up to 3 cm horizontal and 5 cm vertical [3]. A comparative data set was created by measuring those points with a precise total station, with angle measurement accuracy of 1" and distance accuracy of 1 mm +1.5 ppm. Thereafter, two photogrammetric flights above the measured object were done by means of two different UAVs: DJI S1000 with a Sony Alfa A7R camera (full-frame camera) and DJI Mavic Pro with a camera equipped with a 1/2.3 inch image sensor.

Photogrammetric flight missions completed with two different UAVs allowed to compare the quality and the accuracy of the data collected by means of the professional, but expensive and heavy device with products generated from images taken from the amateur, cheap and lightweight UAV. Moreover, surveys of ground control points using two measurement techniques made it possible to assess the accuracy of final products depending on the equipment used.

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SEISMIC DESIGN OF SHALLOW TUNNELS

According to the available statistics [1], shallow tunnels are the underground structures frequently damaged during earthquakes. The vulnerability of these objects is caused by the action of seismic waves reflected from the earth's surface, as well as low rigidity and heterogeneity of grounds. Both Russian [2] and foreign [3] approaches to seismic analysis of underground structures do not take into account the influence of reflected waves, while recent changes in Russian documentation for construction in seismic areas [4] require immediate improvement of calculation methods used.

To take into account the effect of seismic waves reflected from the earth's surface, it is proposed to use the well-known solution of the dynamic problem of the reflection of plane harmonic waves from the half-plane boundary, and determine the stresses in the underground structure on the basis of a quasistatic approach, using the obtained analytical solution of the corresponding plane elasticity theory problem.

As the direction of seismic waves cannot be determined in advance, the seismic analysis for each radial section of the underground structure determines the most dangerous stress state that may occur during an earthquake of the certain intensity. Using a multi-layer model of underground structure allows considering various design alternatives for the tunnel lining, and obtaning the most rational design solutions.

A tunnel lining made of ribbed blocks has been concerned as an example of the design. The influence of various factors on the magnitude of the maximum compressive and tensile stresses that may occur in the underground structure has been estimated. The study has found that the most probable seismic damage to shallow tunnel are compression cracks in the vault and bottom of the lining, as well as tensile cracks in the walls. The expectable damage for a shallow tunnel lining has been compared with the disposition of real cracks appeared in tunnels' linings during the great earthquakes of recent years.

In further studies, it is planned to take into account the effect of the inhomogeneous structure of the rock mass on the stress-strain state of the lining during an earthquake.

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CONTROL OF THERMODYNAMIC PROCESSES IN THE ICE WALLSWHEN SINKING OF SHAFTS

In March 2016, the work began for freezing of soils in the skip and cage shafts of the Petrikov mining and processing complex. During the construction of this facility, the miners faced difficult mining and geological conditions associated with strong water flows up to 2500 m3/h. As a result of this, the construction of shafts was implemented by means of artificial freezing of rock mass in the area of aquifers.The ultimate goal of this process is the formation of an ice wall with design parameters that provide the necessary strength to contain the pressure of groundwater.

The process of artificial freezing of the rock mass is divided into periods of formation and maintenance of the required size: active and passive. For each period, the parameters of the freezing complex of the shafts under construction are calculated, depending on the freezing time, the natural temperature of the rock mass and the surface area of the ice wall.

In the period of active freezing of rocks refrigeration stations are used at full capacity until the creation of ice walls of design dimensions. During this period, the amount of heat removed from the cooled rock mass is the maximum. After the full formation of the ice wall, further increase in the thickness of the wall will be an extra cost. In this regard, the mode of operation of the freezing complex is changed.

When switching to the passive mode of soil freezing,the ice walls must maintain their size and strength. The task of maintaining the ice walls during this period is to divert heat from the frozen rocks from the side of the unfrozen rock mass. As a result, the ice wall is continuously increasing and at the end of the passive freezing period it becomes larger than it was identified by the project, resulting in significant cost overrun.

The parameters of the freezing stations of the shafts were collected, the data of experimental measurements of the distributed temperature of the rock mass were continuously processed.The mathematical interpretation of the results of the shafts thermometry was performed, on the basis of which the three-dimensional temperature field in the entire frozen rock mass was determined.

To control the cooling capacity of the freezing complex forthe maintenanceof the ice walls, we performed mathematical modeling of thermodynamic processes occurring in the rock mass at different parameters of the freezing stations of the shaft.

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PROBLEMS AND PROSPECTS FOR THE DEVELOPMENT OF TECHNOLOGY FOR THE DISPOSAL OF DRILLING WASTE IN UNDERGROUND RESERVOIR

The relevance of this work is due to the need for safe disposal of drilling waste generated during the development of oil and gas fields in the Far North. The technology of their burial in underground reservoirs (PR) has been developed. PR are created by man-made thawing of sandy frozen sediments by injecting coolant [1]. For the construction of a sustainable reservoirrequires a lot of preliminary calculations. The basis of all calculations are the properties of soils, knowledge of which helps to form reliable containers. To date, all parameters of the properties of frozen soils are entered into the design model at one constant negative temperature. It is assumed that during the construction and operation of the reservoir, the properties of the frozen soil around its contour will not change. This assumption leads to inaccuracies in the calculations of the stress-strain state. The study of the influence of the temperature factor was conducted for the first time. Previously, a number of researchers such as Skvortsov A.A., Voronova A.V. et al. developed a methodology for assessing the stability of underground reservoirs [2]. Such scientists as Khrulev AS, Surin SD were engaged in the study of the thermal effect of drilling waste on an array of frozen soils. and others. [3].

Drilling waste placed in the PR has a strong warming effect on the host mass. The temperature in a certain vicinity of the reservoir smoothly changes from the temperature of phase transitions on the walls of the excavation to natural values when moving away from the contour deep into the soil mass. What happens to the properties of this soil with increasing temperature, and how do these changes affect the stability of the mine? The purpose of this work was to answer these questions. The study of strength and deformation properties was carried out using triaxial tests on samples of frozen sand at temperatures of -0.5, -1, -2, -3, -4, -5 ^{o}C. It was found that when the temperature rises from -5 to -0.5 ° C, all indicators above the mentioned properties deteriorate significantly. For example, if the frozen sand at a temperature of -5 ° C, the deformation modulus is 64 MPa, and at a temperature of -0.5 ° C its value drops to 11 MPa. To assess the steady influence of the temperature factor on the stability of the reservoir, the stress-strain state of soils around PR of various geometric shapes was calculated.The problem was solved using the finite element method. It turned out that for a reservoirwith an ellipse shape, significant tensile stresses arise already at a temperature of -5 ° C. A cone-shaped reservoirat a soil temperature of -5 ° C is, however, at temperatures of -4, -3 ° C, tensile stresses form around its contour.

The difference in the stress-strain state of the soils of the array of different temperatures behind the PR circuit is explained by a decrease in the carrying capacity of the soil with increasing temperature. As a result of the research, it was determined that the reservoirs of the same volume and shape at different temperatures of the soil have different stability, which must be taken into account when drafting the construction regulations

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DRIVER SAFETY SYSTEM. IMPLEMENTATION IN EUROPE

The term “safety” is very important in any operation, especially in the mining industry. It is always the aim to increase the safety level on site through knowledge about the origin of the accidents and there frequency. Statistics show that up to 60% of accidents are linked to fatigue and human error. Most of us know the danger and have at least one example of the risk whilest driving a car when fatigued. When an operator gets asleep while driving a haul truck with the heigh machine weight (i.e. 100 t) and loses control, this can cause horrific accidents. With an average speed of **15 km/h** getting asleep for 2-3 seconds the truck covers a distance of **8-12 meters**. On the way traveling without control obstacles like other equipment or a co-worker may occur. Situations like these could result into a damaged truck, damaged equipment and, most important to prevent, injured or killed employees. But there are ways to address this issue.

Caterpillar Inc. offers a solution to this problem. It is called the Driver Safety System. Two Infra-Red (IR) sensors track 24 facial points of operator. Information like eye closure, eye closing frequency and velocity are checked. Whenmicrosleep is detected, the system alerts an operator through audiable speaker alarm and vibration alarm in seat. Theoptical sensor takes a short video clip of the event which is considered dangerous and sends it to the Caterpillar 24/7 monitoring centre. Here all the events will be also manually classified and confirmed.

The Driver Safety System was tested in a limestone open pit mining with a typical working regime for Europe. The company, which has taken apart on the project, has the high safety and schedule standards, so that the results were impressive. The pilot project consists of three phases, every phase takes 20 days. The phase one is a silent phase in which the DSS is only scanning an operator face. It detects fatigue and distraction events. There are no alerts enabled, no data is sent to the live monitoring centre. It is a period to get an actual state in the mine site. Starting with phase two, the first active phase begins. Thesystem begins to alert the driver through the seat vibration and audio alerts from a speaker. During this period, the first step of reducing the number of events can be seen. During the phase three, the second active phase, the monitoring centre starts getting in contact to the safety managers on site, when an event occurs. This period represents the biggest reduction of the events counts. An average reduction of the fatigue events equals to 80% in the end of the project. The pilot in Europe has shown an even higher reduction. However, there was another problem detected: smart phone usage whilst driving. The operators working in the company come from different countries: Belgium, Germany. France, Poland. They have to send and translate the information they get from shift supervisionon their phone to understand their tasks for the actual shift. This is a problem because it leads to distractions. The implementationof the DSS made this issue visible.

In the final discussion with the customer company after the project was finished, it was recommended to continue with the focus of decreasing distraction events and consider installing or upgrading the two-way-radio system in the trucks. This shall help to reduce the use of other devices. At the same time the aim is toprovide education on human fatigue and distraction to the operators.

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COMPARATIVE ANALYSIS OF 3D ARCHAEOLOGICAL DOCUMENTATION UTILIZING TERRESTRIAL LASER SCANNING ALONG WITH HANDHELD SCANNING AND PHOTOGRAMMETRY

As destruction of archaeological excavation emerges as growing issue, especially in the Middle East, appropriate documentation of archaeological sites is very important. The paper presents results of study which aimed to cross-compare three different modern day technologies used to obtain 3D documentation of archeological sites. First utilized technology was FARO Freestyle 3D scanner. Though excavation sites usually cover vast areas, confined spaces may prove difficult for a classical scanner on a tripod. Handheld scanners help in these situations, but require patient operators who are able to provide logical pattern of scan [1]. Attributes as portability and light weight make it ideal for measurements in limited spaces. This mobile device allows for fast, simple and accurate measurements of small construction sites, facades, complex structures, industrial installations, accidents and crimes scenes. Integrated HDR camera provides complex documentation in the best quality. Second of the measurement methods used was close-range photogrammetry with non-metric cameras. This method is already widely used in archaeology thanks to its efficiency and as it is easy to use. The third measurement tool was FARO Focus M70 laser scanner which can be used both indoors and outdoors to collect precise data about objects within a radius of up to 70 meters.

The research was carried out on two archaeological sites in South Jordan: the Roman fort in Dajaniya and the ancient city of Tuwaneh. The documentation of these sites was the main objective of BARI - Buildings ARcheology Inventory project conducted in cooperation with archaeologists from the Institute of Archeology of the Jagiellonian University in Cracow. The tests described in this paper refer to three objects: characteristic passage in the fort wall and one of trenches in Dajaniya and remains of the public baths in Tuwaneh. The aim of the research was pointing out advantages and disadvantages of each method regarding to economics, accuracy, ease of use of equipment, time of data acquisition and post-processing, hardware and software costs.

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SPECIFITY OF THE SLOPE STABILITY MONITORING ORGANIZATION UNDER THE CONDITIONS OF HIGH-STRENGTH HARD ROCK MASSIF OF THE KOVDOR DEPOSIT

At the present time the slope stability monitoring become increasingly important due to the increase in the size and depth of the open pits.

The pioneers in research of the process of rock mass moving in the open pit mining are Fisenko and VNIMI Institute whose methodological recommendations and ideas for ensuring the stability of pit walls and dumps, as well as instrumental observations are still used in the mining companies.

However, in the works of VNIMI Institute the processes of deformation occurred in the high-strength rock massifs actually are not mentioned. Basically, the works concern the questions of landslide processes which occur mainly in the soil masses and information, for example, about various kinds of wedge or plane falling often occurred in the Zhelezny open pit mine of JSC Kovdorsky GOK is absent.

The rockfall processes in the high-strength rock massifs are characterized by the insignificant displacements that precede rockfalling and a fairly rapid rate of process (3 or more mm/h)[1]. These features significantly complicate the process of identifying the potential sites of rock mass deformation and further observation of them.

A system for monitoring the stability of pit walls has been organized in accordance with the scale of deformation areas and destruction of the hierarchically-blocked rock mass and forms of buckling of controlled objects. This system is divided into regional and local levels.

At the regional level the deformations at the pit wall scale are monitored. The observations are carried out with the use of GPS and light-distance measurements at the specially equipped fundamental points of geodynamic polygon located along the open-pit contour.

The interferometric radar IBIS FM is used for local monitoring. It is intended both for identifying the potential deformation sites and for their further monitoring. The accuracy of the radar allows to record inconspicuous displacements of the rock mass before the rockfall.

During the radar operation the considerable statistical material was accumulated, which made it possible identifying the patterns of deformation process development of the rock mass, determining the limiting parameters and developing the temporary instruction for performing observations and processing the measuring results of open pit slopes deformations using the IBIS FM radar.

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ANALYSIS OF RESULTS OF ASSESSMENT OF MANAGEMENT SYSTEM OF OCCUPATIONAL SAFETY, INDUSTRIAL SAFETY AND ECOLOGY OF THE MINING AND METALLURGICAL COMPLEX

The International Labour Organization(ILO) estimates that some 2.3 million women and men around the world succumb to work-related accidents or diseases every year. Additionally, there are some 374 million non-fatal work-related injuries and illnesses each year, many of these resulting in extended absences from work. The human cost of this daily adversity is vast and the economic burden of poor occupational safety and health practices is estimated at 3.94 per cent of global Gross Domestic Product each year [1].Heads of organizations and enterprises are responsible for ensuring the safety of the activities of all workers, therefore, the organization of a management system of occupational safety, industrial safety and ecologyin accordance with legislation and standards is an important task [2]. However, legal regulations are not enough to ensure safety at production sites, the obvious need is for enterprises to create and implement new work tools.

Evaluation audit of some enterprises of the mining and metallurgical complex of the Russian Federation (MMC) was conducted in May – November 2018 by a group of certified auditors of the Department of Technosphere Safety of the National University of Science and Technology «MISIS». The audit criteria were the requirements of the standard OHSAS 18001:2007 «Occupational health and safety management systems. Requirements» [3]и ISO 14001:2015 «Environmental management systems. Requirements with guidance for use» [4].

The results of the evaluation audit confirmed that the integrated management system (IMS), which meets the requirements of audit standards, has been developed, implemented and maintained at the MMC enterprises. However, a statistical analysis of the audit results revealed a number of significant problem elements of the IMS. In particular, there was an increase in injuries and occupational diseases over the past 5 years.Also, according to the questionnaires of employees of MMC, workers are concerned about the current state of occupational health, industrial safety and environmental safety.

One of the solutions at the enterprises of the mining and metallurgical complex is a multi-criteria evaluation of the integration of the management system, identifying effective mechanisms for the integration of elements.The use of this method will improve working conditions and reduce the indications of occupational diseases, injuries, mortality rates, and ensure environmental safety also resource conservation.

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MINE EXPERIMENTAL RESEARCHES ON THE DETERMINATION OF THE ZONE OF AN EFFICIENT CRACKS RADIUS IN CARNALLITE-GALITE ROCKS OF THE GREMYACHINSK DEPOSIT

For the development of Technological regulations, which provides for the forward torpedo array carnallite-halite rocks of the blowout, determine the radius of the effective zone of cracking in the conditions of the Gremyachinsky field.

The paper describes the methodology and results obtained during the mine experimental studies. The results of the research will be used in the preparation of passports of drilling and blasting operations in the mechanized sinking workings on the carnallite-galite layer of potassium-magnesium salts in the mine Gremyachinsky GOK.

The method of determining the radius of the effective fracture zone is to compare the gas permeability of carnallite-galite rocks before and after torpedoing. To determine the gas permeability of carnallite in the array, in the study area, two parallel holes are drilled: the working and the control at a distance of 25 cm from each other, which are sealed with mechanical sealers to a depth of at least 1.5 m. The distance between the pairs of holes should not be less than 0.5 m. The working hole is supplied with gas at a certain pressure and the gas flow rate from the control hole is measured.[1-2]

The results of studies to determine the radius of the effective fracture zone showed that the average values in the array before torpedoing: the volume flow rate of gas - 0.015 cm^3/sec. coefficient of permeability - 0,004598mD; after the torpedoing: the volumetric flow rate of gas of 2.26 cm^3/sec. coefficient of permeability - 14,89mD. The radius of the effective cracking zone is 1,485 m. In the same working holes, the efficiency of torpedoing the array was monitored. The average value of the indicator of air absorption to undermine equal to 0,03 l/min, after the torpedoing – of 2.76 l/min.[3]

Found that the gas permeability coefficient of the effective radius of crack formation for carnallite-halite is 1,485 m. also found that the ratio of air absorption species the maximum effective radius of crack formation for carnallite-halite rocks does not exceed 1.5 m.

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TECHNOLOGICAL JUSTIFICATION OF QUALITY MANAGEMENT OF COPPER-NICKEL ORES IN THE UNDERGROUND ROUND

The relevance of the work is determined by the fact that the instability of the quality of the extracted useful material has a very negative effect not only on the technological and economic indicators of mining and metallurgical companies, but also significantly increasing the loss of useful components, significantly reducing the use of natural resources of the subsoil[1]. In the transition from the development of rich ore deposits of the Talnakhsky ore cluster to less rich ores, there are serious difficulties in the beneficiation and metallurgical processing, due to the deterioration of the quality of the extracted mineral.

In this paper, the conditions and ways of increasing the stability of the composition of copper-nickel ores were studied on the example of the «Komsomolsky» mine. Measures carried out to stabilize the quality of the extracted raw materials at this mine can be taken as the basis for the subsequent design or modernization of mines associated with the subsequent depletion of reserves in the NPR.In the work for the ores of the Talnakh-Oktyabrsky deposit, quantitative laws of the influence of their quality on the enrichment indices were established: the content of metals in concentrates, the extraction of metals into concentrates, the yield of concentrates and enrichment wastes[3]. An objective assessment has been given to existing methods for improving the quality of ores in underground mining and the most promising areas for solving this problem have been established; The technological scheme of mining has been developed to stabilize its quality characteristics that can significantly improve the production of the mine.

The content and structure of the information management system of operational quality control throughout the mining chain has been practically redesigned. At the same time, the system should be built using radiometric and electronic technical means, which are functionally and structurally linked with the technological scheme of the mine[2].Implementation of the developed engineering solutions aimed at practical improvement of the composition of the mined ore mass will improve the stability of the material composition of mined ores and improve the efficiency indicators of the processing industries.

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ENERGY SAVING TECHNOLOGIES BASED ON NATURAL HEAT SOURCES FOR HEATING OUTDOOR AIR

Underground coal mining in Russia, mainly, is carried out in regions with severe climate that determines need of external air heating in the winter before air delivery it to the mine workings. With air quantities (Qa) necessary for ventilation mines reaching 500 m^3/s and more and external temperature -20 – -25°C), the thermal capacity of the unit-heaters is 17-22 MW with heat transfer fluid temperature 60–120°C). Energy costs of such scale lead both to coal mining cost increase and to aggravating environmental issues in areas where coal is used for the producing thermal or electric energy [1]. It is renewable energy sources of natural origin that serve as an alternative to traditional sources of energy, i.e. solar, wind energy, thermal energy accumulated in the solar thermal zone and in the surface layer of the hydrosphere (sea, river and lake water energy) and the lithosphere (mine water and mountain rocks), as well as gaseous energy carriers produced along with coal [2].

Energy-saving technology description Mine water, which is extracted to the surface by a dewatering system, should be used for the preparation of heat transfer fluid as the most available from technical point of view and environmentally friendly source of energy. Mine water flow (Wm.w.) can reach 300-600 m^3/h. Due to the fact that at the reached mining depth the mine water temperature Өm.w. does not exceed 12–15°C), deploying heat pumps becomes a precondition for using it in the preparation of the heat transfer fluid. Heat pump technologies are widely used for air heating in industrial and manufacturing facilities, tomaintain necessary air parameters in metro, for supplying mining facilities with heat.

Mine water can be considered as a promising source of energy for heating outdoor air in coal mines in the winter season. The proposed scheme of air external heating is founded on use of a heat pump enabling increasing the temperature potential of mine water to a value corresponding to the thermal potential of the heat transfer water reached by traditional methods. At the same time, total energy costs for air external air heating can be reduced by 1.5–2 times.

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THE MODERN WAYS OF AN ESTIMATE OF THE BEARING CAPACITY OF THE STRIP FOUNDATION

Nowadays, we widely use a strip foundation in the building around the world. Furthermore, a geotechnical meets a big challenge to make a rough estimate of the bearing capacity of the strip foundation. For this reason, we carried out some research to count the number of the bearing capacity using different calculation methods. For example, the strip foundation was chosen for a few types of the soils such as cohesive, non-cohesive and cohesive with friction angle. The model behavior of the soil was described by the theory of a Mohr-Coulomb.

Our team of researchers chose two calculation methods. One of these was the Russian regulatory document which called “SP 22.13330-2016”. Other was the program ABC “Analysis of Bearing Capacity” by written a professor Martin of Oxford University.

The results of the Russian regulatory showed us the bigger number of the bearing capacity than ABC program, what was a weird.

Analyzing the results of the bearing capacity getting from different ways, we can make a conclude about the discrepancy in numbers. In the future, solving of this problem can reduce the risk and save extra money.

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INDUSTRIAL SAFETY MANAGEMENT SYSTEM

The condition for successful modernization of the production potential of industrial enterprises is the concentration of financial, material and technical resources, scientific and technical potential to ensure the operability, safe operation, and extension of the resource use of fixed assets, industrial facilities through the implementation of an industrial safety management system. In the current crisis conditions, accurate accounting is required, a well-thought-out system for managing the industrial safety of hazardous facilities and fixed assets to monitor their actual condition, prevent emergencies, improve quality and reduce their maintenance costs.

To ensure the normal mode of operation, measures were determined depending on the actual (current) parameters of the technical state of the structural elements of industrial facilities [1].

Assessment of the state of production facilities is carried out by third-party organizations that prepare technical reports – conclusions on the possibility of further operation, provide data on defects and damage to high-risk facilities. The control system is built without the application of modern requirements for reliability and safety. The lack of procedures for the accumulation and analysis of data on the technical condition of structures creates difficulties for timely and professional decision-making on the prevention of emergency situations [2, 3].

The proposed strategy includes a process approach to resource management by building a system of accounting and functional controlling, analysis and regulation of the industrial safety of production assets of enterprises. The implementation of the process approach to the management of industrial safety at the facility level is aimed at ensuring the assessment of risks when extending the resource, taking into account the levels of vulnerability and threats, maintainability while maintaining facilities according to their actual condition.

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DETERMINATION OF THE STRESS-STRAIN STATE IN THE SEAMS OF MINE WORKINGS BY TENSOMETRIC METHOD

Today, there is the problem of controlling the dangerous state of an array of rocks [1]. The materials studied actively form their properties during operation, and the changes that occur have both positive and negative effects on their structure at different scale levels. This necessitates the creation of systems for monitoring their condition in connection with the time of their operation.

The authors presented a measuring complex (Figure 1), used to determine the stress-strain state of cement systems and mine workings, having defects (cracks) in their structure at the micro- and macro-levels. According to the results of the research, an analysis was carried out and a technique was developed to support the defects arising within the structure of natural and artificial conglomerates.

Fig. 1 – Element of measuring complex in experimental sample

The purpose of the proposed method is to increase the reliability of determining the residual life of the materials under study by the methods of acoustic emission and tensometry. According to the hypothesis [2], the combination of these methods will allow with high confidence to control the areas of elastic deformations of natural and artificial conglomerates, to determine the critical point, thereby avoiding the accumulation of plastic deformations. This technique will further prevent the progressive destruction of concrete structures, to determine the boundaries of the alleged fracture or collapse of rock.

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THE STUDY OF ARTIFICIAL THERMAL FIELDS IN THE INTERVALS OF THE LAYERS AND ZONES OF LIQUID AND GAS BREAKTHROUGH FOR HIGH-YIELD WELLS BY THERMOMETRY METHODS

The method of thermometry is based on the study of artificial thermal fields in the intervals of perforated formations caused by the fluid dynamics from the formation to the well. Thermometric studies in perforated wells are used:

- to determine inflow intervals (pickup);
- to determine the emitting (absorbing) layers;
- to determine behind-the-casing flows and watering intervals;
- to identify leaky sections of tubing and casing.

It is known that local positive or negative anomalies of thermal fields in production wells are associated with the flow of fluid into the column from the reservoir. In addition, technological reasons associated with behind-the-casing flows, watering and gas breakthroughs due to the leakage of casing strings and tubing pipes affect the local anomaly of thermal fields.

For gas-saturated strata developed, a decrease in temperature (the magnitude of the anomaly depends on the rate of gas inflow) occurs due to adiabatic expansion (the Joule-Thompson law). Temperature anomalies can also be associated with the entry of a small amount of water or oil into the well, resulting in the mixing of liquids, which leads to a temperature change - this type of temperature change is determined by the calorimetric effect (typical of the upper perforated intervals).

The purpose of this work is to determine, according to thermometry, intervals of fluid inflow, gas inflow intervals, determine the upward and downward annular flows, absorbing and donating layers, as well as justify the feasibility of using mathematical modeling methods to predict the properties of local thermal fields using a comparative analysis of actual curves with theoretical.

Among the main advantages of the thermometry method can be identified: a fairly inexpensive and reliable method, high sensitivity (at the same time it is a disadvantage of this method), it allows differentiating the borehole section, it is well combined with other methods of field geophysics, etc.

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APPLICATION OF NON-DESTRUCTIVE TESTING METHODS TO ASSESS THE STRENGTH OF LIMESTONES IN THEIR SELECTIVE OPEN PIT MINING

One of the ways to improve the technology of open-pit mining of mineral deposits is selective excavation. Such technologies are using the separate excavation of monolithic sections of the massif and areas broken by cracks, interlayers and breccias.

To ensure the high production efficiency, the identification of such areas should be carried out at the planning stage of their development. For this purpose, a rapid assessment of the quality of rock massifs is carried out. The existing methods of visual assessment do not always provide the desired results, since usually the outcrops of rock massifs, are violated and do not reveal the actual state of the areas in depth. In order to achieve the more in depth and objective assessment, one should use the methods based on the study of the physical properties of rocks. This would allow evolution of the strength and fracture of arrays without their destruction.

In this paper, the method of non-destructive testing of the rocks strength is substantiated by of establishing of its interrelations with the acoustic quality factor of rocks, as measured by dynamic effects.

For this purpose, a rock samples dynamic testing laboratory setup was used designed and manufactured based on split Hopkinson bars. It consists of a drummer and two rods (transmitted and incident), between which a rock sample is fixed. The acoustic quality factor was measured by a resonant method instrumented by a specially designed setup including a digital harmonic signal generator and an oscilloscope. The test method involved a series of mechanical impacts on a limestone sample and the determination of acoustic properties before testing and after each impact in a series. As a result of tests, the dependence of the acoustic quality and strength on the number of shock effects was obtained. For comparison, cyclic tests were also performed by quasi-static loading of the sample.[1]

The obtained dependencies can be used in the open pit conditions to identify the areas with different strength of extracted rocks. This will allow for application of selective excavation techniques.

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RESEARCH OF THE IMPACT OF EXTERNAL FACTORS ON THE ACCURACY OF POSITIONING GNSS STATIONS

Factors affecting the accuracy of measurements of GNSS stations, investigated by various scientists, add up to an extremely complex picture of the phenomena. One way or another, these factors can be explained on the basis of certain, often hypothetical processes that occur in accordance with the fundamental laws of physics.

There are a number of different factors that influence the value of the error in determining the coordinates of the base GNSS stations. The greatest magnitude of the error is caused by the delay of the radio signal in the earth's ionosphere [1]. Also, atmospheric noise depends on the time of day. Because ionization is mainly caused by exposure to solar radiation. Temperature fluctuations also depend on the sun and climatic conditions, which cause expansion or reduction of structural materials of the base station, resulting in thermal deformation. Therefore, it can be concluded that with increasing temperature, the material of the structure on which the base GNSS-station is installed is deformed and there are fluctuations in height, thereby reducing the positioning accuracy. It is also established that as a result of climatic features in certain periods of the year there is an increase or decrease in soil moisture, resulting in seasonal variations. This pattern is closely related to the balance of precipitation and climatic conditions.

Although the motion of the satellites providing the GPS system is quite stable in its orbits, there are still some deviations. The reason for these deviations is the gravitational field of space objects – the Sun and the moon. In addition, the Earth is not a completely solid body, in consequence of which under the influence of tidal forces of the moon and the Sun, it experiences elastic deformation, during which there are displacements of points of the earth's surface [2].

To study the influence of the above factors, the following base stations were selected: in a desert region with significant temperature changes and the presence of a rainy period; in a temperate climatic zone in summer and winter. The data of observations of these base stations during different phases of the lunar cycle are also analyzed. Data on weather conditions were obtained from the archives of the nearest meteorological. The analysis was carried out on the basis of the Precise Point Positioning method [3].

As a result of this study, the dependences of the accuracy of determining the coordinates of the base stations on the factors under consideration were determined, and the degree of their influence was revealed. Recommendations for reducing the impact of the studied values are proposed.

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REDUCTION OF THE HARMFUL INFLUENCE OF MINING WORKS ON THE GROUND SURFACE, WHILE CONDUCTING CLEANING WORKS WITH THE APPLICATION OF A POSTAL DEVELOPMENT SYSTEM, BY OPTIMIZING THE WIDTH OF INTERMEDIATE CEL

When conducting mining operations at the Starobinskoe potash salt deposit, shifts and deformations of the earth's surface occur. These factors adversely affect buildings, structures and natural objects. All buildings and structures, as well as natural objects (reservoirs, forest and agricultural land) located in the territories of existing and under construction potash mines, are required to protect against the harmful effects of mining, violating safety and efficiency. their operation. This question has a weak degree of knowledge, because It is very difficult to study the process of moving at an operating mining enterprise.

Research results

According to the "Instructions for monitoring the shift of the earth's surface and deposits of underground buildings and structures at the Starobinsky potassium salt deposit," in the case where the width of interpanel targets is less than 10% of its depth, calculations of subsidence and horizontal shifts in the total depth of the earth’s surface from [3].

It was assumed that the calculations of the expected (probable) horizontal shifts should be performed when working on the table.

The calculations are performed in the Map Manager 6.0 software, which takes into account all the features of the Starobinskoe field development.

Conclusion

The calculation is made for specific mining engineering conditions and shows that the width of interpanel targets affects the shear process and dependence on it can be traced, which is the most possible option for the width of interpanel targets, taking into account the state of objects on the surface.

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SUBSTANTIATION OFMINING SYSTEMS OF THE PETRIKOVPOTASH DEPOSIT

Protection of the mine from possible breakthrough of water aggressive to salts should be provided by the presence of sufficient water-resistant rocks above the formation being worked out, and the correspondence of the parameters of the stopingto specific geological and hydrogeological conditions. At the present stage of knowledge only salt bearing deposits can be included in a waterproof thickness in the Petrikovfield.

The basis for calculating the height of the spread of technogenic water cracks over the formationbeing mined in the conditions of the Petrikov deposit of potassium salts is the conceptual principle used in mining of the Starobindeposit of potassium salts.

The calculation was carried out as follows: for each exploration well, the necessary initial data were determined: the depth of occurrence of the formations, the angles of incidence and the distance between them, the thickness of the water protection layer above the upper layer being developed. In addition, the parameters of the adopted mining system were determined: for the column system– the mining thickness, the width of the developed space of lavas and inter-column pillars, as well as the degree of extraction; for the chambersystem– the height of the chambers and the area extraction coefficient in the treatment unit. On the basis of these data, the calculation was carried out to meet the conditions of water protection for the development of layers 1 and 2÷3 of the column mining system, and the height of the spread of technogenicwater cracks over the developed space was determined. On the remaining area of the deposit, 9 possible variants of the potash layer IV were calculated, the results of which determined the boundaries of the possible development for a particular system.

The calculation of the height of the spread of technogeneouswater-supply cracks over the developed space and the results of the calculation indicate that the condition of water protection of the mine is provided without limiting the degree of extraction of minerals from the subsoil, taking into account the accepted parameters of the potash layer IV of the Petrikovdeposit on its larger area. The condition of safe working of the water proof thickness is considered to be provided if the estimated value of the safety ceiling is not less than 35 m.

Thus, for the development of the resources of the Petrikovdeposit, a column mining system is used as providing the best results in the field of rational use of mineral resources and the most efficient production of the final product. It should be noted that in some areas there are restrictions on the condition of water protection due to insufficient power of water protective stratum.

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ENK - THE OBJECT OF STATE CADASTRAL REGISTRATION (FOR EXAMPLE, THE TECHNOLOGICAL EQUIPMENT OF THE OIL PRODUCING WELL CLUSTER)

The relevance of the chosen subject is that, unlike many other real estate objects, a single immovable complex (further ENK) includes indivisible immovable things, which indicates the complex structure of such a complex, which requires an approach to cadastral works.

Based on the definition of ENK as an immovable, the central part of its definition as a property subject to state cadastral registration is the formation of a complex in the form of an indivisible thing. The work attempts to identify the main features that would help to identify the immovable thing as ENK. [1]

The formation of ENK as a property is shown on the example of the process equipment used in the extraction and transportation of oil from the technological well to the collection and transfer station to the main oil pipeline.As a result of the research, it was revealed that in this case we have an indivisible thing, the division of which in nature is impossible without its destruction, but, nevertheless, changing its parts in size and other parameters does not change its purpose and in the technological process it acts as ENK. [1]

On the other hand, taking into account that a large depth curved underground mine working (technological well), as well as other surface, above-ground and underground technological structures, including oil pipelines, are functioning as part of the ENK, as well as preparing information for state cadastral registration of the aggregate of such objects, forming ENK, requires improving the implementation of cadastral works.To this end, it is proposed in the work to use new technological methods (approaches) to collect information on the ENK facilities and to make additions to the approved forms of the technical plan.

An introduction to civil law of such a concept as “ENK” establishes the legal status of an indivisible immovable and, therefore, simplifies the procedure for its registration, as well as improves the use of complex infrastructure facilities (including linear) in civilian traffic.The decision to merge individual objects into ENK is made by the owner of the land plot and the owner of the object. Registration of ENK rights is a prerequisite for granting it the appropriate status.

Thus, the practical relevance and efficiency of applying the design of a single immovable complex in civil circulation will be largely determined by the refinement and improvement of the relevant provisions of land and town planning legislation, legislation on cadastral registration and registration of rights to immovable property. [2]

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ANALYSIS OF MINING METHOD IN THE CONDITIONS OF THE VERKHNEKAMSKOYE POTASH DEPOSIT AT THE MINE OF «EUROCHEM – USOLSKIY POTASH PLANT»

Mine "Usolsky potash plant" is located in the marginal zone of the southern part of the field, which is characterized by low resisting power, which complicates actual mining. There are no commercial reserves of the bank AB in the mine field of the Usolsky mine, but there are very significant reserves of the sylvinite bank “Krasnyj II” and “Krasnyj III”. Such a change in the development of mine fields determines the need for a detailed assessment of the used actual mining and the parameters of the development system. Research objective is the analysis of possible flow diagrams of dredging of stocks of the 1st southeast panel. In the course of the research the following problems are solved: increase in stability of rocks and safety of work inbreakage face.

The development of the sylvinite bed is conducted by cutter Ural-20R (width 5.5 m) in 3 turns at the height of the "Krasnyj II" in bed thickness 6.35 m and in one move on the "Krasnyj III" with the power of - 3 m Solution this problem deals with Anikin V. V. So, calculations weremade based on the definition of sustainable span of the roof, which the use of the harvester with the Executive body wider than 4.6 m is not possible. Therefore, the application of the current version with widths of 5.5 m causes the appearance of cracks on the pillars. In this paper, calculations are made to determine the parameters of room fender and theirdegree of stress, the time of mining chambers, the number of reserves and losses of minerals. Recommended for use is the development system, in which the excavation of the silvinitebank "Krasnyj II" will be carried out by a continuous continuous miner Joy12HM46 (width 4.1 m), and the bank "Krasnyj III" - cutter Ural-20R.

The analysis discharged on flow diagrams allowed to establish expediency of application of the alternate option. At the offered option of a mining method the extraction ratio increases, in 4.5 increases of mining stope, in 3 increase output per stope, and the prime cost decreases twice.

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PERFORMANCE EVALUATION OF TELEREMOTE CONTROLELECTRONIC UNDERGROUND DRILLING FOR SUBLEVEL CAVING METHOD

Contemporary trends of the mining industry development are characterized by a widespread transition to the underground mining method, increasing the depth of mining and reducing the content of useful components in ores [1]. This, in turn, leads to deterioration of mining andgeological, geomechanical conditions of mine development, increase of emergency situations, increase of raw material production costs and other negative consequences. Against the background of rapidly developing digital transformation in developed countries, a radical solution to the problems of safety and reducing the cost of mining is the transition to lightly manned and remote control technologies [2]. In this regard, the task of evaluating the efficiency of automation of the main technological processes at Russian mines is relevant. At the same time, in the development of rocks, one of the most dangerous and expensive are drilling and blasting operations [3].

The article presents an overview of the world experience of underground mining with the blasthole drilling automatisation. The analysis of pilot run of ore stoping in the implementation of teleremote control drilling of wells on electronic passports at one of the ore deposits of the Kola Peninsula. The stages of introduction of teleremote control drilling technology, its features, changes in the mine infrastructure, labor organization and the main technical characteristics are described.

A technical and economic comparison of the costs of ore stoping during the development of one section was worked out by the sublevel caving method with using of new and previously used (manual control of the drilling rig) drilling technologies.

As a result, the following technical indicators of drilling and blasting operations were improved: drilling accuracy was increased by 60-80%, the output of oversize piece was reduced by more than 2 times, the consumption of explosives by 9.5%, the utilization factor of equipment and drilling performance was increased by 20%. The cost of clean-up excavation decreased by 9.9%. Further research will focus on the study of fully-autonomous (robotic) drilling technology integrated into a single digital control system of underground operations in the structure of the paradigm "Industry 4.0".

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INFLUENCE OF EQUIPMENT WEIGHT ON STRESS STATE OF TUNNEL LINING

The report presents the analytical method for design of tunnel linings subjected to the action of the weight of technological equipment or vehicles in a tunnel. The method makes possible finding new or specifying known dependencies of the stress state of tunnel linings constructed near the earth's surface by the shield method [1].

The authors have proposed an adequate mathematical model of the interaction between the tunnel lining and the surrounding ground mass under the action of an internal locally distributed load simulating the weight of massive equipment. The model is based on the theoretical positions of geomechanics and mechanics of underground structures. It is a further development of the approach proposed in [2].

The method is based on a rigorous solution of the problem of the theory of elasticity for a linearly deformable semi-infinite medium weakened by a circular opening supported by a ring with appropriate boundary conditions. The solution has been obtained with help of mathematical apparatus of the theory of Kolosov-Muskhelishvili complex potentials, analytical continuation, and Laurent and Fourier power series [3].

On the base of solution obtained an algorithm and a computer program are made. The program allows producing multivariant calculations of underground structures and that will contribute to the theoretical substantiation of structural or technological solutions providing linings' strength.

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LITHOFACIAL MODELS OF PRODUCTIVE DEPOSITS OF THE MOSHAKOV FORMATION WITHIN THE SOUTHWESTERN PART OF THE SIBERIAN PLATFORM

Most of the proven hydrocarbon reserves are associated with Neoproterozoicclasticdeposits within the southwestern part of the Siberian platform. These deposits are a promising object for prospecting and exploration of oil and gas fields, which is confirmed by the discovery of the Omorinsky, Ilbokichsky, Imbinsky and Abakansky fields.The development of hydrocarbon reserves in these deposits is complicated by the high degree of their geological heterogeneity, facies variability, lack of constancy of power and stratigraphic volume. In this regard the discovery of deposits and the effective development of hydrocarbon reserves in these deposits is largely associated with the forecast of spatial distribution of reservoir rocks as well as their structural and mineral characteristics.It should be noted that the study of these Neoproterozoic deposits was devoted to the numerous works of various researchers. For example, the scientific works of A.I. Anatolieva, K.I. Bagrintseva, T.K. Bazhenova, V.A. Vernikovsky, A.E. Kontorovich, N.V. Melnikov, I.E. Postnikova, Yu.K. Sovetov, V.V. Khomentovsky and other.

The object of research is the Neoproterozoic deposits of the Moshakovformation of the southwestern part of the Siberian Platform.

The complex of multi-scale lithological studies included analysisthe texture, structure, mineral composition and the structure of the void space of reservoir rocks using optical and scanning electron microscopy, X-ray spectroscopy and X-ray tomography.

The deposits of the Moshakov formation of the Taseeva group are represented by a diverse set of red-coloredclastic rocks to a lesser degree carbonate, sulfate and clay rocks.The rocks are characterized mainly by multi-mineral composition of fragments and cementing part. Porous, and mixed porous-fractured reservoir types are distinguished in different structural zones. Three main types of voids are distinguished in the pore type reservoirs: intergranular, the leaching of carbonate cement, the microcirculation of the corroded fragments of the feldspar. The predominance of this or that type of voids in different structural zones is different. The highest values of productivity are noted in the rocks with porous-fractured reservoir type.It has been established that secondary transformations significantly changed the primary structure of the void space of the reservoir rocks.

The Vendianclastic deposits of the Moshakov formation within the Angara folded zone formed in conditions of different zones of the tidal flat. The deposits have a cyclical structure with a regressive orientation of the sedimentary cycles. Numerous traces of burrowing organisms have been identified in the rocks, in particular large forms of *Skolithos*[1].

The reservoir rocks are confined to the upper parts of the sedimentary cycles formed in the conditions of the sand sheet of the tidal flat.The reservoir properties of rocks are determined not only by facies, but also to a large extent by the intensity and direction of secondary transformations, including fracturing.

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PROBABILISTIC ASSESSMENT OF RESERVES, IDENTIFICATION OF KEY UNCERTAINTIES AND PROGRAM PROPOSALS FOR DETAILED «X» FIELD APPRAISAL

Regardless to the importance of the determination of the geological and technical parameters of geological reserve calculation; it is wondering that many of the petroleum modern companies still don't pay adequate attention to the controlling of the quality and enhancement of the assessment.[1] At the same time, accurate determinations of geological reserve rely on the geological technical parameters.

With the purpose of the risk assessment during the evaluation stage of the field development the seismic and well data analysis had been performed, which are associated with the main geological risks of field developmentforfield «X». Based on this analysis, a probabilistic assessment of geological reserves was performed using 3D geological modeling in SLB software – Petrel. The data highlighted the following uncertainties:

- Geological uncertainty of a structural characteristic - comparing structural map before and after drilling. The key uncertainty is the variation of the structural surface defined by the 2D seismic surveydue tominimum seismic resolution.
- Petrophysical uncertainties such asporosity andfluid saturation are related to a lack of data in comparison with similar resources.
- The position of the oil-water contact. Well data analysisof 1PO well– was tested for the whole interval with pure oil production rate – 97 barrel/day, well 2PO was not tested for technical reasons, and 3PO well was testedwith producing pure oil in the interval 2254-2274 m.
- From sedimentological point of view, reservoir was deposited in the regression cycle and represents the shelf part of the clinoform. Moreover, this fact allowed to notice a different effective thickness in the reservoir, thataffecton NTG ratio. All of these variables can give a huge impact on final result.

To reduce geological and economical risks the program of exploration was adoptedthe following set of works are recommended:

1. Complete well testing in 2PO well in theinterval -2274 - -2290 m.
2. Carrying out 3D seismic survey in the amount of 300 sq.km.
3. Drilling an exploration well to clarify fluid contact (if welltesting will be not successful in 2PO well).

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INVESTIGATION OF SELENIUM CONTENTS IN CHALCOPYRITE FROM SARCHESHMEH COPPER MINE, IRAN

Selenium (Se) element is one of the critical elements.Since, Se was discovered from a red residue in sulfuric acid from mined pyrite at Sweden [1], commercial uses of it have begun. In the 21st century, the applications of selenium include energy efficient windows and thin-film photovoltaic cells [2]. Se is obtained as a by-product of copper refining [3] and produced from anode slimes [4].Based on the mentioned reasons, the countries with the major resources and reserves of copper have the potential for being the resources and reserves of Se [2]. Iran has located on the global copper belt, so, investigating on the copper mines in this country are valuable and important…. The Sarcheshme porphyry copper mine is located in Kerman province and considered as the largest copper deposit in Iran [5].

In this research, the chemical composition of chalcopyrite from the Sarcheshmeh copper mine was studied. Two experimental techniques including ICP-MS and EPMA were used for elemental determination. Based on mineralogical investigation, the most abundant of copper mineral in this mine, include chalcopyrite, bornite, chalcocite, covellite, cuprite, malachite and azurite. ICP-MS technique determined 88.1 (ppm) Se for bulk composition of chalcopyrite.

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CREATION OF GEODYNAMIC MODEL OF SEASONAL THAWING GTS

Objective: to study the processes of filtering and seasonal thawing of hydraulic structures on the basis of the geodynamic model based on the results of complex works. The relevance of the topic is due to regular emergencies on the water bodies of Yakutia, which sometimes entail human losses.

The complex of methods for studying GTS includes thermometry, piezometry, electrical survey (electrotomography method) and measurement of air temperature. A change in the temperature of the GTS is accompanied by a change in the physical properties of rocks. Measurements are carried out 3 times a year.

The object of study 2012 - 2018. mineralized water storage on ruch. Alysardakh.GTS - stone-earthen dam - bulk, non-uniform, talomrezla, maximum height - 35.5 m, the length of the ridge - 1010 m, the width of the ridge - 10 m. The main body of the dam is filled with rocky overburden of marls and diabase. At the base of the dam slopes from the diabase rubble, horse and bottom banquet prisms are poured. Bottom banquet prism performs drainage functions. The central part of the dam is composed of medium-sized sand through which the infiltration of technical water from the reservoir penetrates.

At the research site, 6 electrical survey profiles were completed: on the dam of the reservoir of saline water, in the left-bank contiguity of the storage pond and in the coastal abutments. Alysardakh. According to the results of measurements, profiles of apparent resistivity of soils and plans of isomas at depths with an interval of 10 m were constructed by profiles. According to thermometric well data, temperature sections were constructed.

As a result, a geodynamic model of a reservoir of saline water was constructed, which describes the change in filtration flows and the seasonal thawing of the reservoir pond to the ruch. Alysardakh. This model will serve as the basis for studying the processes at two dozen GTS in the area.

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GEOCHEMISTRY OF NATURAL WATERS IN THE AREA OF THE TOREY LAKES (EASTERN TRANSBAIKALIA)

The formation of groundwater chemical composition undergoes several stages. Among them, are the atmogenic, biogenic, lithogenic and evaporative ones. However, the extent of each one is also influenced by the conditions of the ambient environment [1]. In this regard, particular emphasis is put on the study of groundwater geochemistry in the Torey Lakes area, where within a relatively small area (about 3000 km^2), because of the arid climate and the presence of fractured volcanogenic formation providing water mixing, very diverse groundwater compositions have been observed [2].

To deal with the nature of such diversity, the task was to study the chemical composition of water and the nature of their equilibrium with the minerals of the host rocks at each stage. To achieve this, according to chemical testing data collected between 2017 and 2018, 41 water samples (28 from underground, 10 from lakes and 3 from atmospheric precipitations) were compared.

At the atmogenic stage of water formation, they were found to be slightly acidic and neutral, with a TDS of no more than 0.05 g/L and they were from the gibbsite stage of formation. The composition of precipitation is HCO_3-Na. The lithogenic stage commences when the waters reach an interaction with the host rocks. The main difference here is the chemical composition of groundwater in the Torey Lakes catchment area and the waters beyond. Thus, the former are predominantly HCO_3-Ca in composition, still fresh and in equilibrium with various montmorillonites and hydromica. In comparison with the latter, these waters were less alkaline with a pH (7.7 - 8.3) having a lower TDS (0.3 - 1.0 g/L).

While groundwater in the catchment area is characterized by a higher pH (8.3 - 8.8) and salinity (0.5 - 3.3 g/L), the increase in total dissolved solids and pH here can be associated with a decrease in the elevations in the catchment area as it approaches the Torey Lakes, and therefore, a longer interaction time with the rocks. Among the trace components, Na^+, HCO_3^- prevail here, and with an increase in TDS of over 3 g/L, SO_4^{2-} is the main anion. Cl^- in significant amounts is present at a TDS exceeding 2 g/L. Moreover, according to the data obtained in the course of thermodynamic calculations, these waters, after reaching equilibrium with respect to carbonates, which lead Ca^{2+} and Mg^{2+} out of water, become of the HCO_3-Na type.

The evaporative stage of groundwater formation is the key area of study. In the first instance, it has a considerable impact on the chemical composition of the lake's water: HCO_3-Cl-Na or Cl-Na with TDS up to 131 g/L, and a pH of up to 10, where constant mixing can be observed.

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CORRELATION DIMENSION AS A MEASURE OF GEOPHYSICAL LOG CHAOS

Geophysical logging allows for a continuous measurement of rock properties thought a well length [1]. An obtained curve usually exhibits chaotic behaviour [2]. This work presents a way of describing this chaos in a quantitative manner using fractal correlation dimension [3].

The study was carried out for the log data from the Williston Basin, USA and the Lubiatów oil field in theSowia Góra region. A Python program has been written to calculate correlation dimension. Each time an adequate graph is created. Used algorithm calculated the value of a specified data range. The influence of the range width and shift were examined. A correlation analysis between logs and their dimensions was carried out.

The results indicate that the correlation dimension change throughout a whole data set and correlates in a moderate degree. Additionally, it allows for determining areas where data does not exhibit chaotic behaviour.

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A MORE PRECISE LOOK AT PETROPHYSICAL CHARACTERISTICS OF CARBONATE ROCKS BY PORE SPACE DIFFERENTIATION BEFORE POROUS MEDIA RECONSTRUCTION

Abstract

An accurate reservoir characterization is a crucial task for the development of quantitative geological models and reservoir simulation [1]. We have focused on the advantages of thin section images not only for prediction of porosity and permeability but also for studying the effect of different types of pore spaces on the fluid flow properties of the carbonate rocks. Although various researchers have predicted permeability throughout 3D reconstruction and fluid flow simulation methods [2], the advantages of image analysis for pore space differentiation have been forgotten.

In the introduced methodology, first, the pore spaces of each thin section image have been divided into three categories, including micro-pores (10-50 μm), meso-pores (50-100 μm) and macropores (>100 μm). Each image converted to three sub-images each of which includes one category of pores. Then, the Markov Chain Monte Carlo (MCMC) method was employed to reconstruct the 3D porous media of each sub-image. Third, a superposition operator was used to integrate the 3D sub-models resulting in a superposed (SP) model. In addition, a 3D model was reconstructed based on the initial thin section image before pore space differentiation (not-processed (NP) model). Finally, the lattice Boltzmann method (LBM) was used to estimate the permeability of both SP and NP models.

We have implemented the aforementioned methodology for studying Kangan and Dalan formation, which are the reservoir rocks of South Pars Gas Field, located in the south of Iran. The obtained results in regard to Kangan and Dalan samples are 1) higher percentage of macro pores provides higher permeability, while growth of micro pores percentage has insignificant effect on flow properties due to lack of pores connectivity; 2) In spite of negligible permeability of micro pores lonely, they can improve the carbonate rock permeability in cooperation with the meso and macro pores; 3) the estimated permeability from the SP digital models were closer to the reality compared with the NP models, which were reconstructed without pore differentiation.

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GOLD MINERALS OF UDEREYSKOE DEPOSIT

Udereyskoe Au-Sb deposit (Eniseyskyridge, Krasnoyarskregion)is mainly considered asSb resources with Au as admixture of gold (approx. 1-2 ppm). Gold mineralogy has been previously reported as few notesabout thin inclusions of native gold within sulphides [1,2].

The representative Au bearing sample (~1.5 ppmAu, 3 kg) of productive Udereyskoe's Au-Sb ores was investigated using 3D-mineralogical technology[3]. This technology involves gradual accurate shatter-boxcrushing by short periods (2-5 sec) of rock samples followed by wet-sieving, gravity concentration of all fractions using hydroseparation for production of HS heavy mineral concentrates (HS HMC) by means of Hydroseparator CNT HS-11. The HS HMC as monolayer polished sections were studied underoptical microscopy and using electron microprobe. Additionally, primary sample and all process products were assayed and their chemical compositions were determined.

The HS HMC are represented by: arsenopyrite FeAsS, pyriteFeS_2 and stibnite Sb_2S_3 with rare grains of zinkenite $Pb_9Sb_{22}S_{42}$, chalcostibite $CuSbS_2$, ullmannite NiSbS, galena PbS, sphalerite ZnS and cinnabar HgS.

In the composition of studied HS HMC, grains of four different gold mineral types(all < 70μm)were identified. Three of themhas never been previously observed in this deposit. These four mineral types are:*1) coarse grains (30-70 μm) of native gold (0-25 wt. % Ag)*with inclusions of pyrite and stibnite; *2)aurostibite ($AuSb_2$)* surrounded by thin (1-5 μm) rims of Sb-containing gold (3-6 wt. % Sb) and native gold (100 wt. % Au);*3) palladium gold (3-8 wt. % Pd)* inside coarse (~50 μm) grains of native gold (2-3 wt. % Ag);*4) fine irregular shaped inclusions (1-3 μm) ofnative gold (100 wt. % Au)* inside arsenopyrite, pyrite and stibnite.

The relationships between gold minerals and associated sulphides in monolayer polished sections of the HS HMC represent two generations of Au mineralization of Udereyskoe deposit: 1) primary native gold-I (Au,Ag); 2) more recent (replacing native gold-I) native gold (up to 100 wt. % Au) + palladium gold (Au,Pd) + aurostibite $AuSb_2$ + Sb-gold (Au,Sb). We suggest that the second generation of gold mineralization formed asa result of replacing of primary sulphide gold-bearing generation.

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EXPERIENCE OF ASSESSMENT OF STATE OF SOIL DAMS BY REMOTE INDUCTION SOUNDINGS

Hydraulic structures (HS) are of great importance both for economic needs and in everyday life of people. According to the degree of external influences and loads, the most responsible of such objects are dams, as they restrain large masses of water. At the same time dams are under constant hydraulic pressure, which can lead to violation of the filtration regime in dam body and their destruction. In areas of increased water migration soil is over-humidified, liquefied and it turns into the fluid state. Electrical survey methods provide information about resistivities of the soils, and therefore they are sensitive to areas of high moisture saturation, and they make possible to detect the presence of portions of damaged structures (areas of flooding, suffosion, with increased filtration) [1].

Remote induction soundings (RIS) is method of engineering geophysics allowing to carry out researches enough quickly and to identify areas of high and low resistivity in the study area. This method has already proven itself in the study of state of HS [2], in this work measurements were carried out at two frequencies and an additional parameter was taken into account – the frequency dispersion coefficient (FDC), based on comparison of measurements of alternating electromagnetic field at two or more frequencies and analysis of frequency dependence of medium response, which adds informativeness to the RIS method in assessing the state of HS.

Remote induction soundings are performed using induction equipment MFS–8. This equipment had been developed for high-frequency induction soundings in the Institute of Geophysics, UB of RAS [3]. Set of of the apparatus includes the generating unit of alternating current with loop radiator of the electromagnetic field and the receiving unit with inductive-type sensitive magnetic receiver (sensor). The measurement technology consists of registering the modules of two mutually perpendicular components of alternating magnetic field (H_z and H_r), which are then used to calculate the effective electrical resistivity ρ_{eff}, the effective longitudinal conductivity S_{eff} and frequency dispersion coefficient (FDC) by known formulas [4, 5, 2].

Field works have been carried out at two soil dams in Middle Urals. The main structure elements of the dams are confidently distinguished: soft bulk soils, more durable base rocks, spillways, metal structures; on the dam in Kungurka village shape of old riverbed and rise of bedrocks to the surface are distinguished. The informativeness of the longitudinal conductivity for the determination of watered areas in dam body is confirmed, which may rise due to excessive watering of these areas caused by increased filtration. Efficiency of using the frequency dispersion coefficient to determine inhomogeneities in body of HS is shown at old spillway for watermill inside dam body in Cherdantsevo.

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MARBLE AND GRANITE POTENTIAL AND MINNING PRACTICES IN SHIGAR DISTRICT GILGIT-BALTISTAN

Large resources and different varieties of marble and granite are present throughout Pakistan. However, these resources are not contributing to Pakistan's economy considerably because of its unsystematic, primitive and outdated methods of quarrying, and excavation of these valuable dimension stone, especially the detrimental conventional blasting method which is usually adopted in most of the marble and granite quarries of Pakistan. In this study, the marble and granite mines at different locations, their potentials, and an overview of the blasting method have been analyzed and evaluated. The study area comprises of mainly occurrences of marble and granite. The investigations were conducted to get an understanding of the structure and nature of their formations in different valleys of Baltistan. In addition, the granite and marble deposits were evaluated for mining potential and the impact of currently used mining methods. The study areas lie on either side of the Main Karakorum Thrust [*Tahirkheli et al.*1979]; the northern suture zone demarcating the northern boundary between Kohistan Ladakh Island arc and the Eurasian plate. The island arc consists mainly of volcanic, plutonic, and meta-sedimentary rocks [*Petterson & Windley,* 1985]. These sequences have undergone low to high-grade metamorphism. The general practice of mining in the areas is that a single hole is drilled in the deposit and considerable amount of explosives is placed in it as bottom charge followed by an explosive agent (Ammonium nitrate + fuel oil) as column charge and then blasted. This study evaluates that about 75 % of the rock mass is wasted in the first blast and only 25% of the rock mass is recovered in irregular shapes with numerous microcracks which further results in more than 50% wastage during the subsequent processing in the marble factories. The use of a higher amount of explosive results in a higher amount of shattering which results in maximum wastage of rock at the time of blasting, and subsequent cracking causes further wastage of the rock. Even though the standard dimension blocks may be recovered but the presence of microcracks results in wastage of the valuable stones during the cutting process in marble factories due to the propagation of the microcracks. This is the major drawback of the tiles/slabs made from the blocks extracted by blasting method which loses its value in the international market and thus a big hindrance to export it.

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SEISMIC IMAGES OF LARGE GAS ACCUMULATION ON THE SHELF OF THE KARA SEA

The West Siberian oil and gas province has been the object of research by geologists and geophysicists since the late 40s of the last century. Development of its Northern regions, which began in 1960 and is still ongoing, led to the discovery of several large deposits in Yamal and Gydane such as Malyginskoye, Stormovoye, Kharasaveyskoye, Bovanenkovskoye, Kruzenshternskoye, Gyganskoyeetc [1]. Deep exploratory drilling was began in 1980in the waters of the Arctic.Rusanovskoye and Leningradskoye gas condensate fieldswas opened in the 1990son the shelf of the Kara sea. In 2013, the oil and gas condensate field, which namedPobeda, was discovered south of the Novaya Zemlya archipelago by Rosneft [2]. The experts IPGG SB RAS consider that sedimentary basins of the Arctic ocean will play an important role in maintaining production levels and ensuring energy and economic security of Russiafor the second half of the XXI century [3].

The work is devoted to the development of seismogeological criteria of gas content of the Aptian-Cenomanian sediments of the North of Western Siberia. The study was performed on the basis of complex interpretation of data of seismic exploration, geophysical well logging and deep drilling with the use of the basic principles of seismostratigraphy.Structural-tectonic analysis, the construction of the seismic and geological models of the main sedimentary complexes was carried out.Than a set of seismic images of the major gas deposits was createdfor areas of the South Kara petroleum bearing area.

As a result of the research, it was found that large gas deposits can be distinguished by the characteristic features of seismic recording in time sections. Massive Cenomanian gas deposits in the wave seismic field can be determined by the presence anticlinal structuresin the relief of the reflecting horizon G.The reflecting horizons confined to the gas-water contacts are allocated at the baseof anticlinal structureson time sections. The contacts are of quasi-horizontal or a convex down shape. Also, there is a drop in the amplitude characteristics of the reflecting horizon G, limited to the Cenomanian top and a decrease in the amplitude-energy characteristics of the seismic record in the Aptian-Cenomanian megacomplex. Aptian-Albianbedded gas deposits are mapped on time sections by a sharp increase in amplitudes of the seismic record, forming "bright spot"anomalies in the wave fields.

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GLASS SHARD AND MINERAL ANALYSIS OF LATE QUATERNARY MARINE TEPHRA LAYERS FROM THE EAST AZORES PLATEAU

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Large volcanic eruptions occur frequently on the Azores, accompanied by earthquakes, gravitational collapses and tsunamis, causing severe loss of life and damage to infrastructure as well as financial damage across the North Atlantic. The aim of the M141 Meteor-cruise was among others to sample marine ash layers via gravity coring around the Azores islands, to establish long records of ash dispersal, eruption frequency and composition of highly explosive eruptions.

Major element analysis of glass shards, pumice glass and minerals in pumices from the 445 cm long core M141-1144, located 65 km south of the island Sao Miguel have been conducted to establish origins of fallouts from large eruptions and P-T- parameters of crystallisation for the ascending magmas. Using electron-micro-probe and polarisation microscopy, glass shards, pumices and minerals where analysed at the GEOMAR Helmholtz Centre for Ocean Research in Kiel.

Glass shards compositions in different layers throughout the core display dominantly trachytic composition and most likely originate from volcanism on Sao Miguel. Additional mafic glass is confined to a limited number of layers. By comparing element ratios between K2O and Na2O as well as TiO2 and SiO2 with geochemical data from the GEOROC database from the Max Planck Institute for Chemistry Mainz, Germany [1] it was possible to narrow the possible origin down to the certain volcanoes, most likely Sete Cidades, Furnas and Agua de Pau. Major elements composition of minerals and pumice glass where compared and tested for chemical equilibrium using the Putirka 2003 [2] model and pressure conditions for feldspar crystallization where established with poly-thermal solidus curves from Nekvasil (1992) [3]. Results suggests that relatively mafic magmas stagnated and fractionated in the upper mantle at ca. 8±2 kbar and relatively evolved magmas stagnated and fractionated in the lower crust at ca. 4±2 kbar. This is comparable to the crystallization conditions obtained from other Atlantic Ocean islands (e.g. Galipp et al.; 2006) [4].

Further analysis of trace elements as well as the compositions of the other cores sampled near Sao Miguel is needed to clearly verify the source of the single layers and magnitudes of the eruptions.

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DEVELOPMENT OF INTROSCOPIC METHODS FOR STUDIES OF COALSMICROSTRUCTURE OF THE PECHORSKY BASIN

The modern strategy of solving the problem of ensuring the safety of underground mining among the priorities involves solving the issues of reliable prediction of various types of gas-dynamic phenomena occurring in coal mines. The danger of sudden emissions of coal (rock) and gas in the main coal basins of the country, leading the extraction of coal, in the future will increase due to the deepening of mining operations and the intensification of technological processes of mining. To predict and prevent dynamic phenomena in coal mines, a clear understanding of the distribution and voltage changes in the bottomhole zone of the gas bearing coal seam and the distribution of the strength properties of coal is necessary, since the destruction can begin at the most weakened contacts: natural fractures, macropores, defects, etc., accumulating desorbable methane [1].All this leads to the fact that given the extreme heterogeneity of coals, it is necessary to investigate their internal structure at various scale levels, including macro, meso and micro levels.

In the work with the use of optical and electron microscopy, the structure of the surface of coal samples was investigated, and elemental analysis was performed [2]. It is shown that iron-containing impurities are present in most of the area, which are the catalyst for methane synthesis in coal. Based on the propagation of surface cracks, it was concluded that the coal samples presented correspond to degree II of tectonic disturbance and have a layered structure.

Precision measurements of the elastic wave velocities based on laser-ultrasound structuroscopy made it possible to visualize the internal structure. It was found that in the vertical sections of the crack specimens are located mainly horizontally. Their geometric dimensions and depths are determined. Horizontal occurrence of cracks is characteristic of coal with a layered structure. Measurements of the velocity of elastic waves with an error of about 0.2% made it possible to determine the local elastic moduli. The obtained local values of Young's modulus and Poisson's ratio turned out to be close to the values measured during mechanical tests[3].

Thus, the methods of laser-ultrasound diagnostics in combination with electron and optical microscopy and mechanical tests are a promising direction for diagnosing the study of the internal structure at the micro level and determining the local elastic characteristics.

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SEISMIC AND GEOLOGICAL MODELS OF HYDROCARBON TRAPS INDEVONIANAND CARBONIFEROUS DEPOSITS OF THE SOUTH-WEST OF TOMSK REGION

One of the urgent tasks of hydrocarbon exploration in Russia is the study of relatively understudied rock complexes in areas with developed oil and gas infrastructure.One of such complexes is the oil-and-gas-bearing horizon of the zone of contact between Paleozoic and Mesozoic rocks in Western Siberia.The significant petroleum potential of this complex has long been proven [1] and recently many researchers have studied the tectonic structure and lithology of these deposits [2] and have developed Paleozoic traps models [3]. In spite of these facts, there are still a lot of questions concerning the tectonic structure of the pre-Jurassic complex, lithologic-and-stratigraphic division of the strata forming it and the methods of complex hydrocarbon traps mapping.

This paper proposes the author's model of the geological structure of a number of fields in the south-west of the Tomsk region. Hydrocarbon traps in the pre-Jurassic complex in the area are confined to several genetic types of rocks: dolomitic limestone (D_1), silica-argillite (D_3), and siliceous limestone (C_1). The deposits of the weathering crust, covering silicon-containing rocks, are also productive.

The model is based on the integrated interpretation of 2D and 3D CDP seismic data, well logs, core descriptions, reservoir parameters.The researchwas carried out in proprietary software tools, developed at IPGG SB RAS (the authors have a direct relation to the development of them), adapted for the tasks of geologists working at the stage of prospecting and exploration of hydrocarbon fields.

As a result of the study, a structural map and a map of the material composition of the Paleozoic top were constructed, the faults some of which limit hydrocarbon traps were identified. The following conclusions were made: 1) For dolomitic limestone (D_1), the predictive criterion is the degree of their metasomatic transformation by hypergene processes, that is, they must be located near the erosion surface, outside the tectonic protrusions.After special seismic data processing for better visual presentation and the possibility of reliable interpretation on seismic sections and cubes this rocks correspond to highwave amplitudes. 2) For silica-argillite (D_3)**,** siliceous limestone (C_1) and the weathering crust covering those, contrasting erosion-tectonic protrusions of Paleozoic rocks, intensively dislocated by faults are favorable for traps location andthey correspond to low wave amplitude blocks.

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MONITORING OF LAND USE CHANGES CAUSED BY HISTORICAL UNDERGROUND MINING IN MIEDZIANKA VILLAGE

Underground mining was a part of the history of Lower Silesia, Poland. Miedzianka Village is an example of one of such places, where copper mining and metallurgy was present. First records of its mining activities are dated to the beginning of the 14th century[1]. During the second part of the 20 th century uranium was also excavated in the Miedzianka area. Due to past underground mining, Miedzianka Village surface started to collapse, destroying and burying many buildings and other structures underground [2]. When the subsidence started, people left for the better suited places to live. Nowadays though there are still some inhabitants in the village. The research main objective was to verify the terrain stability in present times and finding and documenting of historical excavation infrastructure. In order to better understand the terrain and its changes the research team acquired current and historical maps of the surface and historical mining maps from adequate institutions. The vectorization of buildings based on surface maps and excavations using mining maps were the next step. The research team planned to use Digital Elevation Model made from data acquired through InSAR technology, although land coverage being mostly forest made the outcome insufficient [3]. Series of five survey marks was established and static GNSS survey was done. Two of those were placed outside the expected deformation area as the control points. Further surveys are planned to be made in order to monitor the terrain changes. The surveying team also found out and charted post-mining remnants like shafts and mining dumps. In addition, for four historical buildings photographs were taken with a non-metric camera to produce 3D models using the Structure-from-Motion method. The results of already performed operations were visually developed, historical buildings in the form of animations, which were made available on the YouTube website, and all gathered data integrated and published within WebGIS application – ArcGIS by ESRI[4]. Until present only first survey was carried out. Next is planned for summer 2019. Only then the real conclusions regarding deformations can be made. Additionally the research team plans to perform levelling between established points and historical buildings. The cooperation with team of geophysicist is also being discussed.

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GEOLOGICAL RISKS IN THE DEVELOPMENT OF THE POTASH SALT DEPOSITS WITHIN THE PRIPYAT POTASH-BEARING BASIN

The Pripyat potash-bearing basin (Belarus) is the third largest source of potash in the world, producing 12million metric tons of fertilizers in 2018 [3].Belarusian potash resource base includes the Starobin depositunder exploitationwith few prospects, the Petrikov deposit underthe development and the Oktyabr depositon balance. All the deposits with prospects differ in mining and geological conditions. To minimize geological hazards and maintain high rates of ore mining it is important to study geological risks fromprospecting toexploitation of potash salt deposits.

All geological risks of the development of potash salt deposits can be divided into four groups. The first group includes internal risks of potash horizons connected to their geological structure and composition of potash salts. Harmful impurities are insoluble residue (the Starobin deposit)and carnallite (the Petrikov deposit) that influence on quality of potash ore.Depletion zones representsareas of eithertotal or partial potash removal by secondary brines. The locations of dissolution features are crucial toresource estimation and mine planning. Instantaneous outbursts of gas and salts are connected with clayey and carnallite layers when they are roof of mine opening. The outbursts can lead to human victims.

The second group represents risks of geological settingof potash deposit.Stratabound potash deposits in thewestern part of the Pripyat basinare disrupted by faults on structural blocks. As faults can be pathways for groundwater the driving of mine opening in faults is possible dangerous processthat pose a floodingthreat. Overlying high-pressure aquifersis one more reason for flooding of mines.Potash-bearingsalt units are disrupted by salt tectonicsin the eastern part.As depth increases, so does rocktemperature [2]. In the mine areas, thepotash horizons are approximately 500-1,200 mbelow the surface.

The third group includes those risks that connected with prospecting and exploration of potash salt deposits.These risks appears as failures to follow procedure methodsand incorrect interpretation of results. They can lead to incorrect assessment of potash resources.

The fourth group represents risks that can be occur in or after the development and exploitation of deposits. These geological hazards are flooding, outbursts of gas and salts, subsidence of surface and earthquakes.

One of the restrictions based on geological risk assessment is safe mineable depth for the development of potash salt deposits in the Pripyat potash-bearing.It is 1,200 mbelow the surface[1]. Increasing geothermal temperatures,in part associated with thinned crust in the Pripyattrough, and deformation of salt with increasing depths andpressures limits where potash can be developed by usingconventional underground mining methods.

It is necessary to conduct complex study and assessment of all geological risks for each deposit in the basin. The results can lead to creation new restrictions or modifying of guidelines for the development of potash salt deposit.

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THE IMPROVED METHOD FOR DIGITAL ELEVATION MODELLING UNDERMINED TERRITORIES OF DONBASS ON SATELLITE IMAGES

Using digital elevation models (DEM) helps to improve the accuracy of the forecasting displacements and deformations of the earth's surface from the influence of underground mining [1]. The formation of DEM for areas of mine fields is a non-trivial task due to the continuous deformation of the earth's surface [2]. Digital processing of raster space images containing data SRTM-survey is one of the most perspective ways to quickly create a DEM of undermined areas ёмки [3, 4]. The actual task is to create a method of digital modeling relief on space images with the highest possible accuracy.

There has been developed a new method of digital processing satellite image rasters containing SRTM data with using control points. The essence of the method is as follows. First, the space image is digitized to form a DEM [3] in the UTM system (Universal transverse Mercator projection). The result of digitization will be a DEM formed in the WGS-84 system. Then, for 6-10 well-identified control points in the image, their coordinates in UTM and Pulkovo-42 systems are determined. Control points should be outside the area of influence of mining works. Then the coefficients of Helmert transformation are determined using the algorithm of this transformation with coordinates of control points in two systems (UTM and Pulkovo-42). At the last stage, using the found coefficients, the re-calculation of the coordinates of the DEM from the UTM system to the Pulkovo-42 system is performed.

The developed algorithm was tested in the summer of 2018 in the Donbass and showed a fairly high accuracy of the DEM, created from space images, close to the accuracy of SRTM-survey. The use of such a DEM significantly increases the accuracy of the forecasting displacements and deformations of the earth's surface caused by underground mining works.

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OPERATION OF MULTI-COPTERS FOR SURVEYING

This paper mainly introduces the mine surveying and a new technology multi-copter in recent years. First, the thesis briefly outlined the application of this technique in different fields.

Two specific cases were carried out to discuss the operation of multi-copter-based image acquisition in open-pit mine and underground mine. In the first case, the digital surface model (DSM) was generated and more ground control points (GCPs) in the calibration would increase the accuracy of the DSM. In the second case, digital terrain model (DTM) of the subsidence was generated and it was used for deriving the topographic characteristics of the subsidence. The DSM in two cases were verified to be accurate and indicated that the multi-copter could operate in mine surveying.

Through analysis and comparison, it was obvious that multi-copter had some advantages and disadvantages. Besides, based on the model in two cases, it is obvious that the model can be also used in those items such as the road condition analysis the blasting analysis and so on. Finally, the thesis forecasted that in the future how could the new technique change to adapt to the mine surveying.

Keywords: multi-copter; operation; open-pit mine; underground mine;

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FEATURES OF THE OLHOVATSKO-VOLYNTSEVSKY ANTICLINAL DONBASS MINERALOGY

The Donetsk Basin is a large synclinorium formed in the crystalline basement of the southern part of the Russian platform between the Ukrainian and Voronezh crystalline massifs. Among the folding structures of Donbass, the main ones are the zone of large linear folds (Main anticline), the northern and southern zones of small folding, the Bakhmut and Kalmius-Toretskaya basins. The main anticline is located in the central part of the Donetsk basin and is a simple narrow linear fold with a steep fall of the wings (up to 60-75), which is divided into several parts: Druzhkovsko-Konstantinovskaya, Gorlovskaya, Olkhovatsky-Volyntsevskaya and other anticlinal folds. Olkhovatsko-Volyntsevskaya anticline as a second-order structure complicates the main anticline of Donbass east of the Gorlovsky thrust. Gorlovsky thrust is tracing in the upper structural floor the western border of the Central transverse rise of Donbass [1].

Antimony-mercury deposits (Nikitovsky ore field) are widespread within the main anticline of Donbass. The western pericline of the Olkhovatsko-Volyntsevskaya anticline is adjacent to the Nikitovsky ore field through the Gorlovsky thrust zone. This characterizes the antimony ore occurrence near the village of Verovka. Southeast of this anticline are polymetallic and gold-polymetallic ore occurrences of the Nagolchansky ore cluster. In the northwestern pericline of the Olkhovatsko-Volyntsevskoy anticline (Lesnoy, Verovsky sections, Galchenko beams) previous studies have established argillisites consisting of quartz, kaolinite, hydromica. The presence of predominantly quartz, sericite, pyrite, and chlorite is expected in the central part, closer to the Nogolny Ridge, as part of pre-ore metasomatites. Southeast of this anticline are polymetallic and gold-polymetallic ore occurrences of the Nagolchansky ore cluster. In the northwestern pericline of the Olkhovatsko-Volyntsevskoy anticline (Lesnoy, Verovsky sections, Galchenko beams) previous studies have established argillisites consisting of quartz, kaolinite, hydromica. In the central part, closer to Naked ridge, as part of pre-ore metasomatites, the presence of predominantly quartz, sericite, pyrite and chlorite is expected [2]. But the central part of the anticline (60–70 km long) is practically not studied mineralogically. Therefore, this work is devoted to a more detailed study of the mineral composition of the Lesnoy-Yuzhny site. Using the method of optical microscopy, were investigated in polished sections of Sandstone and mudstone. The research results showed that the predominant ore minerals of the studied area are galena, pyrite, sphalerite, non-metallic - quartz, feldspar. Perhaps there is the presence of native gold.

Thus, within the limits of the Olkhovatsko-Volyntsevskogo anticline, it is possible to reveal the mineralization belonging mainly to polymetallic, antimony, mercury-polymetallic and gold-sulfide ore formations.

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FEASIBILITY STUDY ON THE OPERATIONAL IMPLEMENTAION OF RESOURCE MODEL UPDATING AT ANLOGOLD ASHANTI CÓRREGO DO SÍTÍO MINERAÇÃO UTILIZING NEW INCOMING SENSOR INFORMATION TO IMPROVE RESOURCE MODELLING

Resource updating is a Kalman-filter based algorithm that lowers the uncertainty of an estimation of an unknown variable by giving a new estimation based on a series of measurements [1]. In the scope of mining, this approach can be used to continually improve short term models or any other sort of model-based predictions. In order to achieve such improvements, deviations from model-based predictions, which most often occur during a mining operation, are monitored and integrated back into the short term model. The aim of this paper is to provide an example for the range of applicability of resource updating along the mining value chain. To be precise, this work was conducted to investigate the feasibility of resource updating at the gold mining complex in Cuiabá and Lamengo, operated by AngloGold Ashanti Córrego do Sítio Mineração (AGA Mineração), and its subsequent processing plant in the state of Minas Gerais in Brazil. While the applicability of resource updating was already proven successful in an open pit mining environment [2], this work focuses on the feasibility of resource updating in an underground mining environment with a low density of available information.

At first, a brief introduction to resource updating and related geostatistical methods will be given. Second, the mining complex in Cuiabá and Lamengo, as well as a summary of the conducted analysis (including the analysis of existing resource modelling efforts, the material flow from the mining sites to the processing plant and the material flow inside the processing plant) will be presented. Third, the results of the analysis and their evaluation will be provided. Based on the results of this study it can be said that continuous resource updating at AGA Mineração can increase the quality of model-based predictions, and has the potential to result in an overall increase in productivity. However, resource updating is only feasible if certain criteria are met. This includes the use of a unitary coordinate system for production and model data, the automation of ore tracking, as well as the adjustment of the numbers of sample increments over the course of 24h.

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KINEMATIC APPROACH TO GEODYNAMIC ZONING BASED ON ARTIFICIAL NEURAL NETWORKS

The use of the most reliable information on the earth's surface displacements is extremely important when attempting geodynamic zoning. Zoning by the analysis of displacements and deformations of the earth's surface, allows predicting the long-term state of the locations of mining and geological objects. Various data on the fields of displacement of the earth's surface and the calculated characteristics of them obtained (deformation, velocity of displacement and deformation, dilation) allow to obtain both fundamental knowledge about the geodynamic regime of the studied region or local area, and serve as a justification for the safety of operation of various natural and natural-technical objects (slopes, oil and gas pipelines, construction sites, etc.).

The aim of the study is to develop and test the method of geodynamic zoning according to the data on the kinematic state of the earth's crust based on artificial neural networks. As a result of modeling, the following results were obtained: the structure of an artificial neural network was developed; on its basis, more accurate maps of the distribution of fields of displacement and deformation of the earth's surface were constructed; a method for isolating geodynamical homogeneous areas of the earth's crust was presented.

The presented methodology involves the training of an algorithm that implements the prediction of the kinematic characteristics of the earth's surface displacement. This methodology is based on the generalizing property of artificial neural networks, which takes into account the fundamental features of the geological environment. Application of the considered method in specialized CAD allows reducing industrial and environmental risks of operation of the objects, which are in difficult mining and geological conditions

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DYNAMIC MODELING OF DEPOSITS BASED ON ARTIFICIAL NEURAL NETWORKS

Today, modern mining industry faces GrandChallenges, such as:

- Creation of digital twins of mineral deposits.
- Development and implementation of automatic monitoring systems to control the state of the subsoil.
- Use of unmanned aerial vehicles and automotive transport.
- Use of computer vision and Theory of pattern recognition.
- Creation of integrated analytics with Big Data tools.

Using of intelligent methods to analyze geological information is the main trend in the development of digital analogue of modern mining. Artificial neural networks are of major interest among existing mathematical models in geology. Currently, a number of artificial neural networks allow us to implement multivariate modeling in different disciplines [1-3]; however, in geology neural networks are used insufficiently.

Withthe help of an artificial neural network, I recognized the ore types of the lead-zinc deposit. On the basis of the data obtained, geologic cross-sections and three-dimensional models of mineral deposits were constructed. Artificial neural network training was conducted on an array of geological data (834 samples). Data of preliminary survey was used to train the neural network. The result obtained was close to the data that was received as a result of constructing a condensed intelligence network.The simulation results showed a good percentage of recognition: 92% (115 samples from the control sample) of correctly defined rock types.

Use of artificial neural networks opens wide possibilities in direction of reduction the time to process geological information with constant increase of its reliability.

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PATTERNS OF MANIFESTATION AND PLACEMANT OF COPPER-NOBEL METAL MINERALIZATION IN THE GABBRO OF SEREBRIANSKY STONE

Over the period of 250 years, the Urals Platiniferous Belt is known as an ore area. Although, the exploration degree of its ore-bearing intrusive complexes differs significantly. The sites located in the Middle Urals, unlike the massifs in the North Urals, which include the Serebryansky Stone Massif, have been studied in detail. The similarity of the geological structure of Serebryansky stone with the Volkovsky deposit, noted by its predecessors [2], the existence of small copper occurrences and points of mineralization have determined the expediency of studies of the patterns of distribution of copper and noble-metal mineralization.

To achieve this goal, geochemical survey of primary halos was performed in 2018. The chemical element content of the samples is determined by ISP-MS analysis conducted by the Central Analytical Laboratory of the A.P. Karpinsky Russian Geological Research Institute (VSEGEI). Contents of precious metals were analyzed by the assay, atomic and emission method conducted by the MEHANOBR Laboratory.

To address the issue of confinement of mineralization in the massif, maps were constructed in copper isoconcentrates for two areas within which old copper mines are located. Their analysis has shown that copper sulphides have been confined to mineralized areas which are small, i.e. up to 150 m in diameter. The results of the chemical analysis have been confirmed by the results of the mineralogical description of scrap samples: in the samples falling into the contours of anomalies, there is a dense embedding of bornite and chalcopyrite.

Gabbro is characterized by an extremely uneven distribution of copper sulphides. Cu content varies widely from 0.01 to 0.4 % in rocks with increased sulfide impregnation while anomalous values are up to 1.5 %. According to the results of the assay analysis of gabbro samples the background, Au content was 0.032 g/t, Pd was 0.049 g/t. The total content of precious metals in areas with increased copper content has been 1 g/t on average, the maximum values reach 3.15 g/t.

The area of distribution of the melanocratic variety of amphibole gabbro with increased copper content has been confined to the central part of the massif, which is typical for the Volkovsky deposit [3]. The set of ore minerals in the metallic gabbro of Serebryansky stone is also similar to the ores of Volkovsky deposit [1]. The average content of copper and precious metals in the mined gabbro of the Serebryansky massif and the Volkovsky deposit are also comparable. The analysis of the totality of the obtained results allows us to consider the amphibole gabbroid of the Serebryansky stone as promising in terms of identification of industrial copper-bonded metal mineralization.

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INFLUENCE OF HYDROTHERMAL TRANSFORMATIONS ON THE PHYSICOMECHANICAL PROPERTIES OF VOLCANOGENIC ROCKS OF THE PAUZHETSKY DISTRICT (SOUTH KAMCHATKA)

The formulation of the research topic is connected with a comprehensive study of the areas of development of hydrothermal processes. The lack of knowledge from the point of view of engineering geology of the areas where these processes are distributed, both modern and already lost their activity today, makes the issue under consideration particularly relevant. Obviously, first of all, attention should be paid to the ground column, which is in the sphere of influence of such a specific process as hydrothermal processing, which predetermines the formation of a new look and change of soil properties.

This problem also has a scientific interest and helps to contribute to the development of soil science. In particular, it encourages consideration of new factors shaping the properties of volcanic rocks.

Volcanic-sedimentary soils of hydrothermal fields in the south of Kamchatka, which are subject to argilization and zeolitization, are studied in this work.

The purpose of the study is to study in detail the effect of hot fluids on volcanogenic rocks within areas with different intensity of hydrothermal processing.

To achieve this goal, structural and mineralogical transformations and the tendency to change the physicomechanical properties of the tuffs of the Upper Pauzhetsky sub-suite (N23-Q1 pau3), composing the upper part of the section of the Pauzhetsky geothermal deposit, were investigated with their thermal waters. The work deals with petrographic and geotechnical features of these rocks; describes the process of transformation of their structural and mineralogical characteristics, up to the transformation into hydrothermal clays, and the accompanying changes in properties (physical, physical and mechanical) in the section of the Upper Pauzhetsky thermal field.

The tuffs of the Upper Pauzhetsk sub-suite are characterized by low indices of physical and physicomechanical properties, high porosity and permeability, have micro-fracture, which contributes to their hydrothermal processing.

It has been established that tuffs undergo significant changes in the mineral composition, consisting in pseudomorphic replacement of vitro, crystal and lithoclasts by secondary minerals, primarily zeolites and smectites. The rocks are softened, the structure of the pore space changes, a network of microcracks is formed, which leads to a significant decrease in the strength and deformation properties. It was confirmed that the change in the properties of tuffs depends mainly on the degree of their conversion by the hydrothermal solution.

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DEVELOPMENT OF A CONCEPTUAL MODEL OF FORMING CAMBRIAN HIGH-PRODUCTIVE COLLECTORS OF EASTERN SIBERIA

The impressive part of the hydrocarbons in the territory of Eastern Siberia of the Nepsko-Botuobinsky oil and gas region is confined to the deposits of the V-$Є_1$ complexof layers B_{3-4}, B_5. Within the central part of the anteclise, a number of features that are associated with the presence of catches and hydrocarbon depositsare established, the main of which is the presence of paleo-protrusions of the crystalline basement. At present, there are no data on the boundaries of zones with high reservoir properties and corresponding hydrocarbon parameters, which are of key importance when calculating reserves. In this regard, it is required to estimate the amount of leaching, which is carried out above the protruding bases and the volume of formed cavernous voidness in carbonate sediments of the productive horizons.

In accordance with the existing model, the development of highly productive zones is associated with the elision stage of the paleobasin development [1]. Clay sediments accumulated during the Vendian time are enriched with water. As a result of diagenesis, the sediment compaction and squeezing the solution towards the projections. [2]The streams of squeezed fluids reached the regional salt cap and dissolved the salts in the cavities, creating an additional volume of vugs.

The paper evaluates fluid dynamic processes within the protrusions.The model is based on paleotectonic analysis and restoration of clay paleo-thickness. [3]

As a result, high reliability of the data was obtained on the basis of fluid dynamic processes modeling and on the basis of actual petrophysical data. The model can be used in the assessmentof volume (area) of highly productive zones, develope and assessment of geological reserves.

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IMPROVED RESERVOIRS ZONES DETERMINATION IN PALEOZOIC FORMATIONS OF NUROL DEPRESSION (TOMSK OBLAST)

Currently in the Western Siberia both search and evaluation of oil and gas promising Paleozoic formations is a very urgent problem due to necessity to increase the potential of the Cretaceous and Jurassic fields by deeper sources of hydrocarbons.The main reason of this interest is to increase number of oil and gas Paleozoic fields discovered annually. The purpose of the research is to determine improved reservoirs zones in Paleozoic formations of Nurol depression.

The object of the research is located in Tomsk Oblast. Pre-Jurassic deposits are the main development objects with high operational parameters. There are two lithological objects: carbonate-clay-siliceous deposits of crust of weathering (M pay) and Devonian rocks of the carbonate basement (M_1 pay).Locally, the reservoir of these pays is hydrodynamically joined.

Carbonate rocks are one of the most difficult to model. Seismic attributes are used to predict improved reservoirs zones distribution. Attributes are directly connected with the seismic parameters V_s, V_p, ρ (primary wave velocity, secondary wave velocity, density respectively) [1].

Petro-elastic modeling is one of the most relevant methods to establish a connection between attributes and predictive parameters. This method allows to determine the dependences between petrophysical properties of rocks and parameters obtained from seismic survey, geophysical well logging and laboratory study [1].

The Authors carried out the analysis of the obtained results of interpretation of seismic data and well data (core description, geophysical well logging and well test results).

The seismic pulse configuration was predicted according to seismic data. The shape of the reflected wave describes integral characteristic of geology rock-layer associations. Considering this, it is possible to establish a correlation between seismic attributes (energy, dispersion, coherence, etc.) and productive parameters. From seismic survey, vertical and lateral wave form changing have to reflect not only the variability of the facies and tectonic environments, but also have to indicate the spatial position and reservoir influence boundaries.

Reference wells were used according to seismic data. These wells entered M and M_1 pays to assess reservoir rocks qualitatively.Seven types of rocks of reservoir with gas, oil, gas and oil saturation were identified according to seismic data and core description. Considering this, the rocks distribution map through the territory of the object was constructed.

The obtained results were compared with the results of the previous research of lithofacial relationship. In deposits of lithofacie of barrier reefs there is anhydrous hydrocarbon saturation with relatively high gas and condensate productive rate [2].

In conclusion, the conducted researches confirm that combined researches of well data and field geophysical survey allow to get the concept of the geological structure of the territory and to predict the most promising zones of improved reservoirs.

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APPLICATION OF UAVSIN PROSPECTING AND EXPLORATION OF MINERAL DEPOSITS

Nowadays, most branches of industry try to reduce cost of production by introducing new technologies. Recently, mining companies have been thinking of usage of UAVs inworking process, mostly in prospecting and exploration of mineral deposits.Field of application of UAV technologies is a new thing in mining industry, but there are some prospects in using it already. However, possibility of successful introduction of Unmanned Aerial Vehicles in working cycle has not yet been studied well. So there is plenty space to explore.

In this work I have undertaken a study of application of Unmanned Aerial Vehicles in prospecting and exploration of mineral deposits, also I have figured out other possibilities of UAV usage in mining.There have beenidentified certain geophysical methods of exploration of mineral deposits that can be used with UAV technology. [1]Therehave been comparedthe usage of classic aviation units and theusage of their unmanned equivalent.There have been determined some setups for different work conditions and types of resources the mining companies are looking for. [1,2]There have been analyzed some improvements that can be achieved by introducing Unmanned Aerial Vehicles into the life of mining facilities. Moreover, there have been found out some examples of including this technology in working process of some leading mining companies. [3] That can stimulate further exploring of UAV in mining.

In conclusion, there has been confirmed the possibility of using UAVs in prospecting and exploration of mineral deposits. There has been estimated positive influence of introduction of UAV in working process. [1,3]In my opinion, further theory researches and real tests of this section may be extremely useful.

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PREDICTION OF GOLD OCCURRENCE IN THE TARQ PROSPECT AREA BY MONITORING OF AU, AS AND SB ELEMENTS AND K-MEANS CLUSTERING METHOD

Introduction

Tarq geochemical 1:100,000 Sheet is located in Isfahan province which is investigated by Iran's Geological and Explorations Organization using stream sediment analyzes. This area has stratigraphy of Precambrian to Quaternary rocks and is located in the Central Iran zone. According to the presence of signs of gold mineralization in this area, it is necessary to identify important mineral areas in this area. Therefore, finding information is necessary about the relationship and monitoring the elements of gold, arsenic, and antimony relative to each other in this area to determine the extent of geochemical halos and to estimate the grade.

Main Part

K-means method is used for monitoring the elements in the present study, this is a clustering method based on minimizing the total Euclidean distances of each sample from the center of the classes which are assigned to them.In this research, the clustering quality function and the utility rate of the sample have been used in the desired cluster (S(i)) to determine the optimum number of clusters. Finally, with regard to the cluster centers and the results, the equations were used to predict the amount of the gold element based on four parameters of arsenic and antimony grade, length and width of sampling points.

Conclusion

Considering the evidence of gold mineralization in the Khoni zone, investigating the extent of geochemical halos and the behavior of gold paragenesis elements is important in the region. For this purpose, the behavior of the elements of gold, arsenic, and antimony was compared with each other in the Khooni area using K-means method and it was examined between two elements. The equations were presented along with correlation coefficients. Then, the relationship of elements was determined using this method by taking into account the latitude and longitude of the samples in order to estimate the grade and more accurate estimation of the appearance and extent of the geochemical halos in the studied area. According to the results obtained from the process of the mentioned elements, the equation is as equation 13 for the estimation of the gold grade based on four parameters of arsenic grade, antimony grade, length and width of sampling points and the correlation coefficienthas been reported 72%.

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MINING UNDER ARCTIC CONDITIONS

As the global demand for resources rises and more and more deposits are being exploited, the mining industry has to expand its business to more isolated parts of the world like the Arctic. The Arctic and the arctic regions contain for example the largest not yet mined reserves of gold (besides the gold witch is solved in the oceans) as well as large deposits of iron, coal, diamonds, zinc, lead and silver. The Red Dog Mine which is located in Northwestern Alaska is the second largest lead/zinc deposit ever discovered with a mineral reserve over 80 million tons, at a grade of 22% combined lead/zinc.

The rising demand for resources and the particularly enormous deposits in the Arctic make mining and interesting endeavor for mining companies. Though the Arctic is one of the most challenging environments for mining. One of the biggest problems is that the arctic deposits are mostly completely isolated. So all the mining equipment has to be carried to the deposit which might be done by a barge like at Polaris mine on Little Cornwallis Island, Canada and the personal might have to be flown in and out on a regular basis. Also the transportation of the excavated ore might be a problem. In anyways the logistics need to be planned and executed masterly in such isolated areas.

Besides the isolation of the Arctic the climate provides a lot of difficulties for mining operations. Most of the arctic regions are located in a permafrost zone with annual average temperatures below zero. Additionally, there is no usual day and night in the Arctic. The sun will shine continuously during for one half of the year, while it is dark during the other half. So the temperatures in the summer might go far above zero which results in thawing of the upper permafrost layers. This thawing might also have crucial effects on the ground stability. So thawing can make the ground inaccessible for machines which are needed to transport material to the mine (especially in the construction phase). Another negative effect of thawing and refreezing of a ground is the ground expansion that might result in the collapse of mining structures/buildings built on the permafrost ground.

These are just two arctic conditions with a great effect on mining operations. There are many more. However, the deposits in the arctic are lucrative enough for mining operations to be carried out. As the necessity for mining in the arctic increases, it is important to know about the conditions that affect a mining operation in the arctic regions. Hence, this thesis will present the requirements such an operation has to full fill to cope with the hostile arctic conditions.

This thesis should give the reader information about the importance of mining in the Arctic and about the requirements, any mining operation has to full fill, especially concerning exploration, mine planning and design, reclamation, drilling and blasting and conveying. Also a short introduction about the Arctic deposits and the Arctic environment will be given. This thesis will orientate on examples of actual mine operations that have been or that are still being carried out.

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TYPES OF ANTICLINE TRAPS IN THE NORTHERN AND ARCTIC REGIONS OF WESTERN SIBERIA (ON EXAMPLE OF FIELDS OF NADYM-PUR, YAMAL AND GYDAN AREAS)

The paper deals with the territory of Western Siberia, in which the main hydrocarbon reserves are concentrated in structural anticlinal traps. Northern and Arctic regions are no exception. Despite the similar modern structure of anticlinal traps, the history of their tectonic evolution is significantly different, and their study has a fundamental aspect of understanding the formation of hydrocarbon deposits in general.

During the study, the complex interpretation of seismic materials and geological data was performed [1, 2], the current structure of the main reflecting seismic horizons was analyzed, and the tectonic evolution of the positive structures of the northern part of Nadym-Purs, Yamal and Gydan oil and gas regions, which included large and giant hydrocarbon deposits, was restored. .

The paper shows that the positive structures of the northern part of the Nadym-Puroil and gas region- Medvejya, Yamsoveiskaya and Yubileynaya - are rootless, they are not confined to the pre-Jurassic basement blocks, the main stage of formation took place in the Turonian-Cenozoic time. The Cenozoic faults played a large role in terms of petroleum potential, they cut off almost the entire sedimentary cover and they were the channels for the migration of hydrocarbons from the Jurassic maternal sediments up the section.

Within the Yamal oil and gas region, the largest positive structure is the Nurminskymegaswell- formed over a large basement block, intensively divided into separate blocks, the Bovanenkovo, Kruzenshtern and Arctic,they are associated with positive structure. The development of these structures took place throughout the entire Mesozoic and Cenozoic, but by the time of the Aptian Age the uplifts were close to the modern form, the maximum increase in amplitude occurred at the time after the Cenomanian Age.

Within the Gydanoil and gas regionGydan and Packetskysurface doming, the Geophysical mesoval are the root structures that developed gradually during the entire Mesozoic and Cenozoic. The East Zelenomysskyswell was fully formed by the the Turonian age and did not experience a tendency to increase after the Cenomanian Age. Thus, within the study area there are three fundamentally different types of structures.

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COMPARATIVE CHARACTERISTICS OF THE SEISMOLOGOLOGICAL MODEL OF THE GYDAN AND NOVII PORT FIELDS

The paper deals with the geological structure, structural characteristics and the restoration of the tectonic development history of the Gydan dome-shaped uplift and the Noviiport shaft, to which the Gydan gas (Gydan peninsula) and Noviiport oil and gas condensate (Yamal Peninsula) fields are confined. Despite the close modern geographical position of the Yamal and Gydan peninsulas, these areas are distinguish in tectonic evolution, sedimentary cover structure and fault tectonics, which predetermine differences in petroleum potential. There is no unified tectonic structure model for the study area, the geologists opinions are different on many issues. The Arctic regions are potentially productivepetroleum Russian Federation area and have sufficient potential for discovering new fields; therefore, a comprehensive study of already discovered fields in the region as a sample is very important.

During the study, methodologyof the comprehensive interpretation of seismic materials and geological data in order to solve predictive tasks was based on the main principles of structural, paleotectonic, seismic stratigraphic analyzes [1]. Structural and paleotectonic analyzes means an analysis of the modern tectonic structure of the territory and paleostructural reconstructions, the restoration of tectonic processes that took place at various stages of geological history. The paleostructural reconstructions are based on the analysis of the sedimentary complexes thickness distribution by area. The analyses ideas and methodology developed in the works of Shatsky (1924), Belousov (1940), Garetsky (1960), Mashkovich (1976).

The paper shows that the Noviiport shaft is formed above the basement high, shaft beganto grow in early Cretaceous time, and the main growth was in Cenozoic. Gydandome-shaped uplift is also a root structure, but growth has occurred throughout whole Mesozoic-Cenozoic history. Due to the more intense Cenozoic tectonics on the Yamal Peninsula, tectonic screens are present in the Noviiport field. The wider stratigraphic interval of hydrocarbon productivity in the Noviiport field is explained by the authors by the differences in the folding stage, the different structure of the Paleozoic sedimentary unit, different paleogeography in the Jurassic and Cretaceous time and, as a consequence, by different source rocks, reservoirs and reservoir caprocks [2].The reported study was funded by RFBR according to the research project № 18-35-00492.

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INFLUENCE OF POST-SEDIMENTATION CHANGES IN CARBONATE ROCKS ON THE FORMATION OF RESERVOIR PROPERTIES AND HYDROCARBON PRODUCTION

The object of study is in Eastern Siberia and is unique in its geological characteristics [2]. The main hydrocarbon reserves are concentrated in carbonate reservoirs of Riphean age. The formation of such reservoir is due to several factors, among which are the conditions of sedimentation and the transformation of rocks at different stages of lithogenesis [1]. The primary properties of rocks are modified by the processes of dolomitization, recrystallization, pyritization, stylolization, sulfatization, dissolution and silification.

The topic under consideration is relevant, since some difficulties arise in the study area during the production of hydrocarbons. Problems are expressed in a low rate of penetration, a high degree of wear of rock cutting tools, a decrease in the productivity of wells. The above problems are probably related to the authigenic formation of minerals. To solve problems, first of all, it is necessary to understand the course of post-sedimentation processes and to be able to predict promising areas.

In the course of work a lithological analysis of rocks was carried out, sections were made with the indicated of intensity of secondary processes, the technique of identifying cavernous intervals using geophysical well logging was applied and the possibility of applying the results was considered.

As a result of the work done, it was found that the process of dissolution had the greatest positive influence on the formation of reservoir properties. Several theories of cavities formation are considered. The presence of formations of various forms of quartz-chalcedony composition is widely developed within the considered interval of the section and manifested with different intensity. Processes due to the formation of anhydrite, manifested to a lesser extent. The connection of authigenic mineral formation with the processes of hydrocarbon production and the change in reservoir properties of the oil bed is noted.

The possibility of identifying the transformed intervals by geophysical well logging considered, a good convergence of the results obtained by comparing the intervals selected by core and geophysical well logging is obtained. In the future, the results of the study can be used in the elastic modeling of the properties of rocks.

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SEDIMENTARY ENVIRONMENTS OF SILURIAN DEPOSITS OF THE SECTION MINDIGULOVO THE SOUTH URALS

The studied section is located in the folded region of the Southern Urals on the right bank of the Belaya River, 2 kilometers from the village of Mindigulovo, Burzyansky District of the Republic of Bashkortostan. Geologically, it is located on the western side of the Zilairsynclinorium, where Paleozoic sediments of the Ordovician, Silurian, and Devonian systems are distributed.

At the end of the 50s, lithologic stratigraphic work was carried out in the territory of the study. During these research the interest of the Silurian depositswas noted in terms of the conditions of their formation [1]. In subsequent years, attention to the study of this issue was not given duringresearch, geological survey and prospecting works. The purpose of this work is to conduct detailed study of the formation conditions of Silurian deposits based on the materials obtained inthe field and their office processing.

A macroscopic description of a section composed of shale with a greenish tinge and dark gray limestone has been made. The results of 41 silicate analysis, descriptions of 13 petrographic thin sections and 13 determinations of the mineral composition by thermogravimetric method are summarized.

During the interpretation of shale analyzes [2], it was established that the parent rocks were subjected to moderate chemical weathering, which included potassium feldspars. The mineral composition of shale is defined, where the rock-forming mineral is sericite. During sedimentation, sediments were recycled above the second cycle. Sedimentation took place under conditions of a passive continental margin; oxidative conditions existed in the bottom part of the sedimentation basin. Subsequently, the rocks were exposed to potassium metasomatism.

Petrographic study of limestone showed a gradual change in the conditions of sedimentation towards the shallowing of the sedimentation basin. In the initial period, the formation of limestone occurred in the facies of an uncompensated or filled depression [3] - pelitomorphic differences were formed. Subsequently, the process of sedimentation took place in the shelf part, where vacustonesaccumulated with numerous organogenic detritus. At the end of the cycle, the forward slope facies dominated, characterized by limestones with sedimentary texture (flare), formed during the underwater creep of sediments.

The materials obtained made it possible to substantially supplement the previous ideas about the conditions for the formation of Silurian deposits and to outline the evolutionary trend in the development of the sedimentary basin of sedimentation of this time.

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IMPROVE THE ACCURACY OF THE INTERPOLATION OF THE POWER OF PLASTS OF THE UG-LEFTING THREAD IN THE INTERMEDIATE FILLING SPACE

The variability of geological conditions significantly affects the efficiency of coal mining. The paper discusses an approach to improving the accuracy of estimating the thickness of the layers of the coal-bearing stratum using the cokriging method, taking into account the correlation between the thickness of the layers that are in a paragenetic relationship within the coal-shifting rhythm.

The most common spatial interpolation methods are: inverse weighted distance method, polygon method, trend surface method, triangulation method, kriging method. Theliteratureonspatialinterpolationmethods [1,2,3] wasstudied.

The strength of the geostatistical approach to modeling is a variogram analysis of the relationship between the magnitude of the mining and geological factors corresponding to specific elementary volumes of the subsurface space, with the relative position of these volumes. By selecting a mathematical model of the spatial variability of a parameter, geostatistics makes maximum use of the available exploration information and estimates the error in spreading the estimates for various volumes of the subsurface.

For interpolation, it is possible to use the geostatistical method of cokriging, which is a type of kriging method. Cokriging increases the reliability and detail of the interpolation results by using additional information on correlated data. In this case, the variance of the estimate is less than the variance according to the kriging method.

If the variable has a normal distribution, then the best estimate of the variable is kriging value with variance. Otherwise, under certain conditions, the best estimate of the variable will be the value of cokriging with dispersion. Further development - partial automation of the cokriging method for accumulation of interpolation results, their analysis and comparison with other methods.

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ONLINE-QUALITY ANALYSIS FOR AGGREGATES BASED ON THE MEASUREMENT OF MAGNETIC SUSCEPTIBILITY DURING DRILLING PROCEDURES

This research paper deals with the development of an online method for the quality determination of magmatic rocks. This method is to be used by aggregate producers that suffer loss of structure of some rocks occurring partially within their deposit. Such a loss of rock structure is not sufficiently or representatively determinable with the usual procedures, which are connected with a high expenditure of time. Thus, it can happen that companies unconsciously sell rocks of inferior quality. This can result in complaints from customers.

With the proposed method, aggregate producers can control their rock quality in-time and at low costs by means of the measurement of the magnetic susceptibility during the drilling process as an indicator for the loss of microstructure. The second chapter of this research describes the online method in contrast to other state of the art methods.

This research paper is based on the field investigations of 10 different quarries within Germany, at which measurements of magnetic susceptibility and structural geology have been made. In addition samples have been taken, which have been analyzed for several parameters that indicate rock strength (microstructure), such as the loss of ignition, the magnetic susceptibility and petrographic properties.On basis of the evaluation of the gathered data a categorization of the applicability of the method can be made. The third part of this paper will describe the research that has been carried out on the basis of two different types of aggregates, to illustrate the applicability of the method.

This research will conclude by giving an overview about the applicability of the proposed method based on this research and geochemical explanations. Over this research the applicability of this method could only be shown for volcanic rocks of basaltic or andesitic chemistry. The rocks must in addition have undergone a hydrothermal alteration processes. Such alteration processes as sericitization and chloiritization cause the oxidation of magnetite. Due to oxidation, magnetite decays into hematite and limonite. This reduces the magnetic susceptibility of the rock, which is largely dependent on ferromagnetic minerals such as magnetite. Due to this reason the loss of rock quality, which has to be induced by alteration processes can be measured on the basis of magnetic susceptibility.

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TEXTURES OF ORE MINERALIZATION FROM MONCHEGORSK (MURMANSK OBLAST, RUSSIA). WHAT STORY THEY CAN TELL US?

The Paleoproterozoic Monchegorsk Complex (Murmansk Oblast, Russia) is one of the largest layered intrusions in Europe. This type of ore deposits has been known as one of the main sources of copper, nickel, chromium and platinum group elements. Ni-Cu-PGEs mineralization is predominantly hosted by peridotites, gabbronorites, pyroxenites and norites [1] and occurs in the form of veins, apophyses, impregnations, layers and so-called reefs [2]. The main ore minerals are pyrrhotite, pentlandite and chalcopyrite.

For this investigation, specimens of massive Ni-Cu sulphides from the closed quarry on the slope of Mount Nittis and harzburgites with disseminated sulphides from Horizon 330 at Sopcha Mountain were collected. Samples were investigated with both reflective and transmitted light microscopy, SEM-EDS and EMPA.

Presence of different ore textures (such as flame-like pentlandite, “leopard” texture) provides clues regarding crystallization processes and origin of the mineralization. Pentlandite often occurs as exsolutions within pyrrhotite crystals or on a boundary of pyrrhotite domains. Chalcopyrite's crystallization took place later, mostly in vein-like form between pyrrhotite crystals. These observations provide an evidence of sulfide melt differentiation to ISS (intermediate sulphide solution, with composition of chalcopyrite) and MSS (mono-sulphide solution, with composition of pyrrhotite and pentlandite). Thin pyroxene rims are commonly present at the boundary between sulfide and olivine grains and contains numerous, μm in size, sulfide inclusions. They are interpreted as an evidence for the presence of liquid sulfides and transport of the olivine clasts. These reaction rims are believed to form from melt interaction between sulfide liquid and a silicate melt film generated by melting of the silicates by the sulfide liquid, similarly to the process responsible for formation of magnetite rims described in the Munali deposits [3].

Microscopic studies revealed presence of small godlevskite, moncheite and kotulskite grains in the sample from Horizon 330. Investigated rocks probably undergone weak metamorphism as secondary processes affecting the rocks. These are inferred from the olivines replacement by antigorite and pentlandite replaced by violarite.

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IMPLEMEMENTATION OF CARTOGRAPHIC BUILDING FEATURES SIMPLIFICATION ALGORITHM IN ARCGIS PYTHON

Study describes the cartographic simplification algorithm, the problem of its implementation into ArcGIS Python environment and its solution. The eponymous algorithm, proposed by Xiongfeng Yan, Tinghua Ai and Xiang Zhang [1], is based on shape cognition and template matching methods. Automatic generalization is common method for generalizing data from databases used to create maps. Mayer used scale-spaces and scale-space events in order generalize building outlines [2]. Lupa and others used Minimal Geometries in automated building generalization [3].

The shape of the building is obtained using turning function which converts the shape of polygon or line saved as a list of points and their coordinates into a function and provides the ability to analyse the similarity between buildings and templates [4]. The authors propose distance between functions as parameter deciding on choosing the best template. Within the researches the other method was proposed. The value of the parameter is equal to the area of the symmetric difference between two turning functions' (building's and template's) areas. The lowest value of the parameter denotes the best template for the building. As template matching method authors propose basing on least-squares adjustment method but in the implemented programme other method was proposed. Programme obtains the transformation parameters using ArcPy library's tool Minimum Bounding Geometry to gain scale and rotation angle and centroids to gain translation.

The implementation was done to a certain extent, some stages of algorithm were implemented using methods other than proposed but the main idea was preserved. The tests of the implemented programme prove that it can be successfully used in order to generalize most of the buildings features.

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MATHEMATICAL ANALYSIS OF PETROGRAPHIC STRUCTURES

Mathematical analysis of petrographic structures has been engaged for more than 150 years, mainly for solving problems of rock genesis [1]. The structural indicatrix method allows to classify and to distinguish rocks that are even close in composition.

The structural indicatrix method is based on determining the probabilities P_{ij} of binary intergranular contacts in an n-mineral rock. The probability distribution can be represented in the form of equality, where m_i, m_j are minerals composing the rock (Fig. 1).

$$\sum_{i,j=1}^{n} p_{ij} m_i m_j = [m_1 m_2 \dots m_n] \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ p_{n1} & p_{n2} & \cdots & p_{nn} \end{bmatrix} \begin{bmatrix} m_1 \\ m_2 \\ \cdots \\ m_n \end{bmatrix} = 1$$

Fig. 1. The expression characterizing the probability distributions P_{ij} in the rock

The matrix [Pij] contains the coefficients of a quadratic form, which corresponds to a surface in n-dimensional space, called a structural indicatrix. It is determined by bringing the matrix [Pij] to a diagonal form. The principle of nomenclature: the Snm structure corresponds to the diagonal matrix D, in which there are m positive units in n positions [2,3].

The structural indicatrix method allows finding even subtle differences in structures and can be widely used in the future.

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OPTIMIZATION OF SURVEYING WORKS AT MINING ENTERPRISES IN THE CONDITIONS OF USING AUTOMATED MEASURING INSTRUMENTS

Due to the increase in the intensity of mining operations, the surveying services of enterprises find themselves in situations when it is necessary to carry out modernization of both the instrumentation base and the survey techniques. In terms of optimizing mining operations, mine surveying services are assigned tasks that require increased productivity and operational efficiency. Currently, these tasks are solved using automated instruments, which leads to a change in methods of work. However, in current regulatory documents, these circumstances have not yet been reflected either in the field of accuracy assessment or in the field of work organization [2].

In this regard, an analysis of the time spent on the production of surveying work at the enterprise Apatit JSC was carried out. For this, a "photograph of the working day" was produced by the employees of the enterprise's survey service [3]. That is, the time of work was recorded by electronic total stations and optical theodolites for several days. As an example, we selected the main types of work that are regularly performed by the surveying service, namely, the assignment of the direction to the mine workings. Observations have shown that, under the same conditions, it is necessary to spend an average of 25 minutes on the production of work by electronic total stations, compared to 45 minutes when using optical theodolites [1].

From the observations it is clear that the time spent on surveying with the use of new instruments and survey techniques has decreased by an average of 1.8 times. The results are preliminary. They should be considered as an attempt to assess the real state of the issue of the organization of the surveying service in the context of modernization of the instrumentation fleet and survey techniques.

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TENDER AS AN INSTRUMENT OF THE ENVIRONMENTAL MANAGEMENT OF ORGANIZATION

One of the main global problems of the contemporaneity are problems of the environment and environmental management. Their emergence mediates realization of almost all social and economic processes which are implemented in the modern world, and possibilities of the solution of such problems in many respects define features of sustainable development of each state.

The scientific novelty of a research consists in improvement of scientific and methodical approach to the organization of rational environmental management by means of establishment of requirements to contents of tender documentation. The argument of need of development of the corresponding approach is based on studying the standard legislative base regulating an order of carrying out the tender; scientific works of the domestic and foreign scientists devoted to the solution of problems of environmental management, the organization of the tender relations [1-3].

Possibilities of increase in efficiency of environmental management are put in realization of the mechanism of development of tender offers and holding tenders. Definition of requirements to contents of tender documentation, including criteria for evaluation of impact of results of implementation of the project on the environment, allows to provide rationality of use of subsoil.

In the general set of criteria the amounts of financing the actions directed to earth recultivation after mining, return of the developed lands to initial purpose and others have to take the certain place.

The legislative statement of a possibility of their use will provide increase in efficiency of environmental management that causes need of preparation of the offers directed to justification of requirements to contents of tender documentation.

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THE ESTIMATION OF INVESTMENT APPEAL OF MINING ENTERPRISES

Every industrial enterprise is looking for opportunities how to increase the competitiveness and to achieve economic growth. Enterprises seek outside sources of financing in a context of limited resources. This demonstrates that question of investment opportunity is becoming more relevance.

Although, many authors attach great importanceto this subject, scientists still did not find common determination of investment appeal. The investment appeal includes productive capacity, financial status, and management of enterprise, industry sector and concerns of investment players. Also, the investment appeal is considered as integrated assessments of enterprise as investment object.

There are different approaches and methodologies to analyze the investment appeal, which are applicable for any economic system.These evaluation methods are described in details in scientific work [1], we agree with authors opinion and consider that with regard to the coal enterprises it is reasonable to use integrated assessment of investment appeal. The benefit of such approach is a comprehensive analysis of economic entities, which includes the set of quantitative and qualitative indicators, which provide more accurate and objective assessment of enterprise. The first thing that needs to be done is identification of indicators that impact on investment attractiveness of coal mines. All indicators can be divided into two groups: mining engineering and economic.Further, it is necessary to reduce relative deviations from a reference of all factors for every mine to multi-dimensional functional called integral index. The final phase is calculation of integral index. The principle of integral index is as follows: the less the value of the integral index is, the better enterprise matches version of the reference, it means that the better it is. The value of integral index will reflect level of its declining and estrangement from the reference [2].

Five state coal enterprises of the Donetsk people republic were analyzed according to this method. We have come to accept that the most investment attractive enterprise is SE "Torezantratsit" ($\boldsymbol{K_i^{инт} = 0,87}$), and less investment attractive are SE "mine KomsomoletsDonbass"($\boldsymbol{K_i^{инт} = 1.46}$), SE DUEK ($\boldsymbol{K_i^{инт} = 1.95}$) and the least investment attractive are SE "Makeevugol"($\boldsymbol{K_i^{инт} = 2.06}$),, SE A. F. Zasyadko ($\boldsymbol{K_i^{инт} = 2.29}$).

The developed methodology is an assessment tool of investment appeal of coal mines according to the sector-specific. This classification of mines by investment appeal allows to identify the mine with more useful impact for investing.

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SELECTION OF STRATEGIC ALTERNATIVES TO INCREASE THE RESOURCE SECURITY OF THE RAW DIVISION OF THE MINING-METALLURGICAL COMPANY

The paper proposes the development of a set of additional indicators for assessing the economic efficiency of an investment project for the company's operating activities. It is proposed to take into account the impact of the project (SA) on the ecology and social environment of the company.

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Under conditions of a high degree in the ferrous metals market, a number of companies in the industry developed a shortage of their own raw materials, which leads to incomplete utilization of production capacity, the impossibility of strategic development and a decrease in the efficiency of the company's activities. [1]

The developed methodical approach to the selection of strategic alternatives (SA) includes the following steps:

1. SA are formulated that correspond to the goals of the MMC.
2. SA is analyzed for compliance with objective limitations.
3. Calculations of additional indicators are carried out; assessment of the impact of SA (investment projects) on the environmental and social areas of the company is carried out.
4. The choice of alternative is made taking into account the obtained scoring and the impact of SA on the economic, environmental and social areas of the company.[2] Formed options for increasing production capacity (strategic alternatives):

•Rreconstruction of the PJSC KMAruda combine with an increase in the production capacity of the mine;

• Acquisition of a license and development of an iron ore deposit.In general, most indicators of economic efficiency of investment projects are comparable. According to the results of the comparison of two variants of strategic alternatives according to the selected criteria, according to the sum of the indicators, the advantage is given to the alternative for the reconstruction of own capacities at the KMAruda combine with a two-point advantage.Reconstruction of the plant is more preferable by the criterion of environmental friendliness: the scheme of non-waste concentrate production is already being applied. According to the degree of influence on the social environment, reconstruction is also more preferable, since KMAruda combine provides jobs for several thousand people. [3]

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IMPROVE MOTIVATION OF EMPLOYEES OF MINING ORGANIZATIONS

Among the core resources of the organization are human resources.Human resource management issues, stable human capital and motivation for staff are still a major problemof organizations. There are different ways in which staff can be motivated and sustainable, depending on factors such as the organization's culture, structure, and direction.Human Resource Developmentof mining sector was selected in this study.

Mongolia is directly dependent on the mining sector as 23.6% of GDP, 72% of industry, 88.5% ($ 6.2 billion) of exports, and 74% of foreign investment.

There is a large shortage of skilled and stable staff in the mining sector.Therefore, examine the features of organizations in the mining sector and the methods employed by them in the field and identify opportunities for improvement.

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CONCEPTUAL BASES OF IMPROVING THE MARKET OF SECURITIES OF THE REPUBLIC OF BELARUS

In modern conditions, the securities market is an integral part of the financial sector of the economy, since it is based on the transition from savings and savings to investment. The role of the stock market is significantly increasing at all levels of the economy, from micro to mega-levels each year. Today, the development of the stock market as an integral part of the economy should be the goal of any developing state.

The securities market of the Republic of Belarus is developing. So far, it is not effective enough against the background of the banking segment in the area of redistribution of capital, but every year the development occurs at a slow pace [1].

During the existence of the market in our country has developed a regulatory framework in the field of issue and circulation of securities. After conducting a review of the securities market, the most important problems hindering its development should be highlighted: an insufficient variety of financial instruments on the stock exchange. Having considered the types of transactions in this market, it was revealed: transactions of derivative securities are concluded only under futures contracts. Analyzed the types of transactions in derivative securities in the market; low awareness of individuals and legal entities has led to a low level of financial literacy in the field of the securities market [2]. Improving public awareness will lead to a revitalization of the market; difficult market entry; difficult policy of conducting an initial public offering of shares due to a difficult market entry.

In addition, the entrance to the market of non-bank organizations is difficult or practically impossible. Forming a significant share of gross value added, small and medium enterprises would play an important role in the development of the securities market [3].

The author proposes the concept of separating the over-the-counter market from the exchange. However, in this case, mandatory registration of securities and trading parties on the stock exchange is not required. This will simplify the entry of non-listed enterprises to the market, namely, small and medium-sized businesses; increase the number of players, which, in turn, will increase the level of competition in the market; will allow to activate the work of the securities market as a whole, and to “grow” large players for future competition already on the exchange.

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PROSPECTS OF DEVELOPMENT OF ENGINEERING AND ECONOMIC PROFESSIONS (MOUNTAIN ENGINEERING) DEPARTMENT: ENGINEERING-ECONOMIC SYNTHESIS

Consideration of the problems of engineering-economic education devoted the works of many scientists, including O. V. Averina, V. T. Vodyannikov, N. N. Melkina, T. M., Mizuk, M. I. Podzorov, A. I. Fedorov etc. At fair view of Kovaleva A. P.«socio-economic changes in society and production require new approaches to training of specialists, especially economists and managers, adapting their training to the changing market environment. The innovative principle of development should be embodied in industry, which implies knowledge and education as the most important strategic resources of industrial policy and economic development in General. The innovative way of development requires to shift the center of gravity in the direction of improving the quality and updating the content of education, the introduction of new technologies of the educational process» [1, p.54].

G. B. Kochetkov, considering the role and place of the engineer in the innovative economy [2] identified the main problems of training in this specialty, to which he attributed: the decline in the quality of teaching mathematics and natural science disciplines in middle school, specialization in the engineering education, the lack of tools and instrumentation base, «the system of engineering education should instill in students the idea of social responsibility, in accordance with which the results of the engineer's work should be evaluated not on the abstract criteria for the effectiveness of the created systems, but on the impact of, what these systems do for the life of society», the creative ability of the engineer, which cannot be only the result of training (there is a need to encourage engineering creativity), "the lack of managers who are able to carry out technological innovation from sample to mass production and develop on this basis a successful business.The named author sees the solution in the creation of a system of measures to overcome the «gap between the creative-engineer and the manager-entrepreneur».

The increase in requirements for potential employees caused by the growth of competition in the world market, the growth of competition directly in the labor market, innovative development, which involves the introduction of highly automated production, encourage the deepening of economic training of engineers. In addition, the specifics of economic training in a technical University should affect the subject of research and the formation of a new scientific school that solves important problems for the country.

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DEVELOPMENT OF THE POTENTIAL OF DONBASS COAL MINES ON THE BASIS OF INNOVATIVE METHODS FOR EXTRACTION RESERVES

Currently in the world a significant number of non-working coal seams remain out of balance and are not used. The renewal of production activities of mines that are in the process of closure, for the final extraction of these seams by conventional methods is not economically effective. The most promising solution for the development of the economic potential of such coal-mining enterprises is the implementation of borehole mining methods, which include underground gasification of coal. In modern conditions, such scientists as Gridin S.V., Zhukov E.M., Kondyrev B.I., Kropotov Yu.I., Luginin I.A., Lazarenko S.N., Kreynin Ye.V., Makagon Yu.V., Ryabchinin OM., Raimzhanov B.R., Saltykov I.M., Chizhik Yu.I., Yankovsky M.A. and others were concerned with the prospects of using underground coal gasification. In the scientific works [1, 2] the experience and efficiency of this technology application in different countries (Russia, China, USA, Germany and other countries), which differ in the mining and geological and other conditions, are considered. In the research [3] alternative sources of energy in terms of energy and resource shortage, as well as the general process of producing synthesis gas by the method of underground gasification and possible prospects for its further use in Ukraine, are proposed.

The analysis of publications and materials of already implemented projects and programs showed that the economic and social aspects of using the technology of underground coal gasification are not sufficiently developed. This is especially true of Donbass coal deposits with complex mining and geological conditions, as well as a lot of political and economic problems caused by the uncertainty of the external environment.

The analysis of mining, geological and other conditions of the closed coal-mining enterprises of Donbass was carried out on the subject of using the technology of underground coal gasification. Its essence and methods, advantages and disadvantages of application are considered. A comparative description of the experience of using the technology of underground gasification of coal in different countries has been carried out, which allows us to conclude about great potential for using this technology in the long term in the Donbass region, where there are abandoned areas with hard coal reserves. The issues of the economic efficiency of underground gasification of coal and obtaining an economic, social and environmental benefits from its use based on existing experience, including the international, are considered.

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THE PROBLEM OF HUMAN CAPITAL STRATEGIC MANAGEMENT IN KUZBASS

Kuzbass region is a large-scale territorial-production complex of Russia that belongs to one of the most Siberia developed regions. Coal-mining industry is its specialization branch. Industrial regions remain as development drivers of a whole national economy.

The development of industrial regions depends on human capital (human resources). It's clear that it is necessary to increase the population economic productivity. Career guidance of young generation is one of the human capital formation stages. Competent work with young people allows guiding labor resources in required branches. Human capital management in Kuzbass must be integrated in strategic region development system. However, the focus is still on industry, as a result the productivity of the human capital generating sphere is reduced. It concerns education, health, culture, etc.

In our opinion Kuzbass in the long term has only two development scripts. The first is inertial, in which frameworks economic growth is mostly because of the consolidation of raw material specialization. Investments are directed to the coal and metal industry development. The economy in this case will have low diversification. Along with it, the possibility of further industrial region development in industrial model is almost exhausted. The second script of development is active, that includes increasing region's competitive ability due to new technologies integration, the human capital development and the non-industrial sector of the economy expansion. It in turn will stimulate to improving the population living standard.

Thus, this way realization will allow to generate developed and varied labor market, decrease population outflow, increase social and investment attraction and in addition to decide environmental problems and provide more stability of Kuzbass social-economic development.

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ECONOMICAL EFFICIENCY ANALYSIS OF A COMPANY BASED ON VBM INDICATORS

Oil and gas industry is one of the main sources of state budget replenishment in Russia, it provides economic and energy security to the country and remains asection, attractive for investments. Vertically-integrated oil companies are mostly interested in an increase of their productive efficiency and their value on the market. In this case, choosing indicators for estimation of company's efficiency,both on operating and strategic levels, is absolutely essential. Therefore, there is a noticeable interest of economists and top management of large companies to the concept of VBM. Many scientists worldwide, such as T. Copeland [1], A. Rappaport [2], M. Scott, G. Stewart, D. L. Volkov[3], V. E. Esipovand others, have studied the ways to control the cost management of a company.

Value Based Management (VBM) is the management philosophy and approach that enables and supports maximum value creation in organizations, typically the maximization of shareholder value. The main difference between traditionally used indicators and VBM indicators is that the latter signalizesthe changesof values to the shareholders and measures how successful the company is at achieving its strategic goals.

A full analysis of the main VBM-indicators, such as Economic Value Added (EVA), Cash Value Added (CVA) and Shareholder Value Added (SVA) has been conducted in this paper. Following that, an assessment of the effectiveness of the oil and gas company was made based on these indicators.

One of the difficulties with this approach is the large amount of indicators developed by various consulting companies. It's important to weight in their advantages, disadvantages and areas of implication. Based on that it is safe to conclude that companies must use whole systems of indicators, instead of a single one. Moreover, companies may face some difficulties in implementing these concepts in the existing systems, these include: an over-reliance on the established traditional means of analysis and management, a blind commitment to thinking at the level of operational management, and the insufficient level of managerial skills.

The concept of value-based management is currently most relevant for analyzing the performance of an oil and gas company. Based on selected VBM indicators, it is possible to build a model of sustainable economic growth for any oil company, which will determine the degree of achievement of strategic goals and will correctly identify reserves available for improving economic efficiency.

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DEVELOPMENT OF THE LARGE-SCALE LIQUEFIED NATURAL GAS PROJECTS SUSTAINABILITY ASSESSMENTMETHODS

The relevance of this work is due to the need to diversify the directions of export of Russian gas through the development of the industry of liquefied natural gas (LNG)[1]. The specificity of LNG projects is such that due to their high capital intensity and low prices for LNG in the world market, such projects are mainly focused on the achievement of external effects [3].

The study analyzed the key trends in the global LNG market and the prospects for the Russian LNG market, identified the main risks and opportunities for creating new LNG capacities in Russia, and analyzed the main business models of the LNG industry with the justification of the most optimal model for Russia. Taking into account the specifics of LNG projects, the concept of "LNG project sustainability" was defined with further analysis of the main stakeholders and their expectations regarding such projects.

Conclusions: 1) Prospects of LNG production potential development in Russia are realistic, Russian LNG is competitive in the world market. 2) The success and feasibility of LNG projects in view of their specificity largely depends on the coordination of the interests of their participants. The main stakeholders of the LNG project are industrial companies, investors, the state and society [2]. 3) The sustainability model of the LNG project is based on the economic value of the asset, rational subsoil use and energy efficiency, as well as the socio-economic development of the region of presence. 4) Assessment of the effectiveness of the LNG project, taking into account the concept of sustainability, should include indicators of economic, social and ecological effectiveness [4].

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ASSESSING ENERGY ALTERNATIVES FOR FRANCE AND GERMANY FOLLOWING THE PARIS ACCORD

As pacts have been put in place throughout the years to reduce fossil fuel us, unlike the Kyoto Protocol, the Paris Accord not only promotes climate change mitigation, but also highlights the idea of "support for and international cooperation on adaptation efforts" (Falkner, 2016[1]).This project aims to find the most cost-effective energy portfolios for France and Germany, two leading European nations, while simultaneously considering the new greenhouse gas emissions limits under the Paris Climate Accord and individual countries' production capacities. As Heinrichs and Markewitz[2] note, the German government is working towards reducing greenhouse gases by 40% by 2020 and 80-95% by 2050 compared to 1990 levels, while France, pledged to reduce emissions by 27% from 2013 levels by 2028, and by 75% in 2050.

In order to do so, a MGA (model to generate alternatives) will be used to attempt to capture the energy supply and demand portfolios for the two countries, with their possible imports and exports with the rest of the world, just as Price and Keppo[3] did in their study to explore the diversity of near cost optimal energy pathways possibilities, as well as their uncertainties. Additionally, the model will stimulate energy supply and demands of different sectors such as transportation or industry, while gathering information such as production of energy type, consumption of energy type by sector, imports and exports by energy type, and will run until 2050. This model will make sure to state a supply and a demand constraint, as well as a greenhouse gas emissions constraint. A cost minimization objective function will also be created in order to create the optimal cost scenario for each country.

With Germany still relying on lignite even after the Energiwiende program (Lenk and Wisotzky[4]) we would expect the country to have difficulties stepping away from fossil fuels, but still investing in renewables. For the case of France, even though there are talks for a nuclear phase out, this energy will be key while the sector of renewable energies grows, and France can similarly import energy from its neighbors when production costs are too high. In terms of sectors of consumption, we expect all sectors except transportation to react smoothly to the transition, since transportation is so reliant on oil and there are no alternatives that could fully fuel the demand.

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PHOSPHATIC RESOURCES: CURRENT STATE AND TRENDS OF INVESTMENTS

The integrated system analysis of the current state of phosphate mineral raw material resources and productions of phosphorus-containing products is made. It is made expected estimates of potential of the countries with stocks in modern economic and geopolitical conditions, with emphasis of attention on the medium terms and the possible directions of investments [1-4].

The author when carrying out researches used the method of the datalogical analysis which is guided by the theory of information which basic provisions provide quantitative assessment of the dependence studied subject area set of the factors entering the analysis. For achievement of a goal collecting, systematization, processing and the analysis of domestic and foreign information on phosphate resources, production phosphorus-containing concentrates in the world, and, in particular, in Russia (assessment of the current state) are carried out, it is defined security of the countries with stocks (is predicted), graphic dependences are created and trends and features of development of the phosphate market are revealed on the basis of their analysis, new projects of development of phosphate resources are considered (medium terms) [2].

Modern trends and the directions of investments into production of phosphorus-containing products in Russia are considered. Features of the development of phosphate resources in the Russian Federation which is based generally on development of apatite fields of the Kola Peninsula are marked out; assessment of dynamics of production of phosphate stocks is executed; potential of stocks and prospects is estimated [3].

Extremely uneven territorial distribution in the Russian Federation of extraction of phosphate ores as the dominating factor involving high transportation costs from production to internal consumers and decrease in competitiveness of domestic production in the world market is revealed. The main direction of investments into development of phosphate mineral raw materials and productions of phosphorus-containing products are formulated [2,4].

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IMPACT OF MARKET PRICES OF CARBON DIOXIDE AS RESPONSE TO PLANETARY BOUNDARIES TO MINING COMPANIES PROFITS AND REVENUES

Significant increases in activity in the global mining industry has led to accumulative global environmental impacts, commonly described as anthropogenic pressures [1], [2].Worldwide, governments and civil society organizations have become aware of the importance of including sustainability in their political agendas, which gave rise to domestic agreements defining planetary boundaries which shall not be exceeded in order to ensure a sustainable future.

The acknowledgment that environment and economy are in an interdependent relationship, led to a discipline referred to as ecological economics [3]. The importance of this field has rapidly increased within the 21st century, nevertheless there are still questions to be answered such as: how much does it cost to achieve planetary boundaries? In order to answer this question, the author assembled and analysed CO2 emissions in the mining industry. Carbon emissions are one of nine key planetary boundaries proposed by literature [1]. The sample of this study includes the largest producers four metals iron ore, aluminium (bauxite ore), gold and copper which, excluding gold, represent 96% of all metals mined globally in terms of bulk tonnage [2].

The author set 2016 as the base year for calculations and used the CO2 emissions reported by those producers' annual corporate reports in order to assess the hypothetical costs for internalization of reported CO2 emissions, and applied different levels of prices based on three different impact scenarios to prevent an increase in global temperature above a 1,5 to 2 °C threshold. The study shows that an appropriate costing of released CO2 emissions would significantly diminish or even fully exhaust certain companies' revenues. The used methodology may allow for a broader analysis within the mining industry or other industries and can inform targeted environmental policy making and taxation in the future.

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REUSING UNDERGROUND MINE SPACE OF CLOSING MINES

Recently in the Donbass more and more mines are being closed, with such large amounts of unused space remaining after liquidation, the question arises of considering it as a certain type of resource. The aim of the work we consider to show the possibilities of reusing underground space, the consideration of the most promising areas of such use, as well as the construction of an economic-mathematical model for choosing the best option for reuse of mining enterprises. Researchers in this area are, for example, V.A. Bezpflug and M.K. Durnin in the work "Comparative economic evaluation of various technologies for utilization of coal mine methane" [1] they gave examples of the use of coal mine methane, as well as showed various methods for its production, and A.S. Kuznetsov, in his work, explained the advantages of using coal-water fuel [2].

The most promising areas to reuse underground space of coalmines are: underground warehouses and storage facilities, peak reserve underground pumped storage power plants and hydro power plants, underground wind power.

We propose the following economic and mathematical model for solving the problem:

$$C_1 + C_2 + C_3 \to min(1)$$
$$k_1(k_2C_2 + C_3) \le R$$
$$C_1 + k_1(k_2C_2 + C_3) \le L$$
$$\frac{0.53(0.57C_1) + 0.53(0.57C_2) + 0.53(0.57C_3)}{n} \ge \frac{0.53(0.57\Sigma C_i^0)}{N}$$
$$\Sigma C_i^0 \ge 0$$
$$\Sigma C_i \le \Sigma C_i^0$$
$$\Sigma C_i \le R$$

Where C1, C2, C3 - the costs of designing, developing and operating a new production;
R - revenues from the exploitation of new mastered production;
L - the costs associated with overcoming the effects of "wet" mine;
S - costs associated with overcoming the social consequences of the mine's liquidation;
N, n - the number of workers in accordance with redundant workers at the closure of the mine and employed workers to a new production;
α, β - shares in the costs of mastering and operating a new production attributable to the wages of workers;
k1 – coefficient, which is taking into account the increase in costs in connection with the geological conditions and the life extension of the underground structure;
k2 – coefficient, which is taking into account the increase in operating costs in connection with the increase in the depth of work.

Based on the above, we can conclude that the closure of the mine is an expensive, lengthy and difficult process with many attendant factors. However, even from a closed mine it is possible to receive economic benefits, allowing to minimize the cost of liquidating the enterprise.

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THE ROLE OF THE STRATEGIC ALLIANCES FORMS IN RESOURCE EFFECTIVE USAGE

The use of inter-firm relationships is considered a valuable factor for the firm development. A huge number of previous studies have focused on the active participation degree of the firm in inter-firm alliances. Many cases of alliances' collapses, however, are easily discovered in past decades. It should be interpreted through structural characteristics of alliances, the role of the firm in alliance building, or the initial size of a firm in alliance development is the attractive interest of researchers. In this study, we had a different position about an inter-firm strategic alliance in participant firms' development: different forms of inter-firm strategic alliances have the distinguished contributions to the organization life cycle each phase.

This study examines the role of different forms of inter-firm strategic alliances in organizational life cycle. We assumed that the different forms of strategic relationship have ability to lead the organizational development phases. That means firms' development are constrained by a lack of internal resources' capacity, liability of newness (Stinchcombe, 1965) and liability of smallness (Baum, 1996). In order to overcome these liabilities, inter-firm strategic alliances are regarded as one effective consideration (Boari and Lipparini, 2000; Lechner and Dowling, 2000).In every phases of organizational life cycle, firms try to grow and survive. Purpose of this study is to search the effective way of how to overcome liabilities of resources, newness, and smallness through appropriate forms of inter-firm strategic relationships.

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THE INFLUENCE OF MULTIPLEX NETWORK TIES ON WORKING BEHAVIOURS

In this research, we use a social network perspective to investigate several explanatory pathways through which interpersonal relationship in workplace impact on individual working behaviors (job performance growth and job satisfaction). There are several theoretical explanations by reviewing the literature on interpersonal relationship in workplace. For example, one of the most popular theory is Burt's structural holes. A structural hole is said to exist between two people who are not connected to each other in a network. According to this theory, it is advantageous for an individual to be connected to many other people who are not connected to each other; in other words, to be the "broker" between two individuals in a network. Including both formal coworker relationships and informal friendships, are integral in understanding employee behavior. Because they have been linked to access to resources such as information, advice, and emotional support.

Social network researchers also recognize the potential for multiplicity, or the coexistence of multiple elements in a social relationship. for example, it is possible for someone to be both a coworker and a friend.

Although this type of overlap is common in organizational contexts, practically no research to date has examined the effects of these complex relations on individual working behavior in Mongolia. We propose and test a model predicting that multiplicity impacts working behavior through offsetting pathway: resource accumulation, whereby the security, intimacy, and trust inherent in these relations increases a person's resources, eliciting a positive association with working behavior. To test this model, data was collected from 140 employees of Mining Company in the Mongolia. Overall, findings suggest that multiplex relationships that comprise both instrumentality and friendship are largely functional for work performance by providing a broader range of support resources.

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THE PROSPECTS OF BELARUSIAN MINERAL RESOURCES INDUSTRY

Mineral resources industry is one of the most important kinds of economic activity.The share of mineral resources industryin global GDP in 2017 is about 1% [1].According to the recent research there are about 2,5 mln.people employed in this sphere[2]. Consequently, it is necessary for the state to receive a detailed analysis, critical information about the development prospects of mineral resources industry so as to take appropriate measuresto improve the efficiency of this industry. This fact explains the relevance of the selected issue.

The Republic of Belarus hascertain mineral potential, which gives the country an opportunity to develop individual industries. Some previously proved directions have been widely disseminated.Among them the following can be mentioned: extraction of granules, powder and flour from stone, extraction ofmortar sand, extraction of dolomite, extraction of peat, extraction of potassium salt and solid sodium chloride in its pure form. A long-range vector of progress is additional researches and preparation for the development of new mineral deposits: lignite as a type of fuel and energy resources, sapropel as a type of agrochemical raw material base,ferric quartzite and ilmenite magnetite ores as a type of metallic mineral resources [3].

Prerequisites for the achievement of economic growth qualitiesin mineral resources industry are being created by the adaptation of new high-technology manufacturing. It means the usage of such modern technologies as hydraulic mining by boreholes, leaching in place andgasification.Due to this fact andtaking into account the specific conditions of workable deposit mining companies will be able to reduce harmful impact on the environment and get an economic effect.Development of joint transnational alliance between Belarus and countries of EEU (primarily between Belarus and Russia) has also a perspective meaning. Not only a technological corporation but service cooperation on extraction of mineral resources can be a baseof such transnational corporations. Belarus is experienced enough to provide such services: 14 belarusian companies, including the largest mining enterprise «Belaruskali», took part in the construction ofpotash plant in Turkmenistan.

Thus, duringthe analysis of this sphere such prospective ways of development as extraction of new mineral resources,increase in the level of manufacturbility of mineral resources industry and enhanced international cooperation with countries of EEU were revealed. The development of belarusian mineral resources industry in designated areas gives an opportunity to expand the recourse endowment, to increase GDP growth due to the increase in output of mineral resources and improvement of productivity.

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RESEARCH ON QUALITY OF COPPER CONCENTRATE OF ERDENET PLANT AND ITS PRICE RELEVANCE

Summary

The present research has aimed to research price relevance logic caused by quality of copper concentration and percent of metallic recovery since copper is deemed to be one of main export products of Mongolia, and to form proper ratio between quality caused by price and metallic recovery. In this presentation, metal balance of recent decade period of ErdenetiinOvoo Enrichment Plant that has been running its operation in Orkhon Province of Mongolia for last 40 years has beenanalyized.

Key words: metal balance, copper price, sales revenue

Abstract

Importance of metal, called copper, is immeasruable. To see from the research of ANTAIKE metal market research institute of China that was published in October, 2017, when intensive development takes place, consumption of copper per person reaches its top point. Using this indicator, it is able to define development level of that country. To see from ICSG report that was introduced on Assemby of copper supplier countries of the world that was held in Santiego city of Chili dated in April, 2018, it is observed that copper supply growth is not likely to catch up level of copper demand growth since 2019. *(Source.: Wood Mackenzie, ICSG, Teck)*

Copper supply shortage has caused by two factors: 1. The fact that global economic growth is going to be averagely 2.1% until 2025, it will increase copper demand by 530 thousand tons every year. 2. Copper mining is going to decrease by 230 thousand tons every year since 2019 in connection with resource of current mines and ore quality. Main condition that is influencing in decrease of copper production is caused by the fact that resource of current 200 copper deposits is going to run out by 2035. Therefore research on coherent of quality of copper concentrate and sales revenue on the market that has better copper demand and appropriate price was made based on indicators of metal balance of Erdenet Plant LLC of Mongolia.

1. Methodology of calculating metal balance and copper price of Erdenet Plant LLC

ErdenetiinOvoo Deposit is one of the main biggest mining constructions of Mongolia that has been supplying copper concentrate export solely from 1978 until 2012. This plant has exported 16.7 million tons of copper concentrate including 4.6 million tons of copper, 131.76 thousand tons of molybdenum concentrateincluding 65.9 thousand tons of molybdenum and sold out 16.2 trillion tugriks product. There was 5763,2 thousand tons of copper and 162,5 thousand tons of molybdenum in total explored ore while 5502,76 thousand tons of copper and 154,05 thousand tons of molybdenum was contained in total processed ore. Of that, copper concentrate including 4570,6 thousand tons of copper and 67,3 thousand tons of molybdenum, and 131,76 thousand tons of molybdenum concentrate respectively were produced and sold out. During the last 40 years period, metallic recovery of copper concentrate reached 76,3-89,28% and average metallic recovery is currently 80,9%. Production of copper concentrate and its sales prices of Erdenet Enrichment Plant covering 2007 until 2017 are shown below.

Copper concentrate and its sales revenue indicators of Erdenet Enrichment Plant

	Indicators	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	Processed ore	мян.тн	25640	25920	26060	26100	26030	26045	26126	28000	31180	31438
2	Content of ore	%	0.574	0.565	0.548	0.540	0.542	0.530	0.526	0.516	0.510	0.495
3	Content of concentrate	%	24.14	23.73	23.65	23.67	23.50	23.23	23.03	23.35	23.25	23.36
4	Metal of	мян.тн	126.79	126.58	123.53	121.70	121.75	119.13	118.94	127.46	139.24	138.94

	concentrate											
5	Metallic recovery	%	86.15	86.43	86.50	86.35	86.30	86.30	86.55	88.22	87.56	89.28
6	Concentrate amount	мян.тн	525.26	533.08	522.03	513.73	517.78	512.85	516.81	546.19	598.52	595.10
7	KF-товар		48.82	48.59	49.89	50.76	50.24	50.79	50.59	51.29	52.07	52.86
8	Metal accumulation degree		42.06	42.00	43.16	43.83	43.36	43.83	43.78	45.25	45.59	47.19
9	Price of copper concentrate	$	1296.3	1016.1	1530.1	1738.6	1617.9	1429.1	1285.0	946.7	906.8	1230.2
10	Sales revenue /copper/	Тэрбум төг	792.01	774.82	1083.8	1124.1	1138.3	1123.6	1207.5	1013.7	1173.4	1788.3
11	Cost of ore processing	Тэрбум төг	103.33	117.05	132.07	186.19	209.59	247.87	281.01	326.79	338.37	384.49
12	Dollare exchange rate	$	1163.1	1430.3	1356.9	1258.5	1358.8	1533.0	1818.3	1970.3	2145.5	2439.7
13	Copper price of London metal stock exchange	Долл/тн	6955.9	5149.7	7534.8	8821.0	7950.0	7326.2	6859.6	5501.7	4863.2	6162.8

Of that, concentrate coefficient (required amount of ore for producing 1 ton concentrate) was 48,82 tons. This indicator increased by 11% and became 52,86 tons in 2017.

Correlation between accumulation rate and concentrate coefficient (Table)

Price formation of copper concentrate

$$Y_{Cu} = \left[\left(- RC_{Cu} * 22{,}0462 \right) * \frac{(\alpha - \beta)}{100} - \right] + YAg - T_{As}$$

-Price of pure copper of London stock exchange

RC_{Cu}-cost of purifying 1 pound copper

$22{,}0456$−coefficinet to transfer 1ton into 1 pound

α-content of copper concentrate

β-Metal loss calculated for concentrate

-cost of selling 1 ton of concentrate

YAg -Sales price of silver contained in concentrate

T_{As}- fine on over arsenal content in concentrate above permitted amount

To see from above mentioned formula, it is certainly seen that smelting and refining cost (TC/RC) and concentrate quality are very important from regression equation. Therefore it is required to do optimization calculation of concentrate content in order to keep sales revenue at highest level that depends on copper price, ore quality and enrichment technology.

Sales revenue of this plant has increased by twice becoming 1932.1 million tugriks in 2017 since 2008. Furthermore it shall be important to seek more possilities to increase business revenue furtherly. When doing regression analysis using data analysis program, following results are seen.

Table 21. Sales revenue, concentrate production, ore content, copper price dynamic of Erdenet plant LLC

Year	Sales revenue (million ₮)	LMSEcopper price ($)	Production of copper concentrate (thou.tn)	Cu in Ore (%)
2008	905084.8	6955,88	525.264	0,574
2009	828295.7	5149,74	533.083	0,565
2010	1164568.0	7534,78	522.033	0,548
2011	1233728,5	8820,99	513.731	0,54
2012	1219095	7949,95	517.782	0,542

2013	1198824.0	7326,16	512.854	0,53
2014	1312299.0	6859,6	516.813	0,526
2015	1054640.0	5501,7	546.19	0,516
2016	1257972.8	4863	598.517	0,51
2017	1932082.5	6162,8	595.096	0,495

Metal Stock Exchange of London

To write down regression equation of factors, it is like following:

$$\boldsymbol{Revenue = -36068,17 + 159,83 * X_1 + 6263,74 * X_2 - 5971251,4 * X_3}$$

When copper price increases by 1USD while other factors are at normal rate, plant revenue increases by 159.83 million tugriks. When amount of copper concentrate increases by 1 thousand ton, sales revenue increases by 6.26 billion tugriks. When copper content in ore increases by 1%, sales revenue decreases by 5971 billion tugriks on the regression equation. It's result is reverse to the copper content in ore because amount of production increases due to the change in content.

The following statistical analysis was carried out by the analysis of factors related to how quality of concentrate of Erdenet Mining Corporationfrom 2007-2017 are depends on metallic recovery, metal content in ore and ore processing.

Quality of concentrate, metallic recovery, metal content in ore, amount of ore processing of Erdenet LLC

Year	Quality of concentrate (%)	Metallic recovery (%)	Metal content in ore (thou.tn)	Ore processing (thou.tn)
2007	23,96	85,8	151.7	25600
2008	24,14	86,15	147.2	25640
2009	23,73	86,43	146.3	25920
2010	23,65	86,5	142.7	26060
2011	23,67	86,35	140.8	26100
2012	23,5	86,3	141.0	26030
2013	23,23	86,3	138.1	26045
2014	23,03	86,55	137.5	26126
2015	23,35	88,22	144.5	28000
2016	23,25	87,56	158.9	31180
2017	23,36	89,28	155.7	31438

To see from the result of this calculation, correlation coeffient is 0,894 which means that metallic recovery, metal content in ore, amount of ore processing influence on quality of concentrate directly.

To write down regression equation of factors, it is like following:

$$\boldsymbol{Quality\ of\ concentrate = 7,85 + 0,1678 * X_1 + 0,0605 * X_2 - 0,0003 * X_3}$$

When metallic recovery increases by 1% while other factors are at normal rate, quality of concentrate increases by 0.16%. When metal content in ore increases by 1 thousand tons, quality of concentrate shall increase by 0.06%. When ore processing increases by 1 ton, quality of concentrate decreases by 0.3%.By considering that sales revenue is highly depends on price of pure copper, we also analyzed the price of copper concentrate based on the price and quality of concentrate of Metal Stock Exchange of London. For example: Price of copper was 6162,77 USD/ton in 2017. When this price decreases until 6000USD/ton, sales price of 23,36% content of copper concentrate decreases by 36,25USD while sales price of 24% content of copper concentrate decreases by 37,29USD.

Price analysis of copper concentrate based on price of pure copper and concentrate content

Copper price, $/tn	5600	5800	6000	6162.7	6300	6500	7000	7500	8000
Content, %	Concentrate price								
22.0	1,039.2	1,081.0	1,122.8	1,156.8	1,185.5	1,227.3	1,331.8	1,436.3	1,540.8
22.2	1,048.9	1,091.1	1,133.3	1,167.6	1,196.6	1,238.8	1,344.3	1,449.8	1,555.3
22.4	1,058.6	1,101.2	1,143.8	1,178.4	1,207.7	1,250.3	1,356.8	1,463.3	1,569.8
22.6	1,068.2	1,111.2	1,154.2	1,189.2	1,218.7	1,261.7	1,369.2	1,476.7	1,584.2
22.8	1,077.9	1,121.3	1,164.7	1,200.0	1,229.8	1,273.2	1,381.7	1,490.2	1,598.7
23.0	1,087.6	1,131.4	1,175.2	1,210.8	1,240.9	1,284.7	1,394.2	1,503.7	1,613.2
23.2	1,097.2	1,141.4	1,185.6	1,221.6	1,251.9	1,296.1	1,406.6	1,517.1	1,627.6
23.36	1,105.0	1,149.5	1,194.0	1,230.2	1,260.8	1,305.3	1,416.6	1,527.9	1,639.2
23.6	1,116.6	1,161.6	1,206.6	1,243.2	1,274.1	1,319.1	1,431.6	1,544.1	1,656.6
23.8	1,126.2	1,171.6	1,217.0	1,254.0	1,285.1	1,330.5	1,444.0	1,557.5	1,671.0
24.0	1,135.9	1,181.7	1,227.5	1,264.7	1,296.2	1,342.0	1,456.5	1,571.0	1,685.5
24.2	1,145.6	1,191.8	1,238.0	1,275.5	1,307.3	1,353.5	1,469.0	1,584.5	1,700.0
24.4	1,155.2	1,201.8	1,248.4	1,286.3	1,318.3	1,364.9	1,481.4	1,597.9	1,714.4
24.6	1,164.9	1,211.9	1,258.9	1,297.1	1,329.4	1,376.4	1,493.9	1,611.4	1,728.9
24.8	1,174.6	1,222.0	1,269.4	1,307.9	1,340.5	1,387.9	1,506.4	1,624.9	1,743.4
25.0	1,184.2	1,232.0	1,279.8	1,318.7	1,351.5	1,399.3	1,518.8	1,638.3	1,757.8

To see from above table, concentrate quality changes by 2%, price of pure copper increases by 9,67-10,47 USD if the price is between 5600-6000USD, 10,79-11,47 USD if the price is between 6162,77-6500USD, 12.47USD if the price is between 7000USD,13,47USD if the price is between 7500USD,14.47USD if the price is between 8000USD. Price of pure copper increases by 500$, it increases by 1$.

1. Optimization calculation of copper concentrate content when sales revenue is at highest level

Basic condition: It was planned to produce 547.9 thousand tons of concentrate with 23% content and 87.85 metallic recovery when processing 30.8 million tons of ore.

Data obtained for calculation: Copper content in concentrate, copper content in ore, silver price contained in 1ton of concentrate, oxidized copper content in ore, cost of transporting 1 vagon concentrate, amount of 1 vagon concentrate. In order to optimize quality of concentrate, copper price, ore quality, enrichment technology indicators were obtained. Of that, when content of concentrate is 24.2%, sales revenue shall increase by 2646,7 thousand $ yearly, metallic recovery shall be 87,54%. This calculation was made when price of pure copper was 6800$.

Optimization estimation of quaity of concentrate

Processing ore					Thou.tn	31000
Copper content in primary ore					%	0,480
Content of oxidized copper in ore, %					%	3
Planned content of copper concentrate					%	23
Price of 1 ton of pure copper					$/tn	6800
Content of optimized concentrate					%	24,2
Loss due to nonoptimization production					thou.$/year	2647,7
Copper recovery at optimized content					%	87,54
β	ε	Transportation cost, $	Amount of concentrate, thou.tn	Sales price, $	Sales revenuethou.$	ϑ_{Cu-Mo}
22.0	87.95	12,353	594.9	1,257.01	755,441	0.5184
22.2	87.92	12,239	589.3	1,269.82	755,979	0.52095
22.4	87.90	12,126	583.9	1,282.60	756,481	0.52413

22.6	87.87	12,015	578.6	1,295.41	756,973	0.52801
22.8	87.85	11,906	573.3	1,308.20	757,423	0.53274
23.0	87.81	11,798	568.1	1,321.01	757,856	0.53853
23.2	87.78	11,692	563.0	1,333.82	758,252	0.54560
23.4	87.75	11,587	558.0	1,346.60	758,592	0.55423
23.6	87.70	11,484	553.0	1,359.41	758,896	0.56478
23.8	87.66	11,381	548.0	1,372.20	759,127	0.57766
24.0	87.60	11,280	543.1	1,385.01	759,300	0.59339
24.2	87.54	11,178	538.3	1,397.79	759,373	0.61260
24.4	87.47	11,078	533.4	1,410.60	759,355	0.63607
24.6	87.38	10,977	528.6	1,423.41	759,209	0.66473
24.8	87.28	10,875	523.7	1,436.20	758,895	0.69974
25.0	87.16	10,773	518.8	1,449.01	758,402	0.74250

In calculations, to consider to have 2% of change of content of concentrate until 22-25% using data indicated in business planning of 2018 that involves planned content of concentrate, copper content in ore, content of oxidized copper, and to calculate metallic recovery in copper concentrate, metallic recovery in waste, and copper price, the most proper value of the concentrate content must be 24,2%. Therefore change of ore reagent consumption, additional costs, and content of toxic compounds must be researched furtherly.

Relationship of Concentrate output /thou.tn/ and concentrate content

Results to be reached:In the result of decrease in amount of concentrate and increase in content, yearly sales revenue shall be increased by 1.7-2.4 million dollars and transportation cost of 29,8 thousand tons of concentrate shall be decreased by 595 thousand dollars.

When optimization value of concentrate quality is 24,2%, concentrate output shall be 538,3 thousand tons. It means that it is 29,8 thousand tons less than the amount of concentrate that has 23% of quality.

Conclusion

1. Main factors that influence in sales revenue of copper of Erdenet LLC are copper rate announced by Metal Stock Exchange of London, smelting and refining costs, quality of concentrate, metal recovery etc.

2. In the result of changing quality of concentrate until 24,2%, revenue shall increase by 1.5 million dollars.

3. The present research covers calculations of concentrate content that will lead the highest level of sales revenue, but it did not cover cost of the product and other detailed research.

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ANALYSIS OF THE LIFE CYCLE OF EQUIPMENT OPERATING UNDER EXCESSIVE PRESSURE AT AN OIL REFINERY

Every year around 20,000 major accidents occur in the oil and gas industry in the world, and in recent years there has been an increase in the accident rate in the oil refining industry[1]. The station of accidents at works continues to be a complex socio-economic problem[2]. Oil refineries are among the most fire and explosive objects, emergency depressurization of process equipment can cause a major accident with attendant emissions of toxic substances, destruction and damage of expensive equipment, process stops, fires and explosions [3, 4].

Using retrospective methods of analysis, for the period since 2008 till 2018 has been studied specifics of repairs, defectoscopy and ways to improve reliability and maintenance-free operating time for column, reactor and heat exchange types of equipment which used at the Belarusian refinery.

According to the data for 2018, more than 3,700 units of equipment operating under excessive pressure have been installed in the territory of the studied enterprise. And more than 3,200 units are in operation. They can be classified by type in the following way: heat exchange equipment (37%); equipment of capacitive type (41%); filters (7%); column type equipment (6%); separators (6%); reactor type equipment (2%).The most common reason for the repair of equipment is the replacement of unions with conditional passage up to DN100, replacement of internal devices, replacement of unions with conditional passage of DN100 or more. Less often performed repair of the base metal and metal of the body welds.

To minimize the number of repairs of base metal and weld metal, it is necessary to strengthen the input control for newly installed equipment, strengthen control over the selection of material for a specific working environment and operating parameters such as temperature and pressure, ensure strict adherence to process regulations, and apply for newly designed equipment modern technical solutions to minimize the number of stagnant zones.

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IMPLEMENTATION OF EMPLOYEE SUGGESTION SYSTEMS DATA, FACTS, PROBLEMS AND THEIR SOLUTIONS

Who knows the reality of work organisation better than the people, who come into direct contact with them every day. It is worth getting to know their insights and taking advantage of their many years of experience. This is a current topic for manufacturing companies, which, under the pressure of ubiquitous competition, need to constantly improve and use good ideas to improve their processes in order to maintain their position in the market. A tool that enables employees to function in symbiosis with the company is a system of employee suggestions. The source of data presented in the article is the report 'Employee Suggestion Schemes: Experiences of Polish Companies' SLMP, Ł.Dekier and A.Grycuk, Wrocław 2014, which discusses the results of research on the functioning of suggestion systems according to Polish entrepreneurs. [1]

The Kaizen philosophy is the basis for suggestion systems. According to the Kaizen Institute, founded by Masaaki Imai, a pioneer and leader in spreading Kaizen philosophy around the world, Kaizen ('Kai' = change, 'Zen' = good) 'is a Japanese term for 'better change'. Applies to business organisations. Kaizen aims to continuously improve quality for everyone, everywhere and every day. Kaizen activities should be either low-cost or cost-free.' [2]

According to Japanese philosophy, employees should be able to express their own opinions and improve their daily working conditions, thus achieving a change of attitude towards building an environment of continuous improvement. [3]

However, the implementation of the employee suggestion system is associated with many difficulties. This is a result of a survey in which representatives of Polish companies took part and shared their observations. However, these problems can be effectively eliminated by building an effective suggestion system that meets the needs of both the company and employees. Jointly developed expectations on the basis of numerous consultations, an appropriate motivational system adjusted to the employees and a cleverly planned suggestion flow path will ensure that the programme will bring the expected results and contribute to the development of the company.

Kaizen is a daily activity involving all members of the organization, which takes into account the processes and their effectiveness. Building an effective suggestion system is a long and demanding way to go, but the benefits that can be gained from its implementation are definitely worth every effort.

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ROLE OF INVESTMENT COMPANIES IN THE DEVELOPMENT OF THE MINERAL AND RAW SECTOR

The existence of humanity is impossible without the mineral and raw sector (MRS), whereas the human civilization has appeared and continues to exist thanks to the using of new types of mineral raw materials. MRS is one of the most important assets of any state, but it is especially true for the Russian Federation. Regarding to this deal, it is so important to invest to the MRS for the effective development of the state economics. In the depths of Russia is concentrated a significant part of the world reserves of a natural gas, diamonds, nickel, tin, oil, etc. Russia takes a leading world position in the sphere of extraction of the main types of minerals. Russian Federation is one of the the largest producer and exporter of MRS products [1].

The development of MRS in Russia is one of the most important “locomotives” of the russian economics and investment in MRS has a direct impact on increasing efficiency of the extraction, processing and realisation of raw materials. A great amount of scientists has been learning the issues of the MRS development, such as Raimbekova U. K., Bavlov V. N., Kimelman S.A. and others.

This issue is absolutely actual due to that fact, that investments are required for the learning and implementation of new extraction technologies of raw materials, as well as for the development of innovative and high-tech mining and processing complexes. For example, “Rosneft” attracts the huge amounts of money to increase a number of works of the processing complex. In the next 20 years, this Inc. plans to allocate about 400 billion $ into a mastering of Arctic shelf. There are expectations, that the mastering of the Arctic is going to become the most important “locomotive” of an economic growth of the Russian Federation [3].

Under the pressure of various international sanctions MRS enterprises of Russia faced to some difficulties in the attraction of investments in foreign investment zones in a case of direct acting. Under these conditions the role of investment companies and funds, which due to their function are intermediaries in the international investment markets, and, therefore, they act as transnational companies by their organizational and law characteristics.

MRS provides a high investment attractiveness and various investors are interested in making a contribution to relevant investment projects, although, the legal schemes are needed to overcome the sanctions, which have been imposed for political reasons by, above all, the United States. In conclusion, investment companies with a designated risk nature are going to help to ensure the MRS development of Russia with the necessary investments and the achievement of leadership at the world level.

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DEVELOPMENT OF A METHODOLOGY FOR ASSESSING THE LEVEL AND DYNAMICS OF CHANGES IN THE INDICATORS OF CORPORATE SOCIAL RESPONSIBILITY OF OIL AND GAS COMPANIES

Recently, the time of technical progress, intensification of competition, aggravation of environmental and social problems, the topic of corporate social responsibility (CSR) has received increasing attention. The complex assessment of the social activities of companies becomes necessary. For oil and gas companies, the assessment of CSR is of particular relevance, since the activities of these companies are daily associated with a detrimental effect on the environment and affect the interests of the population in the regions of presence. [1]

In order to comprehensively assess the CSR level of companies in the oil and gas sector and obtain objective results in this work, the author has developed and carried out a methodology for assessing the level achieved and the dynamics of changes in the corporate social responsibility indicators of companies in the oil and gas industry.

To carry out the methodology, the author studied the reports on sustainable development [2] of oil and gas companies and independently formed an information base for calculating points on indicators characterizing the level of CSR of companies.In the course of the study, 3 major Russian oil and gas companies were analyzed: PJSC Gazprom, PJSC NK Rosneft and PJSC Lukoil, and a foreign company BP p.l.c. The study period includes the years 2011-2015.

In order to assess the dynamics of the level of CSR on the above indicators, the rates of growth of values were calculated for each company and points were attributed. The next step is to assess the achieved level of CSR, which allows you to compare the analyzed companies with each other by the absolute value of CSR indicators. Oil and gas companies were compared with each other by individual indicators and points were also attributed.

As a result of the study, the following conclusions were made: PJSC Gazprom is the leader in terms of changes in indicators (average score was 8.3). However, in terms of the level of CSR achieved, PJSC “Lukoil” holds the leading position (39.1 points). This allows us to conclude that this company is the most socially responsible. The author's methodology for assessing CSR is of practical importance. In particular, according to the method, it is possible to identify the so-called “bottlenecks”, determine what the company has gaps in the field of CSR, outline development guidelines. Moreover, oil and gas companies can use the methodology for assessing CSR to achieve strategic goals, strengthen their positions in the market by investing in certain areas designated as a problem area. The author is planning to develop this topic and methodology in further research, expanding the coverage of the information base.

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PROSPECTS FOR THE EXPANSION OF POTASH SALT PRODUCTION IN THE REPUBLIC OF BELARUS: TECHNOLOGICAL AND MARKET RISKS

At present, for the Republic of Belarus, the extraction and sale of potash salts is not only an instrument of its own national security, but also the most important economic resource for development. Potash salts are of great export value and are exported to many countries around the world.

Due to the fact that the Republic of Belarus has impressive reserves of potash salts, the expansion of their production is promising for the economy as a whole, since it is revenues from the extraction of potash salts that constitute a significant part of revenues in the country's budget. However, there are certain risks in expanding this industry, which can be divided into technological and market. With the current mining technology, there are some environmental problems. The rest of the mine workings are dumped into salt dumps, forming man-made mountains near Soligorsk- the city of the Republic of Belarus, where the main extraction of potash salts is concentrated. These mountains are fluttered by the wind, washed away by rain, which leads to salinization of the soil, rivers and groundwater, and huge areas of forest dry up. Atmospheric air pollution with harmful substances occurs as a result of the operation of fans for ventilation of the mine, with the operation of individual technological installations, which also leads to an increase in the incidence of the population [1].

It should also be borne in mind that due to the fact that this industry is developing at a fairly rapid pace, there are problems with a shortage of qualified personnel, since the government does not have time to train specialists in this field. A significant problem is also the instability of prices on the world market for potash salts. In recent years, world prices for potash salts have been falling, which has a negative effect on the country's economy, since it is this industry that brings substantial income to the country. Alsothe Republic of Belarus is a member of the Eurasian Economic Union, which requires the development of a mechanism for coordinating the industrial policies of all member countries. The expansion of potash production may be in conflict with the economic interests of our country's strategic partner in integration. Our country's membership in the Eurasian Economic Union and accession to the World Trade Organization limits the freedom to establish import and export customs duties on products of mining and processing industry research.

Thus, the increase in production is associated with technological and market risks, which are currently very relevant and pose a significant threat to the economy of the Republic of Belarus. You can notice the emergence of trends in the decline in sales of Belarusian products, which is the motive for a deep scientific analysis of both the state of reserves and the dynamics of the development of mining enterprises, and the search for new efficient, economically viable and environmentally friendly methods for the extraction and production of potash fertilizers.

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EXCEL PROCESS OPTIMISATION KIT (EPOK)

Year by year, more and more companies, representing a wide variety of business and industry sectors, looking for savings in their daily operations, are trying to optimize their processes. “Lean Management" is one of the most popular ideologies, containing a set of universal principles, methods and tools ideally suited for similar purposes. Thanks to it, it is possible to reduce the necessary financial and non-financial outlays, while at the same time improving the safety and quality of work results. Using positions such as “The machine that changed the world” and “Lean Thinking", which are the foundations of Lean ideology, and using Microsoft Excel spreadsheet, a solution was proposed to simulate the selected process and improve it before making real changes in the process [1,2]. “Excel Process Optimisation Kit" (EPOK) is an original project of students from the Student Research Group “Management” thanks to which it is possible to simulate the flow of information and the course of the process with the use of Microsoft Excel spreadsheet, as it is the case with specialist IT systems, such as ERP systems. The use of such a solution gives the possibility to test the planned optimization solutions on a simplified model, reflecting the reality. Optimization of processes, starting from office, through transport, to production, gives the possibility of saving capital, time and fixed assets while maintaining work safety and increasing quality and efficiency of activities. According to research, these values can even reach up to 90 % inventory reduction, increase in annual productivity from 25% to 50% and reduction of the production area by approx. 50%. In many cases, projects for the implementation of Lean Management tools require good planning of activities and testing of various variants. Thanks to EPOK solution, it is possible without the need to invest in very complex process simulators or to test solutions right away in the real business environment [3].

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NEW APPROACH TO THE FORECASTING OF HYDROCARBON DEPOSITS IN THE NORTH-EASTERN PART OF THE TIMAN-PECHORA PROVINCE INCLUDING THE ARCTIC SHELF

Today, in order to replenish the mineral resource base, it is necessary to optimize geological exploration in new areas, covering poorly known complexes. In the Timan-Pechora province, one of these areas is the search for oil and gas deposits in the poorly known terrigenous oil and gas complexesPermian and Triassic ages. For the solution of these tasks and further systematic development, a technique for tectonic-facially-dynamic forecasting (TTFDF) [1,2] of hydrocarbon traps has been developed for the first time, based on finding out the conditions of their formation and patterns of accomodation.

The study and analysis of the formation mechanism of oil and gas perspective traps within the first allocated facial-dynamic zones of activity and stability allowed their typification and then classified, taking into account the genetic type of the structural form of the upper fluid trap, morphology, genesis and display of the Permian terrigenous sediments in the wave field. As a result of research, a search morphogenetic classification of traps of various types has been developed for their prediction and identification at the initial stages of geological exploration in the north-eastern part of the Timan-Pechora province.

According to the results of seismic stratigraphic analysis and identification of electrometric facies [3] in the areas of the Pechora Sea, including the Severo-Gulyaevskaya area, prospects associated with the Upper Permian oil and gas complex are confirmed. Operational local forecast allowed to establishchanges in lithological composition, powers, reservoir properties terrigenous sediments and to identify favorable search zones. Prospects are associated with sediments channel, delta and delta-front genesis.

The article notes that the developed methodic gives foundation for revising the prospects for oil and gas potential and estimating the forecast hydrocarbon resources in the poorly studied but highly promising oil and gas complex, determine the direction of search and a rational complex of exploration in the northeastern part of the Timan-Pechora province, including the Arctic shelf.

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TRAFFIC MANAGEMENT IN GLOBAL NETWORKS BASED ON FUZZY LOGIC

Traffic management is designed to ensure the quality of the information delivery service to the end user and the efficient use of network resources.

Despite the current traffic management techniques, the problem remains in providing the required quality of service. In this regard, this work is devoted to traffic management in global networks based on the theory of fuzzy logic.

Fuzzy logic was chosen as the method. It allows you to evaluate the qualitative characteristics, and provide the result in quantitative terms, which is undoubtedly important for the formulation of recommendations.

Packets arriving at the incoming ports of the router undergo a classification procedure, usually based on the IP packet headers of the TOS field.

After classifying packet headers, you need to limit the traffic rate. There are two fundamentally different approaches to speed limiting: polishing and shaping. They solve one problem, but in different ways [3].

After applying management policies, packets arrive in queues that can be defined per stream or per class. There are four main types of queues: FIFO, WFQ, CBWFQ, LLQ [1].

One of the common methods of fuzzy inference is the Mamdani algorithm.The fuzzy regulator (controller) FLC makes decisions about changing jitter. At the input receives bandwidth, delay [2].

This method allows, by specifying linguistic variables for a certain numerical range of values, to make up rules and form a clear conclusion.

As a result, it was obtained that thanks to this method, it is possible to flexibly control the value of jitter and effectively use the channel capacity.

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VALUE CHAIN OF THE REFINING AND PETROCHEMICAL INDUSTRIES: ASSESSMENT AND STRATEGY INTEGRATION

The concept of value chains is based on the idea of M. Porter [1] about corporate value chains, as well as the concept of supply chains in logistics. Fundamental provisions of the concept was continued in the works of G. Gereffi [2] and other scientists (R. Kaplinsky, M. Morris,P. Grant, M. Meyer, A. Thompson, A. Strickland, T. Andreeva, O. Yuldasheva, A. Bykov, S. Tolkachev, etc.) As a result of the use of outsourcing by modern industrial companies, a distributed production model has been formed in which individual technological operations are localized in various regions of the world. This has reduced overall costs and increased flexibility in the manufacturing process. Thus, the final product is created within the global value chains, in which each country specializes in certain technological operations and contributes to the added value of the product. The key actors in the industrial sector of the world economic system are not national economies, industries and companies, but global value chains.

However, it should be noted that the international competitiveness of an enterprise is determined not only by the conditions of supply of raw materials, but also by the technological level of the production process. The question is which parts of the production process at various stages of the value chain should be invested in order not only to increase the company's profit, but also to increase the added value of national origin per unit of raw materials used.

This task was successfully solved by the author. 1. The theory of the concept of value chains has been developed and adapted to the conditions of the national economy of Belarus, the use of the value added indicator in the assessment of vertically integrated corporations is justified. 2. A methodical approach to the analysis of value chains in the oil refining and petrochemical industries has been determined, taking into account the technological process and the peculiarities of the formation of prices for oil and oil products. 3. A methodology has been developed for identifying the most productive links in the value chain in the oil refining and petrochemical industries, in which the indicator of value added generated within each process has been used for the first time. The method allows to select the final and intermediate products with the highest level of value added per physical unit of raw materials used. The author has proposed a system of indicators for assessing the effectiveness of individual links in the value chains, which can be used to form a competitive strategy for enterprises and increase competitiveness. This system includes indicators of the structure of value added, indicators of the dynamics of value added, resource efficiency indicators. 4. Differentiated strategies for integrating the value chains of the oil refining and petrochemical industries of the Republic of Belarus are proposed. A distinctive feature of strategies is to focus on maximizing value added.

Practical application of the research results allows building an effective value chain for interacting economic entities, thereby increasing their efficiency and competitiveness. The results of the reasearchwere introduced into the educational process of the Polotsk State University, tested and used in the activities of Belarusian enterprises of the oil refining and petrochemical industries.

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ECONOMIC EVALUATION OF THE POSSIBILITY OF IMPLEMENTATION OF PROJECTS OF COMPLEX USE OF MINERAL RAW MATERIALS ON ARCTIC TERRITORIES

The relevance of such problem as complex use of mineral resources (CUMR) on Arctic territories is increasing now due to the growth of ecological risks, gradual depletion of mineral and raw materials and necessity of meeting the important challenges within environmental management [1-2].Projects of complex use of mineral raw materials have a critical feature: focus on long-term ecological, social and innovative results [3]. At the sametime,they are notable for a high level of knowledge and capital intensity. Despite the range of existing papers devoted to different aspects of complex use of mineral raw materials, there are no publications devoted to economic evaluation of such projects from the point of view of their features and possibility of using modern mechanisms for its support.

Key research methods include strategic and comparative analysis, a decomposition method, sensitivity analysis and methods of economical evaluation of projects.

The study presents features of projectsof complex use of mineral raw materials, factors affecting the economic efficiency such projects and effects of its implementation on Arctic territories. Criteria for assessing prospects of these projects are formed. Potential mechanisms for support of CUMR project's implementation are discussed. These include supportive measures by development institutes and tools of tax and legal environments. Effectiveness of the use of measures from the example of Afrikandskiy project is assessed.

The study makes a number of recommendations aimed at promotion of implementation of complex use of mineral raw materials projects. They include administrative, budgetary, financial measures and such modern mechanisms as foresight-research, instruments of "green economy" and the cluster approach.

The results achieved will form the basis for creation of managerial and organizational arrangement within development of the complex use of mineral raw materials concept on Arctic territories.

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COMPREHENSIVE OVERVIEW OF LEAN MANAGEMENT TOOLSUSED IN THE PROJECT TO BUILD A MINIATUREPRODUCTIONLINE„AGH LEAN LINE”

The world is changing, modifications, innovations and improvement sare constantly progressing. The approach to organisation management is also changing. Nowadays, classic business and organization management methodologies are being a bandoned and more and more often modern concept sare being implemented. The implementation of such a new system in a production company is not aneasytask. Very often there is resistance and misunderstanding on the part of production workers, but also of worker sathigher levels.

Sponsored by currently one of the most popular methodologies implemented in manufacturing companies and gaining popularity in non-production environments is Lean Management. It is a concept that has developed on the basis of TPS (Toyota Production System) principles and tools [1]. However, introducing changes in the functioning and approach of employees is extremely complicated, it requires understanding of the philosophy of this methodology, getting to know the basic principles and developing the habit of self-discipline and self-improvement. These aspects are all the moredifficult to achieve, the longer the life of the unit and (statistically) the older the staff [1,3].

Student Scientific Circle Management functioningat the Faculty of Mining and Geoengineering of Stanisław Staszic University of Mining and Metallurgy in Kraków (Poland), recognizing the need to educate and understand the basics of Lean Management methodology, with the support of its Alma Materdecided to build a tool allowing for effective learning of elementary LM methods. The project„AGH LeanLine"; consists in building a comprehensive Lean Manufacturing system based on RFID and Andontechnology, as well as Lego Mindstorms, which is another development element in the Quality and Production Engineering Laboratory (Lean Lab) of the Faculty of Mining and Geoengineering of AGH University of Science and Technology.

This article describes the conditions and diagram of the process of building the AGH Lean Line project and a description of individual methods used in the simulation game of production of a specific finished product (including Value StreamMapping, 5S, PokaYoke) [1,3].

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SELECTION AND TESTING OF OPTIMAL PARAMETERS AND RATIONAL SEQUENCE OF PROCEDURE GRAPH PROCESSING FOR OBTAINING QUALITATIVE DATA

At the stage of processing seismic data using the CMP method, different types of seismic waves are separated in order to extract as much of the primary reflections as useful information, increase the signal-to-noise ratio and increase the detail of a priori information. The processing graph is an adjustable sequence of analysis procedures and further transformation of seismic information during its processing.

The aim of the work was to study the geological and geophysical materials and the processing of seismic data to select a rational sequence and optimal parameters of the profile processing graph procedures. The study analyzed 2D seismic data on a 480-channel profile obtained at area “X” in the Bukhara-Khiva oil and gas region, near-surface conditions for work and their impact on the quality of seismic materials. The studied data were used to select acceptable parameters of the graph. The processing process consisted of two stages:

1. At the first stage, a preliminary graph (G1) was developed and implemented. Result (G1) was thoroughly analyzed, the main problems related to the traceability of reflecting horizons, the level of interference and surface conditions were identified.

2. At the second stage, on the basis of taking into account all the deficiencies of the preliminary graph (G1) (the changes affected the amplitude adjustment, noise reduction, deconvolution and residual statics procedures), an adjusted graph (G2) was formed. As a result of the implementation of the adjusted graph (G2), a time slice of better quality was obtained.

At the final stage of processing, several procedures for the correction of static and kinematic corrections were investigated, and the time section was migrated to estimate the presence of diffracted waves on the processed data.

As a result, processing procedures that improve the quality of the cuts due to interference suppression were selected and an optimal graph was formed, which can be referred to when processing seismic data obtained in a similar area.

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THE PRODUCTION OF POTASSIUM SALTS IN THE REPUBLIC OF BELARUS. TECHNOLOGICAL, ORGANIZATIONAL AND ECONOMIC PROBLEMS

Belarusian land is a wealth of natural resources. It is one of the largest deposits of potash salt. That is why this work is very relevant. Potassium salt - the natural resource, which of course, for the national economy is very useful. This is especially true for gardening and farming. It will be impossible to get rich harvests without it. Therefore, the development of its deposits should be given special attention. Potassium salt is one of the most valuable minerals in Belarus.

The aim of the work is to study the problems of potash salt extraction in the Republic of Belarus. The object of the study, in turn, is potassium salts.Extraction of potash salt is carried out by a mining method. It is quite dangerous. The fact is that the salt layers are fragile and unstable. And as a result,landslides often happen in the mines [1]. The causes of such seismic events are: echoes of larger earthquakes in the Alpine system, movement along faults, which separatethe blocks of the earth's crust, man-made causes associated with the formation of voids and collapse during the extraction of potassium salt in Soligorsk.Besides the danger of earthquakes, this area is a zone of ecological crisis. According to the law on environmental protection, this means that measures to prevent the harmful effects on the environment and on its restoration should be taken. In this region we can see such ecological problems as: salinization of the fertile soil horizon and pollution with heavy metals, man-made salt karst, formation of wetlands, salinization of fresh surface and groundwater, the appearance of waste heaps up to 120 m high, which are exposed to water and wind erosion, subsidence over the spent space of mines, destruction of plant cover. Contaminated areas occupy several tens of kilometers and expand every year.

In this regard, it is necessary to improve the environmental monitoring of the area: to increase the efficiency of using the natural resource potential while ensuring the integrity of natural complexes; ensure sustainable reduction of harmful effects on the environment; reduce the ecological load of the territory; rehabilitate contaminated areas and restore their biosphere functions. The first step towards this is ecological modernization. It is necessary to improve the methods of extracting potash salts, following the experience of leading countries-producers of potash fertilizers. This method is more progressive and cost effective. It involves the replacement of labor-intensive and expensive work on the construction and operation of mine workings, reduction of the preparatory period and full automation of technological processes while maximizing occupational safety and environmental protection. Also, with the help of this method, the possibility of extracting potash salts in difficult mining and geological conditions and at depths inaccessible to mine treatment increases greatly.

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ANALYSIS OF THE PROJECT SELECTION TECHNIQUE IN THE PORTFOLIO OF OIL AND GAS COMPANY (ON THE EXAMPLE OF GPN-DEVELOPMENTLLC)

The activities of most large companies are based on the projectsportfoliomanagement. Nevertheless, portfolio management is still developing, which leads to the imperfection of the used methods and the high relevance of issues related to this area of project management.

In 2005, the Project Management Institute releasedthe Standard for Portfolio Management [3]. Subsequently, researchers offered their own methods of portfolio formation and assessing its effectiveness [1; 2].However, the lack of scientific work taking into account the specific of the oil and gas industrywas noted. In this regard, the purpose of the research was toanalyze the methodology for selecting projects in the portfolio used in GPN-Development.

To carry out the selection, it is necessary to make a list of requirements for theportfolio,to identify the criteriareflected the requirements, to evaluate a project according to the criteria and to determine priority ofits realization.There are 4 base methodsof project prioritization: the pairwise comparison, the rank method, the scoring method and the method ofhierarchy analysis.

In GPN-Development to determine the priorities of projectsa multi-component integrated indicator (MII) was formed by company's experts on the basis of the scoring method.In spite ofa number of its advantages, since the selection of criteria and determination of their significance are basedon the expert assessments, there is a high probability of making a wrong decision.

In order to analyze the impact of possible expert's errors on the resulting indicator, 15 current projects of GPN-Development were ranked according to the MII formula, as well as modified MII formulas with the adjustment of the specific weights of the criteria and the change in the number of criteriausing the available data on their financial and economic indicators. The analysis of the results showed that the priority of the projects depends on the composition of the evaluation criteria and the specific weight assigned to each of the criteria in the overall indicator.

Next,the influence of the chosen method on the results of project selection was analyzed. For this purpose, the prioritization of the projects was carried outby the pairwise comparison, rank method, and the method of hierarchy analysis. The calculations showed that in some cases the MII significantly underestimates the rank of the project compared with the other methods. It indicates the risk of loss of effective options using only one method in the selection of projects.

Thus, the complexity of multi-aspect evaluation of projects in the process of project selection determines the imperfection of existing mathematical models, which leads to the need for subjective expert analytical methods. In order to reduce their negative impact on the results of project selection, the prioritization of projects should be carried out by several competent experts using various economic and mathematical methods.

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DIFFERENTIATION OF THE MINING LICENSE PRICES BASED ON THE PROFITABILITY ESTIMATION METHOD

The study is devoted to the issue of mining industry attractiveness magnification for entrepreneurs in order to increase competition in the subsoil use market.

Successful development of the mining industry is a guarantee of stable economic growth of the country's economy. A stimulus for the interest growth for deposits from the list of objects of the unallocated geological fund mining could be an improvement of objective assessment of their investment attractiveness, both taking into account the real availability of the mineral deposits, and the differentiated attitude of the state to them as the owner of the mineral resources base.

The principle of differentiating the cost on subsoil use licenses considered in the study is based on the proposed classification of deposits according to the predicted profitability of their development, which takes into account objective and subjective factors affecting the degree of investing risk in the development: geographical location of the site, distance from the main infrastructure and communications access, degree of reliability of geological exploration data, interest of regional authorities in the development of the proposed site, their willingness to provide economic support to a new-born enterprise during the pre-exploitative period.

According to the affecting degree of the considered factors, the *funds-return-ratio* defining "cash-back" of the nominal declared value of the license was proposed and calculated as a criteria for effective legal and economic regulation of relations between the state, as the owner of the subsoil mineral resources, and the potential subsoil user. A part of the subsoil use license cost, determined by the funds-return-ratio, is proposed to be returned to the license holder through a tax deduction mechanism during the period preceding the mining enterprise's output to the full project capacity.

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DETERMINING THE INDUSTRY AVERAGE FINANCIAL RATIOS OF MINING SECTOR AND ITS RELATION TO ECONOMIC CYCLE

Determining the industry average financial ratios and publishing it publicly has a numerous usage such as analyzing financial reports by comparing own financial ratios with the industry average, benchmarking with the good performing companies, using on company valuation and research papers.

As of the fourth quarter of 2017, there are total of 218 listed companies operating in 10 different industries in Mongolia. However, one of the challenges for investors, policymakers, and researchers is that there are still no unified industry average financial ratios exists.

Key words: mining sector, financial ratios, industry average, economic cycle, real GDP

This study aimed to determine the industry average financial ratios of mining sector, its characteristics, and its relationshipwith economic cycle. We have chosen the mining sector due to its crucial attribution to Mongolian economy.

For the numerical data, in order to determine the industry average, we have used annual reports between 2010 to 2017.

For estimating business cycle, we have used the data of real GDP between 2010 to 2017, and it is representing the economic growth.

This study aimed to determine the industry average financial ratios of mining sector, its characteristics, and its relationship with economic cycle.For the numerical data, in order to determine the industry average, we have used annual reports between 2010 to 2017.

Industry average financial ratios of mining sector is estimated by using the financial ratios of 11 listed companies. According to the result of the study, we conclude that the liquidity, operating, and profitability ratiosof mining sector are procyclical, and debt ratios are countercyclical. Due to economic growth in 2017, mining sector liquidity ratio, receivable turnover, and inventory turnover ratios increased by 0.7, 0.6 and 2.4 unit each. The ratio of debt to total asset of the sector is reduced by 10% from the end of 2017 to 50%. The gross profit ratio of the sector is 6.45%, while net profit margin is 0.45%. However, compared to the previous year, the gross profit margin decreased by 1.5%. The growth in COGS affected to decrease the gross profit margin over the last 2 years.

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CREATION OF THE PROJECT DEVELOPMENT OF OIL COMPANY

Fundamental changes in the economy demanded changes in all areas and sectors of the economy, especially in the oil industry, as at present, according to the strategy of the Organization of Petroleum Exporting Countries, there is a reduction in oil production, a reduction in demand and a decrease in the price of oil. This suggests the need to formulate an enterprise development progr.am aimed at expanding and developing the oil sector.

In the current business environment, the problem of the integrated development of the oil sector is acquiring a number of updated aspects, which make it possible to speak about the features of the adaptation period in the development of the oil industry market.

Regardless of the field of activity of the company (production or provision of services), quality service is the only strategic decision that allows you to beat the competition [1].

The development of an oil company development project is necessary to ensure the attainment of the goals and objectives established. Analysis of development paths aimed at changing the existing state is carried out according to the parameters of changes in relation to the basic variant of development, based on the result of extrapolation of the existing trends and the possibilities for their implementation. At the same time, the concept of development is important, for the formation of which it is necessary to define a system of variable parameters characterizing the structure of strategies and target standards for the development of measures for their implementation.

This work is devoted to topical issues that are in the field of crisis management in the field of oil and gas industry. Analysis of the activities of oil companies is of scientific interest in the framework of determining the most effective management model.

A description of the research object is given, a full analysis of the activities is carried out, and the strengths and weaknesses of the company are identified. Developed solutions to identified problems. Predicted sales of the company, defined the technology of the company in question. The project financing scheme is described, the main performance indicators are calculated using a scenario approach that takes into account risks that may affect the success of the project.

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CYBERSECURITY IN THE MINERAL RESOURCE AND RAW MATERIAL COMPLEX

Currently, there is a sharp increase in information security incidents, the spread of which is expanding. These incidents have an impact on the mineral resource and raw material complex as well. The development of the mineral resource and raw material complex and its effective use are important factors for the sustainability of the national economy, ensuring geopolitical interests and state security. The mineral resource and raw material complex determines the economic potential and the standard of living of the country's population, and is also the basis for other industries, since it provides them with raw materials. In modern scientific literature topic of cybersecurity of the mineral resource complex has not been widely considered. Separately, the topic of the introduction and use of information technologies in the system of organization and management of the mineral resource and raw material complex was studied by T.V. Bulgakova [1], V. Byala, E. Mizgal [2]. Based on the analysis of literary sources, we note that the topic of cybersecurity in the continuum with the mineral resource and raw material complex reflects a high degree of novelty.

All of the above requires urgent solutions to issues related to cybersecurity in the mineral resource and raw materials complex. Methods of computer attacks require a systematic approach to creating an integrated security system capable of countering these threats. First, in order to implement the information security system of the mineral resource complex, first of all, it is necessary to develop a comprehensive system of indicators covering all aspects of the functioning of the mineral raw material cyberspace. Next, it is necessary to develop models of threats to the cyberspace of the mineral resource complex. In this case, it is needful to create mathematical models that will allow to obtain data on the degree of threats to information security, by drawing up a risk analysis, as well as the effectiveness of existing protection measures [3]. The last tip is the development of methods for ensuring the sustainability of the cyberspace of the mineral-raw material complex under the influence of threats on it, based on the obtained numerical characteristics of information security.

In modern conditions, cyber security problems are moving away from the level of information protection on a separate computing facility to the level of creating a unified cyber security system. The creation of an integrated cyber security system will support the mineral resource complex, which is a determinant of the sustainable development of the national economy.

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DETERMINATION OF THE DIAGNOSTIC SYSTEM PARAMETERS FOR POWER GENERATING STATION COMBUSTION ENGINE

The only solution to provide reliable power supply for petroleum industry is the use of power stations with internal combustion engines. The new reliable work of electrical equipment is a complex of diagnostic procedures for determining the technical condition and timely repair. At the heart of the diagnostic process is the receipt of experimental data, diagnostic features, which, depends on informativeness degree, determine the state of the subject under the study. The main reason for the power generating plants with internal combustion engines loss of the working state is the wear of a cylinder-piston group. For the diagnosis of internal combustion engines, which allows in most cases, by comparing the experimental data obtained with the normative ones, to establish a technical diagnosis, number of diagnostic methods are provided. One of the progressive methods that allows the diagnostics of the cylinder-piston group's airtightness is to measure compression using compressors and compressorsografs. The disadvantages of this method include the high workload associated with the engine disassembly and data inaccuracy.

The indicated drawbacks are deprived in diagnostic system of the internal combustion engine which use the level of the starter current as a diagnostic parameter [1, 2]. Application of this method allows to significantly increase the results informality and reliability with simultaneous reduction of labor costs. However, this method of diagnosing requires pre-set data on the currents and the voltage value of starter engines for its implementation, which significantly limits the application of this method, and makes it impossible in case of creation of new engines models.

The purpose of this study is to determine the inertial parameters of the system with the consideration of the complex motion of elements of a cylinder-piston group of a single cylinder internal combustion engine in the diagnosis without fuel supply by the starter current.

To predict the real inertial forces that occur with diagnosing of a power generating station internal combustion engines, a mathematical model that takes into account the effect of changing the reduced moment of inertia is developed. Established that the change in the reduced moment of inertia for one spin of the crankshaft is in the range of 0.8%. Considering the insignificant influence of the variable component of inertia, the given moment of inertia of the system can be calculated without significant loss of accuracy only as a constant component.

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A RESEARCH ON COAL QUALITY NATURE OF SOME COAL MINES OF MONGOLIA

ABSTRACT

Outcome of coal industry in Mongolia is showed at the close level between 1990 to 2004. That means ensuring economic demand can be basement of its achievement. However, more interesting a phenomenon was dramatic growth coal exportation of 2004 into total mining production in especially Coal.

In order to determine coal quality terms when operational process is going on the steps, it should be used measurement units of geological exploration works. In the study results, the determined quality terms through exploration project jobs of brown and coking coal is examined comparison study while production processing. Furthermore, it is possible to create information data center based inter-relative studies between the managing opportunity of average estimation in the quality terms by and situational terms of the geology-mining.

The highlighted point of this study is the correlational calculation between coals qualities term in several Mongolian Mines through using econometric and mathematical models.

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MECHATRONIC RETAINING AND RELEASING SYSTEM

In March of 2018, the student competition INNOVACE of the company ACE Stoßdämpfer GmbH was announced for the second time. At this year's edition INNOVACE 2018, mechanical engineering students Mathias Blessing, Jannik Montag and Chris Taschelmayer participated as a team for the Technical University Georg Agricola in Bochum. The team worked on its project called "grACE" in the period from April to the end of August, also in the context of the Bachelor module Design Engineering 2018 under the direction of Prof. Dr.- Ing. Stefan Vöth. In November, the project was named the winner of the competition, along with another paper, in the corporate headquarters of ACE Stoßdämpfer GmbH in Langenfeld. The task includes the following points: A connector (male) is to be caught and held by a retainer (female). The holding device must be able to hold 20kg. The installation space for the device is 50mm x 50mm x 25mm. The male should be connected to the mass via a rod with a diameter of 5mm. The mass at the male is 10kg, impinges with a maximum speed of 0.5m/s and generates a kinetic energy of 1.25Nm. At least 30% of this energy is to be absorbed when impacted by ACE SLAB plates. The locking of the connector must be wirelessly released via an external control device (smartphone) and further requirements.
For a structured problem-solving, the task was first divided into sub-problems. For each subproblem different solution concepts were worked out, graphically presented and their advantages and disadvantages determined. On the basis of previously defined criteria (such as size, energy consumption or safety), the collected solution proposals were evaluated with different factors. After selecting the solution concept, the components hook-lever and maleconnector were first in the foreground, since these are the starting point for solving the problem of the locking retainer mechanism.

In conclusion a structural design with technical proof of function and feasibility was provided. A proof of strength could also be provided. A communication/control principle was developed for the communication between the locking retainer with internal sensors and the smartphone and the task was fulfilled.

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EXERGO-TECHNOLOGICAL EXPLICIT SELECTION METHODOLOGY FOR ENERGY CONVERTER OPTIMIZATION – CASE OF AUTOMOTIVE APPLICATION

Significant research efforts are considered in the automotive industry on hybridelectrified powertrains in order to reduce the emissions and to improve the fuel economy of vehicles. Powertrains electrification resulted in a wide range of hybrid vehicle architectures where the fuel consumption strongly relies on the energy converter performance in term of efficiency and power density [1].

This study investigates the fuel savings potential of an extended range hybrid electric vehicle (EREV) using different thermodynamic energy converter. A review on the different energy converters is performed and qualitative and quantitative criteria are identified. Then, an exergo-technological explicit selection methodology based on exergetic and technological analysis is conducted to identify the best thermodynamic configurations [2-4]. The energy converters studied are the split cycle engine, the internal combustion gas turbine, the external combustion gas turbine, the combined cycle gas turbine, the Stirling machine, the vapor cycle machine, the thermoelectric generator and the thermoacoustic system.
An EREV model is developed and energy consumption simulations are performed on the worldwide-harmonized light vehicles test cycle (WLTC). Fuel consumption simulation results are compared to a reference EREV using a conventional internal combustion engine auxiliarypower-unit.

Results show a potential of 10% to 30% of fuel savings when considered the split cycle, the combined cycle gas turbine and the internal combustion gas turbine thermodynamic machines as auxiliary-power-unit as substitute to the reference internal combustion engine. Consequently, the identified energy converters present a potential for implementation in future EREV. Furthermore, the methodology developed in this study can be applied to identify the best thermodynamic configuration of energy converters for other industrial applications, such as energy production, solar, naval and aeronautics applications among others.

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AUTOMATED SYSTEM FOR EXTRACTING AND PROCESSING DATA PUBLICLY AVAILABLE ON THE INTERNET

Processing public data to standardize and streamline it is a promising direction for developing information systems in a variety of industries, from universities and schools to mining enterprises. The main purpose of this research is to synthesize and implement an information system able to process and structure publicly available data to increase the efficiency of working with it.

Right now the schedule of the university does not provide a convenient way to obtain information that matches specific queries (e.g. schedule for group “НГД-18-7” for Friday only) resulting in a large waste of time. The article describes an application that is able to retrieve, process, analyze and provide information about the schedule of the university satisfying the requirements of the user in a human-readable format.

To be able to sort and filter the schedule application must structure the data fetched from PDF schedule files publicly available on the university website [1]. This problem was solved by synthesizing a flexible polymorphic algorithm for parsing initial data which can adjust its own behavior to process various input data. The structure of the algorithm allows it to be adapted for processing data of various origins, which makes developed program applicable for systematizing the data of mining enterprises as well as the schedule of Mining University.

The designed system is based on the Spring Framework and implemented using the Kotlin programming language [2]. The web interface of the application allows a user to view the schedule of certain groups of the university, as well as the schedule of teachers and classrooms (user interface allows filtering odd and even weeks and days of the week). Requested information can be provided as feed (user-friendly form widely used by other schedule/timetable applications) or as a table. The application provides open RESTful API endpoints to integrate processed schedule data into existing information systems of the university (http://personalii.spmi.ru, http://lk.spmi.ru) [3].

Summing up the research the algorithm for analyzing the initial data was synthesized and a system for processing and providing filtered schedule data was designed. A working prototype of web-application based on Spring Framework (http://raspisanie-mining.ru) implements the required functionality for the schedule of first-year students and is being used by a team of testers in the educational process.

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ANALYSIS OF THE POSSIBILITY OF INCREASING THE ENERGY EFFICIENCY OF A SELECTED SINGLE-FAMILY HOUSE

The article involves contemporary energy problems, especially the progressive degradation of the environment and evaluating the influence of individual sections on the air pollution, specifically on a low-pollution occurrence [1].

In particular the thesis is focused on the municipal and household sector. Most of existing polish buildings are old, so the wooden building, covered by a fibre cement was analyzed in this essay and its energy efficiency was evaluated. This house is located in Silesia region [2].

Subsequently focused on a proposal of safe disassembly items, which contains a fibre cement and thermo modernisation. Two renovation options are proposed and one of them is made to keep the specificity of wooden construction, what is so important in the context of sustainable development [3].

In article were also analyzed technical, economic and environmental aspects of undertaken activities. What is more, the capabilities of financing the thermomodernisation were discussed in the elaboration [4].

The single-family buildings are responsible for a poor air quality in Poland. The thermomodernisation could reduce the carbon dioxide emission about 70% as well as decrease heating costs.

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«MINING 4.0» RECENT DEVELOPMENTS IN THE MINING INDUSTRY

Mining activities provide several materials for people in different fields. For example, architects need steel, which is processed from iron ore, for construction. This is the reason why the mining industry has played an important role for hundreds of years over the world. In recent decades, mining has gotten several technological breakthroughs, which help mining companies to increase the output of mineral products and mining safety as well as to reduce running costs. The newest trend is called “Mining 4.0”, which includes technologies like autonomous mine trucks, unmanned aerial vehicles, and automated drilling system.

This research thesis aims to introduce these technologies of “Mining 4.0” and show in which aspects they have improved mining. First, the term “Mining 4.0” will be explained. Then, to illustrate and to analyze “Mining 4.0”, this paper will introduce several “Mining 4.0” technologies and their application in different mining fields. In this way, these technologies will be explained, some examples of utilization will be given, and their state of developments will be presented. Their advantages and disadvantages will also be discussed.

The research paper will give the overview about how these modern technologies work during mining. For example, the UAV (unmanned aerial vehicles) could help surveyors to explore uneven areas and check the effect of blasting, when there are several toxic fumes [1]. Autonomous mine trucks and trains could work 24 hours a day to haul the mineral products, which is more efficient than mine trucks and trains driven by a human [2]. Automated drilling system could monitor the drill pressure and speed by being equipped with digital sensors and recorders, which means that miners could get different sizes of boreholes in different rock conditions to optimize blasting. Mine ventilation, which can make up to 50 percent of the energy costs [3], could be improved by sensing and monitoring the air flow and temperature in the underground mine [4]. These technologies undoubtedly have improved productivity and safety conditions in the mining industry as well as reduced running costs. Finally, a conclusion and an outlook conclude this research paper.

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ELECTROCHEMICAL BEHAVIOR OF STEEL ST20 IN HYDROGEN HYDROGEN CONTAINING ENVIRONMENTS

In gas fields, gas production is mainly used for carbon steel St10, St20, St75. The presence of H_2S and SO_2 in the environment increases the process of metal corrosion. In this regard, in this work, corrosion of carbon steel St20 in hydrogen sulfide containing media was investigated. Corrosion tests were carried out by electrochemical method. In the work, organic acetylene containing compounds were used as a corrosion inhibitor, which was introduced directly into the medium in an amount of 1.0 wt.%. Polarization curves on a P-5827M potentiostat were recorded by the electrochemical method. A saturated silver chloride electrode was used as a reference electrode. Potential was recalculated at n.e. The i- E curves were taken from a stationary potential with a potential change rate of 0.5 mV / s. [1]. At the beginning, the cathode curve was recorded, and after reaching the stationary potential, the anode one.

Research has shown that the introduction of propargyl alcohol into the solution with the time is improved, and with the addition of acetic aldehyde, it is somewhat ennobled. In general, the potential of St20 steel in the inhibited solution has more positive values than in an inhibited solution. The nature of the change in potentials suggests that the introduction of propargyl alcohol into the solution causes inhibition of the predominantly cathodic process, butyric aldehyde, predominantly anodic.

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NEW METHOD WORKING OF DOLOTS FOR BOREHOLES DRILLING DURING THE MINING OPERATIONS

Roller drilling, which has found widespread use in the mining and petroleum industries, has drawbacks due to the limited structural stiffness and high level of vibrations. To eliminate this drawback, single cone bits [1] were used, the peculiarity of which is the presence of one roller cutter mounted on a rigid, cantilever pin. Thus, a single pin chisel with a vertical pin [2], when drilling wells with a diameter of 215.9 mm, showed the best results [3] compared to a three-beat bit. This experience is advisable to use when drilling small diameter wells and boreholes.

The authors have proposed a new way of drilling a bit, which provides for the transfer of axial force directly to the roller cutter and the transformation of the bit case rotational force into the forces of an impact of the drill bit head in another plane.

Comparative tests of the Sh-76 and tricone chisel were carried out on the drilling bench and showed an increase in the drilling rate of 1.9 times, a decrease in the level of vibrations by 5 times, compared with the tricone bit with the same operating parameters. The direction of further research is the substantiation of effective parameters of a bit with a diameter of 42 mm or less.

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THE APPLICATION OF SEARCH METHODS FOR SOLVING OPTIMIZATION PROBLEMS IN GEODESY

As a rule, excessive data is used to solve any problem in practice. When it happens, the problem has several solutions (or, in some cases, a possibly infinite number thereof). As a result, a problem arises of how to optimize the solution process.

The purpose of the optimization problem is to find a solution in accordance with any objective function (such as the criterion of efficiency or quality) [1]. The branch of mathematics which studies how optimization problems are solved is called mathematical programming. Most practical problems are nonlinear in nature, i.e. the objective function and /or the connections between the parameters are nonlinear.

Search methods are very effective in solving optimization nonlinear problems due to their advantages [2]:

- a great variety of mathematical algorithms which have already been developed;
- the possibility of combining these algorithms with each other and with other methods of nonlinear programming;
- ease of programming;
- independence from the accuracy of the preliminary values of the parameters defined (you can take values that are far from the true ones without compromising the solution process);
- there is no need to formulate error-correction equations or constraint equations or use a system of normal equations and solve them;
- there is no need even in using the first derivative in the process of linearization.

The paper describes the results of running search algorithms in Visual Basic for Applications (VBA) for solving optimization problems in geodesy: the solution of the combined intersection, the determination of coordination parameters for two coordinate systems, the approximation of a circle. The following algorithms of search optimization have been developed: genetic algorithms, the method of simple search with a variable step size, the parabolic optimization method [3].

Search methods are convenient in programming and a large number of already existing methods along with the development of new search algorithms makes it possible to adapt them to solving any problems, including those in the field of geodesy.

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ESTIMATION OF ENVIRONMENTAL SAFETY OF OIL AND GAS INDUSTRIAL OBJECTS USING THE INFORMATION AND KINETIC APPROACH

Nowadays, the estimate of the production facilities environmental safety of the mineral resource complex is an issue of the day since this area is also a major consumer of technical devices. The main problem of the oil and gas industry is a high degree of mining and transport equipment deterioration [1] which increases the need to improve the means to maintain their efficiency. However, due to the use of ambiguous monitoring methods related to the evaluation of efficiency of the criteria, the challenge to improve the accuracy of methods for assessing the state of facilitiesremains and the solutionwill optimize measures ensuring the safety of exploiting.

One of the ways to improve the reliability and environmentally-safe operation of oil industry facilities, pressure vesselsin particular, is to apply hardening technologies at various stages of production or directly during exploiting. There are both traditional well-developed, and fundamentally new technologies (ultrasonic, laser, electro-physical, electron-beam, pulsed, etc.), allowing to obtain thin coatings (or layers) on a variety of materials. Such developments, improving materials and products, are necessary to be examined on the feasibility of their use and the quality of the samples. The degree of hardening should be the criterion for assessing the quality.

Existing methods for estimation of the quality of hardening technologies can be classified in terms of the type of monitored signal and its connection with the processes determining the strength of the material. Signals recorded by the methods of transmission and reflection of waves introduced from outside are connected with the strength and damage growth process ambiguously since they miss the nano-scale factors due to the wave bending around the strength anomalies. Promising here are the methods of radiation since they emit waves that are connected with the process of damage of the material. These are electromagnetic and acoustic emissions (AE). The main problem of strength AE control is connected with the complexity of interpretation and quantitative linking of the results of AE signals registration with the strength characteristics. This paper proposes an information and kinetic approach that relies on a multi-level model which relates the AE parameters and determines the strength of the processes.

This approach showed high information content for estimating the state of pressure vessels, deep-sea apparatuses, complexly loaded metal structures, products made of composite materials and at other industrial facilities [2-3]. Thus, using the information and kinetic approach the environmental safety can be estimated.

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THE IMPORTANCE OF THE CLEANING OF THE PANELS FOR BOTH CSP AND PHOTOVOLTAICS APPLICATIONS

Since the late XX century global awareness about climate change hasbeen on the rise, as the changes in temperatures around the globe became moreapparent [1],causing to look for safer energy alternatives. One of such is solar energy. Average solar irradiance reaching earth isapproximately 1361 W/m² [2]. There are many methods for gathering solar rays. Ones of the most interesting methods are theConcentrated Solar Power and photovoltaics, yet they are not flawless. Locations for solar power plants generally consist of open arid, desert like,regions. Such areas are abundant in dusts andsubject to strong winds.Particle accumulation on thepanel and mirrors surfaces decreases efficiency. Furthermore,the wind at high speeds, exceeding 15 m/s, can cause surface damage. A typicaldegradation of 2% every day is recorded [3]. Thus it is vital to maintain andprotect the mirror surfaces, as they depend on their reflectivity.

There is some interest in cleaning methods, from simple removal using pressurized water to sophisticatedexperimental results using static electricity to shield from dust, yet there is apossibility that contact cleaning of polymer mirrors could damage the polymer. Ina recent study it was noticed that the actual brushing orientation might have animpact [4], [5]. Hencethe aim of the work was to investigate that matter in order to optimize the cleaning process.

The experiment consisted of various samples being cleaned with FANUC M710-iC robot assistance and their assessment with a reflectometer. Three brushes of varying hardness were used. They moved with three different speeds and three varying motions were simulated: linear only, linear and rotational and rotational only, the last serving as a check group due to the practical unsuitability of the motion.

Concluding the experimental part single linear motion was betterthan paired motions, but the differences werestatistically irrelevant.Rather than direction only, all of the variablesshould be taken into account, as the result was not only dependent on thebrushing direction. Most damage was produced by the slow feed and hard brush, although there was no direct connection between the orientation and the damage. As further recommendations it would be crucial to check not only different motions, but the brush inclination and the dependence of the variables between themselves, as well as investigate the samples after long term sun exposure.

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APPLICATION OF COMPUTER QUANTUM-MECHANICAL MODELING FOR THE SCIENTIFIC SUBSTANTIATION OF ENERGY-SAVING TECHNOLOGY OF LAYERING OF DIFFERENT-SIZED MOLECULES ON METALS

The method of layering of different-sized molecules of ammonium compounds on metals developed at Saint Petersburg Mining University (Patent RU No. 2425910) was implemented at a number of mineral-resource and energy companies of Russia and Republic of Belarus [1,2]. In fact, the method is an energy- and resource-saving technology of improvement of anti-corrosion and anti-friction properties of the surface of metal structures, which operate in mining and chemical industry. Energy conservation is achieved due tothe layering of ammonium compounds at room temperature. The monolayer application of the substance (5 mg/m^2) provides lowmaterial consumption, and therefore the reduction of the cost of applied material to about 0.0026 cent/m^2. One of the perspective ways to optimizethe technology is quantum-mechanical modeling of complex structure formation processes on metal surface. The purpose of this work is to analyze the quantum-chemical characteristics of molecules of quaternary ammonium compounds (QAC) in order to improve the technology of layering of QAC; study properties formationof the surface.

In the research, the modeling of modification agents' (ammonium compounds) molecules was conducted in HyperChem software environment using a semi-empirical method "Modified Neglect of Diatomic Overlap" (MNDO) [3]. In addition, dispersed copper powder PMS-1, as well as samples, modified bydifferent-sized QAC were analyzed using an indicator method.

For the first time, quantum-chemical modeling in HyperChem environment was carried out for modification agents of the process of layering of QAC on metals. A series of amplification of nucleophilic/electrophilic properties and dipole moment for QAC-based modifiers were obtained. As part of the study of the donor-acceptor properties, the differences in the characteristics of the molecules of the alkamone (A) and triamone (T) were quantitatively and qualitatively established. The mechanism of occurrence of synergistic effects [2] was found to be related to the formation of the electron T…A interaction due to the nucleophilic and electrophilic nature of the modifiers. Molecules' properties were compared with the sorption characteristics of modified metals.

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MICRO ABLATION OF HARD MATERIALS BY LOW ENERGY PICOSECOND LASER

Nowadays, laser processing are well known in almost all area of technologies and is applied for every kind of material. The most popular are: welding, cutting, drilling, machining, texturing and general tooling. The main aim of laser surface micromachining is to develop surface area with changed properties applicable in a particular purpose. Lasers used to this kind of treatment are constantly being improved and the time of laser pulses is shortened, which results in improved quality of micromachining[1].

In this paper basic information about laser surface texturing of tool steel are presented. Tool steel alloys are the most common steel alloys in almost all area of technologies. Among the methods of tool life increase the surface treatments with laser source are getting more and more attention. For laser ablation, micotexturing and generating structures size in range of 150nm two types of pulsed laser (excimer and solid state) are used in industrial production. In this paper diode-pumped solid-state laser with a 6ps pulse length was used. Few years ago the shortest pulses time which were obtainable was 10 nanosecond, nowadays femtosecond lasers are applied. Generating pulses in active laser medium is corresponding to lifetimes of the atomic energy levels. Wide ranges modifications of pulse energy and pulse duration is possible by using different pulse generation techniques[2,3.4].

A number of studies have investigated different surface modifications to extend lubricated area of working parts of devices. To obtain net of dimples on a tool steel surface, the diode-pumped solid-state picosecond laser with a 355nm operating wavelength was used. As the investigated material tool steel ASP 2023 type was used as a base material.To compare the interaction of the laser beam with uncoated material and with hard coatings, PVD coatings were created. Different dimple diameters with the same distance between them were obtained as a result of LST (Laser Surface Texturing) process. Also pattern of lines in the same distance between them and square grid were used.

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SOLAR TECHNOLOGIES IN HOUSEHOLD APPLICATIONS

Due to the constantly growing demand for energy and the simultaneous depletion of fossil fuels, the global energy sector faces the difficult task of finding alternative energy sources that will satisfy the energy needs of the humanity.[1] However, these sources should fulfill several conditions - ensure continuity of supplies and be economically justified in the same time. One of the solutions of the problem may be the use of photovoltaic and solar panels in both residential and public buildings – systems can be used to electricity and hot water production. Another option for the most efficient use of solar radiation is BIPV technology, which allows to maximum use of surface area of the building to assemble solar panels.[3] Those are only a few examples of multiple solar technologies which should be use in every household. After analyzing the simulation for a residential building with a photovoltaic and solar installation for domestic water heating, a significant change in the cost of electricity and gas consumption can be observed. The use of such systems has also a positive impact on the environment - it contributes to the reduction of CO2 emissions.

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BOREHOLE WATER INTAKE MATHEMATICAL MODEL, WITH TAKING INTO ACCOUNT CLOGGING PROCESSES IN WELLS AND WATER-LIFTING EQUIPMENT WEAR

Under the conditions of widespread use of groundwater for water supply purposes and the need to save energy and material resources, the problem of optimal operation of borehole groundwater intake water is of particular importance.

All elements of borehole water intakes: wells, submersible pumps, pipelines with shut-off and control equipment and hydrodynamic regime of groundwater are interrelated. During operation of such systems, a change in the hydraulic parameters of any of the elements leads to a change in the capacity of the water intake as a whole. [1]

A system of nonlinear algebraic equations, equal to the number of water intake wells, is usually used for the mathematical description of the operation of the group of underground water intake. Each of the equations represents the balance of the heads of the flow in the pipeline with a pump in it that draws the water from the n-th well of the water intake. [2] In transferred to customer the mathematical model of water intake, received from the field survey water intake, it is necessary to predict the decline in water intake productivity in the time, that is caused by negative processes occurring during its operation. It is known that the specific flow rate of water intake wells decreases in the course of operation due to clogging processes according to the dependence close to exponential. Moreover, the rate of the decline for each well is individual and can be taken into account, for example, as the magnitude of the "aging" coefficient. Installed in the wells water lifters have a certain resource and warranty period, set by the manufacturer. However, the actual wear rate of the water lifter will be determined by the presence of mechanical impurities in the water and its mode of operation on the network, i.e. being in that particular well. In another well, the intensity of reducing the energy characteristics of the same water lift may be different. It is also important to take into account the rate of increase in the hydraulic resistance of the water intake pipelines, which for this water intake is determined by the chemical composition of the water and the pipe material.

This paper proposes a mathematical model of water intake, which takes into account the listed processes, it also allows you to make a forecast of its operation in the time to plan preventive measures to maintain its stable operation in order to increase service life and reduce the life cycle cost of water intake facilities and equipment. [3]

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IMPROVEMENT OF EXECUTIVE BODIES OF COMBINES «URAL-20R», PROVIDING IMPROVING THE QUALITY OF POTASSIUM ORE GRANULOMETRIC COMPOSITION

The processes of cutting and moving potassium ore during the operation of the «Ural-20R» tunneling combines are accompanied by the crushing. This leads to an increase in the number of unenriched pulverulent classes (particle size less than 0,25 mm) in breakage products. The presence of particles of this size class has an effect on the degree of recovery of the useful component during enrichment [1, 2]. This determines the decline in profits of the mining enterprise. Improving the quality of the granulometric composition of ore by increasing the mass part of enrichment classes in it is an actual scientific and practical task, the solution of which is possible by justifying the rational parameters of the rock-destroying executive bodies and the loading equipment of the «Ural-20R» combines as well as the development and implementation of executive bodies that implement perspective cutting schemes [3].

The analysis of sources of formation of dust-like classes at work of the «Ural-20R» combines has been executed. Defined the field of rational (minimum output of pulverized classes) parameters values of destruction of potash array when using chess and sequential cutting schemes. The analysis of correspondence of parameters of work of planetary-disk Executive bodies of combines «Ural-20R» of various modifications to rational parameters of cutting was carried out.

The technical proposals for the improvement of the executive bodies of the combines «Ural-20R» by using cross schema of the destruction of the potash array were presented. Proved that the proposed technical solutions will to improve the quality of the ore and reduce the specific energy consumption of the process of destruction.

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TRANSMISSION OF THE ELECTRIC POWER BY THE THREE-WIRE DC POWER LINE, WHICH IS OPERATING IN A SHORT-TIME OVERCURRENT

The average annual increase in electricity demand is going to be 1.22%, which is determined by the development program of the Unified Energy System of Russia for the period from 2018 to 2024 [1]. The transmission capacity of transmission lines has necessitated increase for decided that problem. In the theory the transmission capacity can be increased changing the operating mode of the line. This was implemented by changing the classical method –AC transmission– to a new one – the transmission of electricity by three wires DC, which was operated in a mode of intermittent current overload by direct current [2].We can use this method as in the mining industry to supply remote mining areas from the Unified Energy System of Russia, as in the eastern part of Russia to connect individual energy systems with each other [3].The aim of the work was the experimental determination of the factor of safety for the power of the three-wire direct-current power transmission line.

Created experimental stand included one three-phase transformer, which reduced the linear voltage of 380 V to a safe – 43 V. For the experiment, we decided to use the load block with a variable resistance from 10 to 100 Ohms as a consumer.For wire switching, a wire switching board of a three-wire direct current line was developed, based on the use of electromagnetic relays that the microcontroller turn on and turn off according to a predetermined algorithm. We chose the optimal wire switching speed not less than the transition time in the power line wires and the smoothing capacitor [2]. The task of the capacitor was to maintain the voltage across the load during transients caused by switching. The impedance of the wires of the power line realized as inductance coils and link of high resistance wires at the end of the line.

As a result, we obtained graphs of the wires temperature from the experiment time, found the factor of safety for the transmission electricity by a three-wire DC line operating in the new mode, fixed voltage dips at different capacitances. The experiments fully confirmed the theory.

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DESIGN OF A HEAT EXCHANGER OF TUBES AND SHELL (1-2) FOR A CHEMICAL PLANT ASSOCIATED WITH A PYROMETALURGICAL FOUNDRY

The aim of this study is to combine fundamentals heat transfer for heat exchangers with calculations derived from research and approved codes such as TEMA and ASME. The practical problem to solve is to cool sulphuric acid to a specific flow of the same one and to size the equipment for this purpose.

Heat exchangers are a fundamental element in any type of industry that requires the optimization of the energy produced to be transferred along the production chain or processes. After the passage of the first decade of the new century, the minimum energy consumption on the part of the industrial sector has been seen as a priority objective. The heat exchangers play a fundamental role to be one of the most used equipment for that purpose, managing to eliminate both cooling systems and systems that increase the temperature of fluids of high power consumption. This is achieved by passing fluids of different temperatures through the opposite sides of a material, as all materials have conductivity properties; the hot fluid transfers the heat to the lower temperature fluid.

In summary, the objective of this article is to create a heat exchanger, taking into account the necessary and sufficient design restrictions. At the same time, the justified study of the materials to be used in the design.

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THE ELECTROSPUN1D NANOMATERIALS AND THEIR APPLICATION POSSIBILITIES

Over the last fifteen years, one-dimensional structures have been particularly popular in the field of both scientific research and expected wide application possibilities [1, 2]. Unlike other zero-dimensional, two-dimensional, or three-dimensional nanostructures, nanowires have two limited quantum directions resulting from their nanometer diameter due to which electrons can easily move in a precisely defined direction, which is determined by the length of a single nanowire. This allows for the use of this structure in elements in which the main challenge is to conduct electricity excluding the tunneling transition. In addition, due to very high energy densities occurring in single-dimensional oxide nanomaterials resulting from the nanometric diameters of individual nanowires, these materials exhibit extremely different and better optical, magnetic, and electrical properties in abducting their counterparts in the micrometer scale [3].

The rapid progress that has been made in the field of nanotechnology, particularly in the last sixteen years, has made it possible to develop new technologies for preparing nanoscale objects, including composite, polymeric and ceramic one-dimension nanoaterias with small diameters of just several nanometers. Materials in the form of nanofibers, nanowires or nanorods are characterised by a considerable length and a small cross-section whose diameter may be approximately 100 times smaller than their length. The most effective technology of production of 1D nanomaterials is producing fibres in the electrostatic field, which does not require complicated procedures and expensive equipment. This type of process allows to produce polymer and composite nanostructures on an industrial scale relatively easily and quickly. The electrospun1D nanostructures were studied using scanning electron microscope (SEM) and transmission electron microscope (TEM) to analyse the influence of used temperature on the morphology and structures obtained ceramic nanomaterials. In order to examine the chemical structure of nanowires, the energy dispersive spectrometry (EDS) was used. Optical property analysis was performed on the basis of UV-Vis spectra of absorbance as a function of wavelength. Using the modified Swanepoel method which the authors proposed and the recorded absorbance spectra determined banded refractive index n, real n' and imaginary k part of refractive index as a function of wavelength, complex dielectric permeability ∏, real and imaginary part ∏r and ∏i of the dielectric permeability as a function of the radiation energy of the produced ceramic nanowires.

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AERODYNAMIC FLOW THROUGH A MICRO-TURBINE ENGINE COMBUSTOR

The development of unmanned aircraft observed in recent years has led to both a reduction in the overall size and the miniaturization of turbojet engines. The length of currently manufactured miniature turbojet engines does not exceed 200 mm and their weight reaches almost a kilogram. Engines are characterized by low thrust, which is in the range from 30 to 100 N.

The thesis presents an analysis configuration of the MW54 combustion chamber with quasi-reversed airflow. Supply and distribution of the air stream to the combustion chamber and ring canals were described. The main purpose of the thesis is to consider the possibility of using transparent materials on the case outer of the engine.

The first simulation that was performed was the airflow.The main purpose of the simulation was to check whether there is an adequate amount of air needed for ignition in the primary combustion zone.A heat transfer simulation was also carried out.The obtained results provide the basis for the thesis that it is possible to apply transparent material to the outer shell of the engine. An example of such material can be borosilicate glass, which can withstand temperatures up to 450 .

The conducted simulations of air stream distribution provide the basis for inference that reorganization of air stream distribution is required in such a way as to ensure the required amount of oxygen in the primary zone.The temperature outside the chamber assumes low enough values and makes it possible to use an external wall of another material. The use of transparent materials on the outer casing is particularly interesting in terms of the construction of the measuring stand.

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ENERGY EFFICIENCY WITH USE INNOVATIVE MATERIALS IN THE FAR NORTH WITH USE OF CAD

A variant of an energy-efficient house with the use of composite reinforce in the Arctic (Republic of Sakha) is proposed.

The relevance of this work lies primarily in the importance of this issue in the construction field. According to statistics, construction projects consume 40% of the world's energy. Industrial and residential buildings are becoming one of the main sources of thermal emissions of carbon dioxide into the atmosphere.

Methods of analysis, synthesis, mathematical modeling, computer modeling, systematization, multiple decision-making were used in the work.

The proposed design of the house satisfies a given set of climatic conditions: the design of the roof, walls, Windows, doors etc. This house is calculated using CAD Autodesk Revit in combination with the 'Lighting', photovoltaic panel module 'Solar' and Autodesk Green Building Studio. Calculated the location of building on the cardinal directions and revealed the effective position in terms of energy consumption at home. Measures are proposed to reduce wind flows from the Western facade, the device of solar panels and structures to ensure natural ventilation.

As a composite material, basalt reinforce, which is produced in the city of Yakutsk, the Republic of Sakha, is proposed, which significantly saves money on the carrying frame and its transportation. The calculation in the software package Simulia Abaqus 2017 showed that the use of this type of bar mat has a positive effect on the resistance of the structures of the house and reduces the thermal bypass at the corners of the rooms.

In the end, the annual energy costs, taking into account all energy saving measures, turned out to be equal to 19 kWh/m2, which satisfies the requirement of "Passive house".

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MINE VENTILATION SIMULATION – NATURAL VENTILATION IN AUSTRIAN MINES

When it comes to underground mining sufficient ventilation is essential for health and safety of the workforce. In addition the power costs for ventilation can be significant cost driver for a mine operation. Due to this fact an optimized ventilation concept should be established. Because of the complexity of underground mines the supply of certain areas with sufficient airflow can be quite challenging. Therefore empirical and analytical forecasting methods have been established. But these methods are quite time consuming and can often not cover all influencing factors. Because of this the usage of modern simulation software like „VentSim“ are therefore important.[1] So this paper deals with the optimization of a ventilation system in an Austrian mine and gives a short overview of some underlying Physical laws which are essential for natural ventilation.

Therefore a simulation model has been built and a rough estimation of some influencing parameters especially for natural ventilation was made. To improve the quality of the simulation, measurements in the mine were carried out and implemented in the model. A comparison between the simulation and the measurements gives a first impression about the preciseness of the simulation. In some cases small influence parameters have to be adjusted afterwards to get a higher accuracy.

After completing the model the airflow is optimized according to diluting carbon dioxide concentrations and the fresh air quantity in certain areas. This is mainly done by inserting artificial resistance into the simulation model for air flow guidance. To determine critical areas after a CO2 emission and the way the gas spreads through the mine, some special CO2 simulations were carried out. Also other causalities, like the event of an underground fire, were simulated to increase the safety for the workforce. The simulation allows a forecast of the quantity of fire event emissions as well as their spread through the underground mine.[2] Therefore safe areas and emergency exits can be located. Furthermore such simulation can be done in real time, which can help to guide the airflow in a way, labour can exit the mine safely. However, such fire events in a natural ventilated mine can change completely the airflow direction in the mine and are therefore quite challenging.

The results show that the challenging factor in this mine, as in other natural ventilated mines, are factors which are influencing the air density difference between inner and outer environment. It can be seen that this difference depends mainly on the temperature, the moisture and the thermal-gradient as well the pressure difference given by the vertical extension of the mine. So only when the temperature inside and outside are nearly equal the airflow has to be created artificially by a fan. But it can also be seen, that if that is not the case, the natural ventilation is sufficient enough to dilute a CO2 emission to an acceptable value.

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INFORMATION SUPPORT OF IMITATION MODELING OF TECHNOLOGICAL PROCESSES OF MINING PRODUCTION

In the conditions of an automated, automatic and flexible production process, the auxiliary and servicing processes unite in varying degrees.

A variety of technological processes requires the availability of raw materials, forms and quantities of the required energy resources, as well as stages (operations) for the conversion of raw materials, temporary processes of the process, type of finished products.

Modern technological processes are complex objects. Complex non-linear connections between variables, insufficient information about the patterns of the processes that occur create considerable difficulties in creating adequate models of technological processes.

Justification of the choice of DBMS

Microsoft SQL Server DBMS has a large functionality that allows you to implement almost any task (based on this system) when building a corporate IT infrastructure.

All data can be stored in an unlimited number of users. Saving information in the server will automatically be available to all users.

The main advantages of the chosen DBMS are:

Easeofadministration;

ConnectivityInternetconnectivity;

Kind of speed and functionality of the database server mechanism;

Means the availability of remote access.

The considered database processing packages are powerful software and complex programs for creating various information systems. The development of this model is not only the database, but also its logical model, taking into account the general database schemas, taking into account the specifics of the functioning of the DBMS.

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THE APPLICATION OF THE INFLUENCE COEFFICIENT IN THE CALCULATION OF THE RELATIVE ERROR OF GAS METERS

In this work the subject about commercial gas metering in the conditions of operation of counters of a consumption of gas is touched. Anobjectof a research is the gas consumption counter, and as an object of research – a relative error of the counter of a consumption of gas in the conditions of its operation.

The author tells about the influencing factors on value of a relative error of the counter of a consumption of gas and as they are reflected in a formula of calculation of an error.

For assessment of a relative error of the counter of gas in the conditions of its operation the author offers use of functions of influence which in this work are displayed on schedules. The counter of a consumption of DYMETIC-1261G gas of production of JSC Daymet which consists of the flow sensor, pressure, temperature and the microcomputer is mentioned in this work.

The influencing sizes in this work is temperature and pressure the measured environment gas counter. In this work the range of temperature and pressure is chosen and the numerical values of coefficients of influence (influence function parameter) corresponding to certain values of temperature and pressure are found a mathematical way. In this work function of influence is presented in a tabular style, and on the basis of the received values the schedule for visual presentation is constructed.

The author provides calculations of a relative error of the counter of a consumption of gas according to rated values in technical documentation on the counter and calculation of an error taking into account influence coefficient. From the received values and the carried-out analysis, the author draws a conclusion about applicability of this method of calculation of a relative error of the counter of a consumption of gas in the conditions of its operation.

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IT-TEHNOLOGIES ARE IN PETROLEUM REALM AS INNOVATIONAL PAWN IS OF SUSTAINABLE DEVELOPMENT BUSINESS

Nowadays, IT technologies not impossibly imaged without them using in petroleum industry so as one is appeared pawn of technological efficiency.Vice-president Tom Gran is of energetic enterprise, recycling and communal agencies Dassault Systems [2] has said the petroleum realm is impacted by many factors which are often met from them rising claims to ecological safety and following by international standards in wholeas well as reclaiming properties with arduous fossil fuels. Thus, this article focuses on recommendations from innovational workshop achievements and «the-state-of-art» IT-realm for sustainable development of business in petroleum companies.

Investigations are conducted in scopes of report ones have deduced an m about effectivity integrated IT technologies in petroleum realms. In oil- and gas-transmission with line-tubes, special IT technologies have been integrated in PC allowed to estimate short time and in complex of outside factorswhich are able to influence in transmission: seismic activity, potential negative risks of unforeseen rush gas, operative building 3D-model of line-tube for optimization function whole system of networks [4].Thankful for all-inclusive analyse in estimations this electronic integrated system will control for processes with minimization interference of specialist that it will degreed impacting on environment.

On mine fields are applied to be have structureddata consist of complex number models: shelf zones, low-grade oil, gas reserves and etc. This information reclaimquick and quality to predict geological aftermaths. 3D-vision and elaboration large amounts of information are used on platform «big data» it is group of co-operative programs and her basic software installation medias: Open Inventor (2D- and 3D-grapfic), TechViz transmits and 3D OpenGL-adds in «virtual» space. It can accept and render incoming data from sources: seismic measurements, geotechnical engineer and debit of chink [1]. In addition to 3D-print have been addedin petroleum realm are able to fabricate different geometric and complexity from composite materials [3],meanwhile it is needed conduct additional investigations in this field.

Thus, for sustainable development business in petroleum realm is needed using IT technologies so as ones will reduce consumption human resources there having beenaxed amount negative risks and emergencies for environment and lifting up economic character of petroleum companies.

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DEVELOPMENT OF THE METHOD OF DETERMINING THE DISTORTIONS SOURCES CONTRIBUTIONS TO THE ELECTRIC POWER QUALITY INDICATORS

The widespread non-linear load leads to deterioration in the quality of electricity. However, quality indicators must comply with both international and state standards. At the same time, the higher harmonics compensation problem has not been completely resolved as well as the issue of assessing the effect of non-sinusoidal voltage on the equipment continuity [1]. Thus, the issue of identifying the sources of higher harmonics in the common power supply network of enterprises becomes relevant.

This study is devoted to the development of a method to determine the quantitative contribution of the distortion sources to the power quality indicators of the enterprises power supply systems with a common network. Despite the presence of methods that allow detecting a dominant nonlinear load, none of the methods provides accurate information in a percentage correlation [2-4]. In addition, none of the methods is officially approved by the standards of the power quality. In this regard, a new method has been proposed that is almost independent of the measurements accuracy since it is based only on the type of the dependence. Also, this method has uniqueness what is a significant difference from the known methods. The proposed method is based on the variation of the input system impedance carried out by changing the resistance of the transformer windings what can be implemented using a load tap changer. The efficiency of this method is confirmed by the results of simulation carried out in Matlab Simulink. At this stage of research, the method allows determining the dominant source of higher harmonics relative to the point of common coupling. Besides, there are stated the prospects for applying the method to determine the contribution of individual consumers to the change in the quality indicators of the power supply system of enterprises.

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IMPROVING THE EFFICIENCY OPERATION OF MINE SHUTTLE CARS BASED ON INTEGRATED CONTROL

Upon expiration of the standard service life of mine shuttle cars specified in the operational documentation, its further operation is prohibited. Mine shuttle car, as a technical device used at a hazardous production facility, is subject to industrial safety expertise upon expiration of the standard service life. In the framework of the examination of industrial safety, it is necessary to determine the operating time and to perform the calculation of the designated lifetime of the mine shuttle cars. The lack of scientifically based methods for estimating the operating time and residual life of the mechanical transmission units of delivery vehicles, the low information content and the complexity of implementing the methods used to control the technical condition lead to an increase in the number of accidental failures, the elimination of which is accompanied by prolonged downtime of not only a specific transporting machine, but also equipment in complex [1, 2].

Currently, the most promising way to control the technical condition and operating parameters of the mine shuttle cars is to analyze the magnitude and nature of the loads acting on the drives of mine shuttle cars. The magnitude of the instantaneous loads of the drives are determined by measuring the voltages, currents and powers consumed by the mine shuttle cars electric motors. The values and nature of changes in the energy parameters of drive engines are the most reliable and accessible primary information for further diagnosis [3].

To assess the state of the material of the body of a mine shuttle car and identify hidden defects, it is advisable to control the thickness of the material of the body, as well as diagnose the nodes of mining and transport equipment by exciting oscillations in certain areas of the body with a single blow followed by analysis of the response. Measurement of the material thickness provides control over the wear of the body surfaces, the evaluation of the time parameters of the motion of the wave of excited vibrations inside the object allows analyzing the parameters of the environment, identifying and localizing the zone of occurrence of the defect.

The proposed approach for determining the designated service life of mine shuttle cars allows you to: objectively evaluate the operating time of the machines in actual operating conditions; on the basis of instrument control to determine the degree of wear of the elements of the car that are not replaced during the operation.

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OPEN AUTOMATIC REGULATION SYSTEM WITH COMPENSATION FOR OIL VISCOSITY REDUCTION

Nowadays one of the main methods for decreasing of oil viscosity is its thermal heating [1]. This method is characterized by relatively low efficiency. The technology of oil processing, which consists in exposure of oil to pulse current in order to reduce its viscosity, is more promising [2].

The necessity for automation of this process comes from the need to constantly control changing parameters of the system, namely: a gap between discharge electrodes, outer environment conditions (temperature), pressure in the pipeline, and also consider the initial viscosity of the extracted oil [3]. Implementation of an automatic regulation system (ARS) in the facility is required. The ARS will allow to automatically administer capacity and frequency of the pulse current according to all characteristics which affect the oil viscosity, and also adjust the gap between the electrodes as they wear out.

Let's apply the open ARS with compensation as the first variant of the solution. This is due to the complexity of configuration of a closed ARS under the lack of a precise model of a technological process for oil viscosity reduction, which most likely appears to be non-linear. The open ARS with compensation, based on the viscosity reduction process model, is proposed. The model is implemented in the MATLAB system and takes into account the initial kinematic viscosity of oil, its temperature and density.

It's planned for the future to enhance the model of oil viscosity reduction by current pulses by adding into it a monitoring system for controlling of theinterelectrode gap, and it will also consider pressure in the pipeline.

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DEVELOPMENT, CALCULATION AND ECONOMIC EVALUATION OF THEINSTALLATION FORLIQUID NITROGEN CUTTING

Abrasive waterjet cutting is a method of cutting materials using a high-speed jet produced by the injection of abrasive particles into a water jet ejected through a nozzle. Abrasive waterjet cutting can treat universal surfaces and cut both elastic and brittle materials without affecting their microstructure [1]. Unfortunately, the wetting of the material may limit the scope of this technology. In addition, the used water and abrasive must be collected after treatment for later use, which is often replaced by disposal, polluting the environment. These disadvantages can be overcome by replacing water with liquid nitrogen. Liquid nitrogen cutting is a dry and environmentally friendly technology eliminating cross-contamination. After use, liquid nitrogen evaporates into the atmosphere without polluting the environment [2].

The purpose of the work is the development, calculation and economic evaluation of the installation for cutting with liquid nitrogen under pressure. The development of a new type of cutting required the specification of the technical requirements for the installation and the process as a whole. Changes were made to the existing layout of the waterjet machine installation and a conceptual model of the liquid nitrogen cutting installation was obtained. The main equipment was selected and the characteristics of this equipment became the input data for the installation.

Due to the novelty of the process, there are no formulas or empirical regularities for calculating cutting forces. Nevertheless, having determined the stresses arising in the material during processing, pressure, and force of the abrasive jet of liquid nitrogen, and having evaluated the structure of the cryogenic jet stream [3], an assumption was made about the ability of the abrasive jet of liquid nitrogen to cut a wide spectrum of materials. Liquid nitrogen cutting under pressure was compared with the existing analogues and an approximate economic assessment of this type of cutting was made.

Dry cutting with liquid nitrogen is an original way to cut the material by spraying a stream of nitrogen under high pressure and low temperature. This method involves the use of a stream of nitrogen as a tool for cleaning, cutting, stripping and surface treatment. As part of this work, basic principles of the new method of processing and cutting materials were investigated, the equipment of the installation was selected, and the ability to cut materials was evaluated. In the future, the materials of this study will be used to create the installation for dry cutting with liquid nitrogen in order to increase the efficiency of cutting, coating removal, hardening of materials, reduce costs and a negative impact of material processing on the environment. In view of the evaporation of the carrier jet, the use of abrasives prone to sublimation under normal conditions seems promising. This will also be the subject of further research.

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THE DEVELOPMENT OF MONITORING SYSTEMS FOR THE CONCENTRATION OF PARAFFIN PHASE IN THE TRUNK PIPELINES

The rapid development of the transport system increases the requirements for the transportation processes.Accidents and their consequences during the distillation of hydrocarbons by oil pipelines are an extremely important issue today. To eliminate accidents, the entire transportation process is often stopped, which causesadditional material investments, the decrease in the productivity of the system, late delivery of raw materials, serves as a source of environmental disasters in various regions of our country.According to NP "Center for ecology of fuel and energy complex" losses of oil raw materials during production and transportation in Russia are 3.5 – 4.5%, respectively, losses range from 18 to 23 million tons per year [1].

The main problem considered in this paper is the formation of asphalt-resin-paraffin deposits (ARPD) on the inner surface of the pipeline and the need to develop a system for monitoring and controlling the thickness of these deposits.In practice, ARPDare formed on the inner surface of pipes, in well pumps, discharge lines and storage tanks [2].Accidents occur due to late detection and removal of deposits on the inner walls of the pipeline.The research carried out in this work is aimed at developing of non-contact method of measuring the ARPD in the main pipeline with permanent automatic adjustment of the calibration characteristics to increase the accuracy of the device, the creation of an algorithm for calculating and processing the results of measurements in order to reduce the likelihoodof environmentally hazardous situations.Existing methods of dealing with paraffin are not always effective because of the unreliability and delay characteristics of the measurements and properties of the sediments [3].

As a solution to this problem, it is proposed to use and improve the promising and widespread in foreign practice non-destructive control method based on radioisotope radiation, which is a new, innovative solution to the problem of deposition of paraffin on the inner wall of the pipeline. The developed system of measurement, using the effect of photoelectron absorption of gamma rays, allows measuring the thickness of deposits with high accuracy. The error is ±5 mm, which is sufficient to ensure reliable, trouble-free operation of the pipeline system.

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MODELING OF OPERATION MODES OF ELECTRICAL SUPPLY SYSTEMS WITH NON-LINEAR LOAD

It is known that the higher harmonics generated by valve converters, widely used in industry [1] and low-voltage electrical networks [2], adversely affect the operation of all equipment, especially the operation of capacitor installations [3].

Power supply system (PSS) with a typical range of transformer capacities 10/0.4kV ($S_{\text{т nominal}}$), which work on linear and non-linear load and capacitor battery (CB) was considered.The transformer was simulated by three phase voltages, inductance and active resistance. Line load was also modeled by inductance and resistance; capacity bank was modeled by capacity. The non-linear load is modeled by a three-phase bridge rectifier.All regulated powers were represented in shares of the rated power of the transformer.

It was established that the current overload ratio of capacitors exceeds the allowable overload ratio (1.3) in the modes of operation of the PSS for non-linear load and close to the resonant mode and the amplitudes of the higher harmonics of the current of a capacitor battery exceed the amplitude of the current of the main harmonic.

Besides, the impact of nonlinear load on the quality of the supply voltage was evaluated. The values of the total harmonic voltage component(K_U, %) is less than 8%with non-linear load power(P^*_d) not exceeding the value 0.7p.u. provided the transformer is loaded to 0.75 $S_{\text{т nominal}}$ non-linear and linear load and the absence of CB. The quality of the mains voltage deteriorates markedly when the CB is turned on over the entire rangeofpower CB. In case P^*_dmore than 0.2 p.u., then$K_{U,}$ % more 8%that doesn't meet the requirements for the quality of electricity.

Moreover, it is shown that the amplitudes of the higher harmonics of the current generated by the rectifier significantly different from the values $I^*_n = 1/n$p.u., accepted in calculations in the technical literature during resonant operation of PSS. Particularly, at resonance on the 11th harmonic:$I_5^* = 0.159$; $I_7^* = 0.088$; $I_{11}^* = 0.023$; $I_{13}^* = 0.019$ p.u.In case of resonant modes thereducing the value of the higher harmonics of the current, generated by the rectifierrelated to current switching angle increasebetween the diodes due to the appearance of the oscillatory component of thecurrent harmonic of the resonating frequency.

Thus, the following processes occur in resonant and close to it modes: the voltage quality deteriorates greatly, the capacitors are overloaded with higher harmonics, the relative amplitudes of the higher harmonics of the rectifier current decrease.

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DEVELOPMENT AND RESEARCH OF EFFICIENT METHODS OF FINISHING TREATMENT WITH THE PURPOSE OF INCREASING WEAR RESISTANCE OF RODS OF HYDROCILINDERS OF MINING MACHINES

In oil and gas, machines are widely used volumetric hydraulic actuators of the translational motion, in particular, piston hydraulic cylinders, the output and the most loaded link of which is the rod. One of the most important and urgent tasks facing the mining machine-building industry is the production of rods with high performance properties, which determines the need to improve the technology of their manufacture.

To increase the wear resistance of the working surfaces of the rods, surface hardening is traditionally used followed by chrome plating[1]. The accuracy parameters of the executive surfaces are achieved in the process of round grinding, carried out before the deposition of coatings, and the required surface roughness in the basic version of the manufacturing technology is obtained, as a rule, by polishing after chrome plating.

It is known that in matters of ensuring high wear resistance of a part, both the physicomechanical properties of the material of the surface layer and the geometric accuracy, roughness and microrelief of the working surface, formed by finishing treatment, are of decisive importance [2].

The study of the geometric accuracy of cylindrical specimens of steel 40X after deposition of the coating showed that in some cases chroming leads to the appearance of unacceptable shape error in the form of orality[3]. In this case, the resulting shape tolerance is almost equal to the size tolerance, which is unacceptable for rods, the accuracy of the surfaces of which corresponds to IT7-IT8 [4]. Traditional polishing processing to eliminate the formed error is not possible. In this regard, the finishing processing of chrome-plated samples was carried out in one case by hard turning with cutters equipped with non-refillable plates of cubic boron nitride, in the other - diamond smoothing. So, as a result of machining by turning, the required parameters of the geometric accuracy of cylindrical samples were provided, and the roughness Ra of the treated surfaces varied within 0.32 ... 0.26 μm. With diamond smoothing performed immediately after chrome plating, the roughness of Ra surfaces was 0.4 ... 0.32 μm, along with the formation of a regular micro-profile, with a degree of hardening of the surface layer equal to 20-26%.

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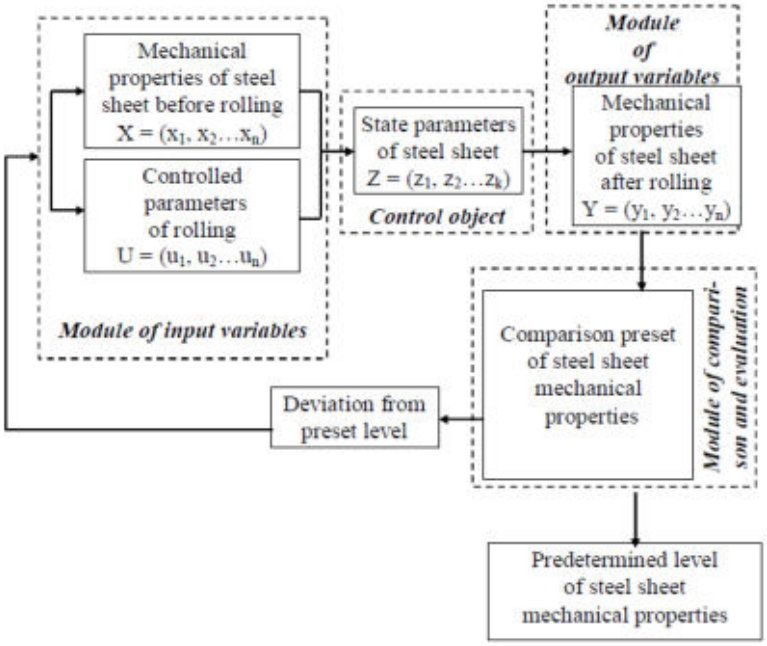
DESIGN OF TECHNOLOGICAL PROCESS FOR PIPELINE STEEL SHEET MANUFACTURING BY HOT ROLLING BASED ON SYSTEM ANALYSIS

Demands for pipeline steel sheet properties increase continuously because of enhance of oil underground mines in Arctic zone. Workability of oil and gas lines depends on pipes' quality, level of properties, and reliability. One of the urgent tasks of the manufacturers is to ensure the high level of quality for pipeline steel.

Technological process of product manufacturing is considered to be one kind of technical systems. In order to improve different technical system characteristics Theory of Technical Systems can be used [1]. System analysis makes it possible to find links from input and output parameters of the technological process in order to find effective ways for quality improvement.

At present time the manufacturing of high quality pipeline steel sheet is possible by thermal-mechanical rolling [2]. The aim of this paper is to apply system analysis for pipeline steel sheet manufacturing by hot rolling.

System analysis of pipeline steel sheet manufacturing allowed to find links between input and output parameters of the process [3]. In order to predict pipeline steel sheet properties and to correct technological modes at its manufacturing the algorithm was carried out which consists of modules of input and output variables, module of comparison and confirmation.



Algorithm for the prediction of pipeline steel sheet microstructure and mechanical properties changing at hot rolling.

This approach can be used for further mathematical simulation of hot rolling process to get the pipeline steel sheet with the desired level of operational properties.

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FUNCTIONALIZED NANOSTRUCTURED MATERIALS FOR NOVEL PLASMA ENERGY SYSTEMS

Currently, the research in the field of alternative energy is becoming increasingly important due to the promising possibility to solve a wide range of problems concerning the creation of compact, reliable, autonomous power sources for spacecraft and other applications it provides. Specifically, the problem of effective solar energy conversion into electricity is of great importance conditioned by the fact that most of conventional satellites rely on solar energy as the primary source of power for their proper functioning. Conventionally, solar energy conversionprocess is performed according to one of the two fundamental mechanisms: the first one being the "quantum" approach, utilized in photovoltaic cells, and the second one is the "thermal" mechanism, requiring the presence of concentrated solar radiation to generate electricity using various types of heat engines (i.e. thermionic energy converters or TECs).

In practice, devices that combine both paradigms lose their effectiveness due to the rapid degradation of photovoltaic cells, caused by a significant increase in operating temperatures required to maintain the thermionic emission current density at an acceptable level.Concentrators based on the effect of photon-enhanced thermionic emission (PETE) make it possible to realize photovoltaic and thermionic phenomena in a single physical process. The prototype proposed in the study [1] utilizes the phenomenon of thermionic emission of photoexcited electrons from a semiconductor cathode at relatively high temperatures (over 200 °C), which allows the use of thermal energy, increasing the theoretical efficiency of the combined conversion to the values around 50%.

The possibility of synthesizing systems based on PETE with semiconductor (GaN) electrodes was demonstrated in [1], however, the number of incident photons, exceeding the band gap of GaN (E_g = 3.3 eV), is less than 1% of their total number thus the combined energy conversion efficiency decreases dramatically. In this study new materials based on porous silicon (PS) for the subsequent synthesis of PETE electrodes are proposed, since the value of E_g for PS could be controlled in a wide range from 1 to 3 eV due to the presence of the quantum confinement effect, as well as a wide variety of mechanisms for surface functionalization [2, 3].

The potential of proposed energy conversion devices is not just a more efficient solar cell but a possibility to create an entirely new tandem process, allowing to achieve significantly higher efficiencies of a combined power generation mechanism.

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IMPROVING THE EFFICIENCY OF PETROLEUM TRANSPORT SYSTEMS BY OPERATIVE MONITORING OF OIL FLOWS AND DETECTION OF ILLEGAL INCUTS

The paper proposes a model of a radioisotope measuring system, including monitoring the presence of unauthorized inserts, paraffin deposits, head of oil flow in a controlled area with simultaneous measurement of its density, speed and quantity[1].

When operating oil pipelines, there is an issue of unauthorized inserts and paraffin, resin and salt deposits on the pipeline walls that come with the oil stream, creating emergency situations and increasing production expenses, badly affect environment, damaging ecology and spoil underground water, kill animals, birds etc. Oil spills contaminate rivers, lakes, and ground waters. oil transportation monitoring issues are still subject for further studying [2]. Thus, there is the need to invent radically new automated process control and management system, together with measurement means intellectualization.

The measurement principle is based on the Lambert-Beer law that describes the dependencebetween the gamma-radiation frequency and the density together with the linear attenuation coefficient for a substance. The rate of fluid flow is determined by the labeling method, due to the detection of free gas in a moving stream. Local head losses caused by changes in the nature of the pipeline and various inserts were determined by the adapted Weisbach formulas.

Moreover, a laboratory device was developed and tested on the basis of Mining University, todetermine the optimal location of the detection unit relatively the radiation unit.According to the obtained data, we concluded that theinstrumental error of 30 cm from the detector device is minimal and satisfying. Using the measuring system with high accuracy (± 0,2%), one can measure the thicknessof paraffin deposits with an absolute accuracy of ± 5 mm, which is sufficient to ensure reliable operationof the pipeline system.

Safety is a key advantage, when using the proposed control system [3]. The measuring system has no contact with the medium measured, all components of the measuring system are mounted on the outer side of the reservoir, and measuring is implemented through its wall.The developed radioisotope measuring system has the simplicity of design, low cost, reliability and durability (half-life period of Cs137 is 30 years) [4].The results of the project have been agreed and transferred for use at the NPF Complex-Resource LLC.

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BLUE MINING EXAMPLES FROM CHINESE MINES

Traditional practice in mine planning often concentrates on estimation techniques that fail to account for the intrinsic uncertainty of geology and grades, which may have significant consequences on the mine operation. Dealing with these uncertainties has been a major topic in the last years, where different algorithms and stochastic optimization models have been proposed to tackle this issue. Nowadays, mine planning should also focus on long-term comprehensive development to balance synergies and conflicts in order to maximize synergies and minimize conflicts.Blue mining, which was in introduced by Langefeld and Kellner during the 2013 SDIMI meeting on Milos Island, Greece, meets the challenges of Sustainable Development in Underground Mining. It containsfollowing aspects: energy efficiency, energy transformation, energy storage and distribution. The goal of blue mining is to increase the energy efficiency of mining operations, and reduce the environmental footprint, by using unused natural or technical energy sources (like geothermal energy or water energy).

The applicability of the blue mining concept will be investigated in this report on the basis of Chinese mines. China, as a major mining country, cannot ignore the importance of sustainable mine planning for the overall development of the mining industry. China's mining industry has developed rapidly while ignoring many problems. Mining companies and the whole energy industry face serious problems to balance economic, environmental and social matters. For now the Chinese mining industry is going through a transformation, which takes into account a more sustainable development.

This paper will illustrate this transformation to “blue mining”. Firstly several Chinese mines will be introduced. Secondly, a mine, where the blue- mining concept could be applied, will be selected based on local geology. Thirdly, the aspects that can be improved by blue mining will be discussed. This research will close by giving specific optimizations for mine planning for such a mine.

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ECOLOGICAL RISK ASSESSMENT SYSTEM BASED ON FUZZY LOGIC ALGORITHMS

An expert information system for ecological risk estimation, operating on complex-structured and inadequate data is described in this work. Program usage allows avoiding subjectivity in decision-making process, when large volumes of diverse information are present. This becomes very important in stressful conditions of ecological emergencies.There's a number of studies about fuzzy approaches in ecology [1,2],but none of them offer a complete computer program, capable of supplying a user with all the tools necessary for risk assessment.

Mining industry, being the key and probably the most science-intensive one, has to cope with problems of innovation development and implementation. This is caused by peculiarities of mining industry, especially by dependence on natural conditions. All these factors force companies to work in state of uncertainty. Solution to this problem should be based on mineral risk estimation, made by companies working in the sphere. It should also rely on huge amount of geophysical data and take into account ecological aspects of raw material extraction [3].

Special documents, so called "Sanitary Regulations and Norms", regulate hydroenvironmental situation in Russian Federation [4]. However these documents can't be used to estimate water quality precisely as they only give only 2 options: compliance to the established norms and discrepancy between them and what is actually present. Sometimes specialists in the sphere of ecology need broader gradation. Such feature is realized in the developed program. Mathematical apparatus is based on fuzzy sets theory (Mamdanifuzzy output algorithm). During the process of solution the program calculates truth values and defuzzificates initially fuzzy input data. Defuzzification implies centroid method. Not only multi-factor risk assessment is done by the program, but also quality of ecological attributes is rated. This becomes possible because fuzzy systems give the opportunity to avoid strictly bivalent estimation of compliance/discrepancy, broadening the range of possible variants between these two extreme points.

The program is written in accordance to modern programming techniques – object-oriented programming is used. Program uses tools available in Java, Generics, Collection API, lambda-expressions. Swing GUI was composed using the standard designer in NetBeans IDE. A special module (a database) was written in order to parse and process data files saved in Excel.

Mathematical apparatus and program realization makes it possible to use the system in any sphere of a mineral complex, processing large quantities of data and making decision-making process effective.

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HEAVY DUTY MACHINES DESIGN OPTIMISATION

In the construction process of heavy machine tools, the application of complex solutions in the field of counteracting the negative effects of deformations of machine bodies is a rarely considered problem, however, considering the dimensions of the machine with the increase in dimensions, the problem is intensified. Weight reduction, increased stiffness, improved vibration damping and minimized temperature impact on the machining process as a response to increasing demands on quality, accuracy and speed of machining while minimizing machine and process costs, pose new challenges for constructors, generating new needs [1,2,3].
The article presents novel approach to design and optimisation of bodies of heavy-duty machines. The effect of the carried-out research is the methodology for optimizing the construction form of the bodies of heavy machines using the finite element method and methods based on algorithms of advanced computer optimization methods. The developed methodology is an effective tool supporting the design and construction process of machine tools in the selection of the construction form of heavy-duty bodies.

As it has been noticed proposed methodology can scientifically improve the design process of new generations of heavy-duty machines and allows you to create a basis for development smart (intelligent) machine which fulfills the requirements and ideas of Industry 4.0. Without preparation of series of prototypes, it allows to achieve advanced solution with avoided development version errors what leads to resources and founds savings.

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DEVELOPING STANDARDS FOR THE DIGITIZATION OF GEOSCIENTIFIC OBJECTS

Digitization in geosciences spans a wide area from computer-based handling of documents and administrative or economical processes via the creation and sustaining of collection-related databases to complex geological surface and subsurface models as well as models of specimens capturing their physical, chemical, mineralogical or (palaeo-)biological properties. Although various digitization approaches are widely applied in geosciences, there are few reproducible and broadly accepted standards for the different methods.A young researcher group based at the TU Bergakademie Freiberg (Saxony, Germany) aims to fill in this gap by developing standards for the digitization of four types of geoscientific objects: ore samples, drill cores, rock plates and fossils. In addition to these object-based topics, a mathematical and an economical subproject are parts of this integrative framework. All contribute to the conception of a Saxon Digitization Centre for geoscientific objects, planned as a structure for production, management and providing of several types of geoscientific data.

In the first phase of the project, the applicability of several 2D and 3D imaging techniques has been testedon selected objects. For digitization of ore samples, different macrophotographic approaches as well as computedmicrotomography (µCT)have been evaluated. It turned out that the photographic setting must be adapted not only to the rock type but also to the scientific question to be addressed. For drill cores and similar cylindrical objects, 3D imaging with photogrammetric methods has been implemented and first trials with µCT have been made. Rock plates have been digitized in 2D using digital cameras, flatbed and overhead scanners, digital microscopes and profilometers; scanners appear to have an advantage especially when dealing with shiny or translucent mineral grains. Internal and external morphology of vertebrate fossils has been captured using digital and laser scanning microscopes, photogrammetry, 3D scanning and µCT, and digital 3D prints have been produced.

Forthcoming steps include the implementation of analytical methods and automated image recognition classification tools, georeferencing of the data and their web-based presentation.

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THE THREE DIMENSIONAL PRINTING THE MINING EQUIPMENT

The Additive Manufacturing (AM) methods are one of the most intensively developed technologies, whose are representing a realistic alternative to many conventional manufacturing techniques. The most popular AM methods, which enable manufacturing parts from metal powder are Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), which belongs to the Powder Bed Fusion PBF methods.Fabrication of the details at the CAM stage in the SLS/SLM procedure consists of spread super – thin layer of powdered to the working plat-form and next sintering it selectively with a laser beam, which is guided according to bitmap (virtual recording of the manufactured element) and raise the temperature of those areas just above the melting point. The combination of AM with reverse engineering or imaging technology allows the production of components of mining machines. While a good proportion of items used in mining are relatively simple and generic, many are still precision engineered in order to be able to withstand significant loads and challenging environments [1-3].

Though 3D printing technology does not appear to exhibit limitations from a design point of view, this is not the case from a technological perspective. Based on the obtained results it can be concluded, that the properties of components produced by AM are strongly related to the process parameters (process variables), which directly influence the thermal cycle during laser beam – powder material interaction. The aim of the research was to characterize 316L steel components, manufactured by SLM for obtained microstructure and phase structure in correlation with mechanical and electrochemical properties. The samples were manufactured by Selective Laser Melting (SLM) using SLM/SLS machine type AM 125 (Renishaw). As a part of this experiment an attempt was made to determine the influence of values of energy density (E) used in the SLM process on the properties of manufactured samples. The SLM process was carried out with an energy density calculated according to the formula $E = P/(t \times PD \times SP)$.

The result of performed experimental prove that selection of the right SLM parameters is very important in determining the final properties, which enable safe use of created elements and their reliability.

3DP has the potential to challenge the concept of economies of scale, and drive value in an era of scarcer resources, increased volatility and higher demand for flexibility and customisation.

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REDUCING THE NEGATIVE IMPACT OF TECHNOGENIC MASSIFS' HAZARDOUS WASTES ON THE QUALITY OF ENVIRONMENTAL COMPONENTS

The article contains results of the researchin the field of reducing the negative impact of technogenic massifs' hazardous wastes on the quality of environmental components. The waterproofing of the technogenic massifs foundation with the help of the material, based on the mixture of secondary high-density and low-density polyethylenes is offered as a technology of reducing the negative impact.Research methodology includes experimental methods in field and laboratory conditions. Samples of surface water and groundwater in the area of the study object were selected during the research, chemical analysis was performed, quality of natural waters was estimated, the physical and mechanical properties of polymers, as well as their resistance to the aggressive environments impact, were investigated [1].

As a result of ore beneficiation by flotation process waste products are produced for the factory, which are called enrichment tailings. The tailings are mixed with acidic mine water in the main building of the factory, then via the slurry pumping station are passed in tailings pond of hydraulic type and are used for mine reclamation of abandoned open-cut minings (coffins) and stowage of underground mine [2].

The mineral composition of tailings is presented by pyrite, chalcopyrite, sphalerite, quartz, feldspar, chlorite and sericite. Chemical composition is FeS_2, $CuFeS_2$, ZnS, SiO_2, mixtures of aluminosilicates, chlorous acid salts $KAl(AlSi_3O_8)(OH)_2$.

Currently the project is developed for mine reclamation of abandoned open-cut minings (coffins) with the use of wastes which are formed during the process of ore beneficiation.

In order to increase the degree of protection from filtering pollutants of industrial wastes during the storage operation of tailings into abandoned open-cut minings (coffins), it is possible to use a mixture of secondary polyethylenes qua impervious coating. This coating should have high degree durability and be resistant to aggressive environment. In this connection it was necessary to determine the physicomechanical properties of polymers, definition of impervious material resistance to the effects of aggressive environment [3].

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INFLUENCES OF GEOTECHNICS ON CLIMATE CHANGE IN GERMANY

Climate change is one of the major socioeconomic topics today. This report deals with climate change and its impacts in Germany and illustrates several ways geotechnics can limit the negative impacts of climate change.

This research will firstly introduce climate in general and its impacts in Germany. Than different advantages of water management including renaturation, dams, dams and dam construction will be presented, as well as the growing importance of coastlines and flood protection, and an insight into slope and avalanche protection and how they can protect against the effects of climate change. The reduction of CO2 in the atmosphere can also be guaranteed by geotechnical methods. Here, geothermal energy and CO2 sequestration are cited as examples. Subsequently, an approach of geotechnics carried out in Germany will also be discussed. To this end, a look at the coasts and flood protection in the North Sea in particular, as climate change is already having a strong impact here.

On the coast, precautionary measures have to be taken, water has to be purified and water has to be renatured. In addition, slopes have to be fortified, avalanches have to be con-trolled, CO2 emissions have to be reduced and many other tasks have to be completed. In Germany, climate change, coasts and flood protection are particularly affected. Precautionary measures must therefore be taken. With the help of dunes, dikes, groynes and other measures, sea-level rise must be prevented. As has become clear, geotechnics can often help here. However, no end to climate change is in sight. New possibilities must continue to be found that contribute to securing life on Earth.

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HABITAT FRAGMENTATION AT TADOBA ANDHARI TIGER RESERVE: AN ALARMING THREAT THAT NEEDS TO BE RESOLVED.

Abstract:

Biodiversity sustains human livelihoods and life itself. The unscientific ways of mining possess a serious threat to the biodiversity, resulting in the reduction of forest cover and fragmentation of habitat. Coal consumption is projected to increase to about 1500 million tons per year by 2031/32. In 2010, India produced 532 million tons (Annual report 2010-2011, Ministry of Coal, India). This huge increase in demand leads to the destruction and fragmentation of large areas of forests. The Chandrapur region, home to the Tadoba-Andhari Tiger Reserve (TATR) presents a perfect example of what is at stake if coal mining is allowed to expand across the central Indian landscape. This paper portrays how fast TATR is becoming an isolated enclave, by industrial projects, primarily coal mines and recommendations that can restore the biodiversity of this finest tiger habitat.

Issues pertaining to the significant environmental and wildlife impacts from mining in forest areas, as well as human displacement and social impacts are not being factored into the current 'negotiation' process. Chandrapur district in Maharashtra is one of the locations where the dispute between protecting tiger habitat and increasing coal extraction is most pronounced. In order to understand the ramifications of this conflict, Greenpeace had organized a Fact Finding Mission to the Chandrapur area from 7th to 9th September 2011.

Over the last 20 years or more, coal mining has eaten away at important forest corridors connecting TATR to other forest blocks in the larger landscape. If mining is allowed to spread into fresh forest areas in Chandrapur, the process of isolation will be completed in a few short years, and one of central India's finest tiger habitats will stagnate and inevitably decline. Hence suitable remedies and alternative thoughts should be provoked before the declination of biodiversity.

Greenpeace is a global organization that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment. Greenpeace had organized a Fact Finding Mission in the Chandrapur area from 7th to 9th September 2011.The objective of this Fact Finding Mission was to visit the Chandrapur region, interact with civil society groups and officials of Coal India Ltd. and the Forest Department, and to visit mining and afforestation sites and proposed mining areas.

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PHYTOREMEDIATION OF THE SALT MINE WATER BY COMMON REED

Salt mining waters are characteristic for deep mining in the Ostrava - Karviná district, located in the Czech Republic [1]. Due to their high mineralization and associated salinity, they may cause salt stress in some organisms. However, there are halophytic plants that are adapted to high salinity and they can withstand the salt stress [2].

Common reed is classified as a halophytic plant and after long-term research it was confirmed to have phytoremediation ability. Phytoremediation is a technology that uses green plants to remove, accumulation or decompose contaminants in the environment found in groundwater, surface water, sediments soil, sludge [3].

Phytoremediation processes in salt mine waters were experimentally tested in laboratory conditions on hydroponically grown reeds. The reduction of the salt concentration in the water samples from the hydroponic system, together with other chemical parameters, was monitored.

For comparison, the experiment was also performed on common reed hydroponics taken from the mine Lazy, that are adapted to salt mine water, and common reed hydroponics taken from pond reeds, that are not loaded with high salt concentrations.

It was prove by research that the common reed is able to work as root zone wastewater treatment plant for salt waters (not only salt mine waters) and it is able to withstand salt stress.

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GOLD MINING IN COLOMBIA: ENVIRONMENTAL CHALLENGES AND NEW TECHNOLOGIES FOR A SUSTANTIAL ECOLOGICAL DEVELOPMENT

The global negative changes taking place in the environment in the XX - XXI centuries require a better understanding of the fact that the socio-economic principles on which the development of society takes place must undergo fundamental changes. It is necessary to change the strategy of consumption of natural resources in favor of harmonious and balanced development, applying modern technologies.
The mining industry plays an important role in the economy of Colombia. In the western side coal is mined, in the valley of the "Magdalena and Atrato" occurs the oil extraction (1/3 of the country's production), in the central part is carried the gold and silver production [1]. In Colombia, 44% of the 1122 municipalities in the country have a tradition in artisanal (informal) mining and 23% of those have artisanal gold mining. There is no previous "classical" geological exploration, no drilling, proven reserves, ore tonnage establishment or engineering studies undertaken. In 2016, gold production was 61.8 tons, of which the formal sector only represented 13%, while the informal miners produced 87% of the gold [2]. The main environmental challenges of the gold mining sector in Colombia are the pollution of natural ecosystems through the generation of solid waste, emissions of mercury during gold amalgamation, water pollution by cyanide wastes and greenhouse gas emissions.

In the article, the main aspects of the most important gold deposits in the country are listed, emphasizing on the mafic–ultramafic Complex Condoto of the Choco region and the placer deposits of the given area. Are presented the main methods used for gold mining in different areas of the country, and more specifically, are given details about the technologies of gold production which includes the processes of amalgamation with mercury and cyanide leaching. A research was made for the state of art about the methodologies used to remove cyanide from ore production water, along with its advantages and disadvantages [3]. Faced with the found panorama, is proposed the application of an extended oxidation process, in particular electrochemical oxidation as an alternative to the water treatment.
To achieve a more sustainable gold mining production in the country, it is necessary to develop a framework for sustainability assessments to support decision making in the sector. Efforts need to be made on the research and application of new high-tech solutions to improve resource-use efficiency and biodiversity protection.

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IMPROVING THE EFFICIENCY OF OPERATION OF CAREER CAR DUMP TRACKS.AIR MONITORING IN THE QUARRY

During mining of deposits by the open method, heavy-duty mining dump trucks are widely used. The operation of the column of machines in the quarry for the transportation of rock from the face to the crushing and screening plant is accompanied by a significant impact on the ecological situation in the region.

The main factors of negative impact on the environment from the work of a column of heavy-duty machines are emissions of exhaust gases from diesel internal combustion engines, as well as increased dustiness of air from the interaction of wheels with the surface of technological roads.

The main directions for improving the environmental situation of the work of dump trucks are the following:

- application in the exhaust system of the engine of modern filters;
- constant monitoring of the condition of the surface of the tracks on the ledges of the quarry and the road from the pit to the crushing and screening plant and the organization of work to reduce dust generation during the movement of vehicles;
- the formation of optimal technological routes taking into account the reduction of transient modes of operation of engines;
- development of recommendations for optimization of operating modes of machines, taking into account the climatic conditions in the quarry.

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FROM THE LARGEST CORPORATE SUSTAINABILITY INITIATIVE TO SMALL COAL MINES IN COLOMBIA

Is it possible for small coal mines to apply the concepts of the United Nations Global Compact, the world's largest corporate sustainability initiative?

In Colombia, the department of Boyacá produces the 4.36 % coal production by small and medium-sized mining operations [1]. Up to 50 % of the operations are characterized by artisanal mining techniques such as pick and shovel. The other half of the operations in the region is conducted by semi-machined techniques with tools such as pneumatic hammers and compressors [2]. Families or miners' associations own those mines and carry out the mining business absent of international standards [3]. Nevertheless, globalization and the entry of new economic dynamics are pressuring these mining operations to improve in environmental, social, productive and economic dimensions.

The concept of this work is firstly to describe the UN Development Goals and the Global Compact, especially concerning the mining industry. Based on this UN vision and mission statements strategic goals have to be developed that are suitable under the circumstances of the small and mediums sized mining industry in Boyacá, Colombia. These goals have to be discussed with the owners of the mines and their stakeholders. Secondly, more concrete objectives have to be developed for the different fields of the mines, like occupational safety and health or environment protection. Thirdly, based on the objectives measures have to be planned, realized, controlled and an evaluation process has to follow to realize improvements (P-D-C-A cycle).

The aim of the dissertation is to improve the situation in the small and medium sized mines in Boyacá to give the miners, their families and the communities a better perspective based on better mining (and post-mining).

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USE OF MEMBRANE BIOREACTOR FOR POORLY-BIODEGRADABLE INDUSTRIAL WASTEWATER TREATMENT

Treatment of many industrial wastewaters is usually difficult due to large variations in its volume and composition, high concentration of organic matter and salts or presence of poorly biodegradable compounds [1]. Besides that, biological treatment of such wastewaters can be negatively affected by the presence of compounds inhibiting activity of activated sludge microorganisms [2], particularly the nitrifying bacteria [3]. Since European legislation requires nitrogen removal from wastewater before its discharge into water bodies, stable and complete nitrification (biological oxidation of ammonia nitrogen to nitrate) is required.

In this study, the influence of pharmaceutical and chemical wastewaters onmembrane bioreactor (MBR) performance was investigated in detail. Thestudy focussed on nitrification performance, which was evaluated based on influent andeffluent parameters as well as batch nitrification tests in a pilot-plant MBR (50 L). The industrial wastewater wastreated in mixture with municipal wastewater at a constant flow rate to adapt microorganisms in MBR. Their loading with industrial wastewater was, therefore, increased stepwise from 0 to 75% of industrial wastewater in the MBR influent.

Stable MBR operation and nitrogen removal was observed until the content of industrial wastewaterin the influent reached 40%. In this phase, concentration of ammonia nitrogen in the effluent from MBR was on average 0.56 mg L^{-1}, corresponding to more than 98% removal efficiency. When content of industrial wastewater reached 50%, breakdown of nitrogen removal was observed. However, afterseveral months of adaptation, nitrogen removal recovered. No nitrification was observedwhen the industrial wastewater share exceeded 50%. Adaptation of nitrifying bacteria inthe MBR was also confirmed by results of kinetic tests. The inhibition effect of theconcentrated industrial wastewater to the MBR sludge decreased substantially after severalmonths of exposure, while the inhibition of referential activated sludge remained constant.

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STUDY OF ACID MINE DRAINAGE TREATMENT METHOD BY USING OPEN FLY ASH CHANNEL IN COAL MINING

Acid mine drainage (AMD) is prominent issue of environmental pollution in mining. This acidic water is generatedas the consequences ofsulfide mineral contactwith oxygen in the presence of water, when conducting overburden/waste rock stripping activity. AMD can cause long-term impairment to waterways and biodiversity as the effluents contain toxic substances that have serious impact to human health and ecology. Once occurring, AMD might last for years or even decades without human intervention; strictly depend on the availability of its sources. One of the common methods in AMD treatment is the addition of material with high alkalinity, such as lime, sodium hydroxide, etc., hence, buffer theacid generation reaction. Fly ash, as the by-product of coal combustion, is material with high neutralization capacity but this far utilized only for cementing purposes without more consideration in the capacity to buffer acidic water despite its abundance amount. This happens due to the fly ash presumption as hazardous material and acts as pollution agent. Therefore, the study to understand the utilization of fly ash as neutralizing material for acid mine drainage treatment is interesting to be conducted.

In this study, fly ash is used as the main neutralizing material using open fly ash channels, as acid mine drainage treatment. This study aims to determine the effectiveness of utilizing fly ash in the process of acid mine drainage neutralization and understand the factors that influence the level of efficiency and effectiveness of open fly ash channels on a laboratory scale.

This experiment uses a PVC pipe with a length of 100 cm and a diameter of 5.08 cm with a sample weight of 600 grams (30 cm on the channel). The research simulation was carried out with 2 scenarios of acidic water content as independent variables (Channel 1: distilled water + H_2SO_4, Channel 2: distilled water + H_2SO_4 + Fe) by sampling 500 ml at the outlet of channel. The duration of simulation on channel I was conducted for 67 days while in channel II, the simulation was conducted 46 days. At the end of experiment, the efficiency level of neutralization of pH in channel I was 124.6% while channel II was 81.87%. Leachate I channel samples showed a decrease in pH (9.84-3.05) and channel II leachate samples showed a decrease in pH from pH (9.38-2.87).

The results of this study indicate that the level of efficiency and age of channels on channel I is higher than channel II. Elemental test results (XRF) on fly ash used in this test shows increase in Ca and Fe content. Precipitation of iron hydroxide and gypsum seems to affect the channel efficiency because it causes porosity and permeability of the channel to decrease by covering the surface layer on the fly ash so that the neutralization process becomes ineffective.

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It's no secret that alternative energy production methods literally burst into our lives and started a coup that leads to progress. The growth of energy consumption forces scientists and engineers to look for alternative energy sources that would be renewable.

And more and more attention is attracted by the sun. The flow of energy sent to Earth over the course of a year is at least two orders of magnitude greater than the energy contained in all fossil fuels. Using only 5% of solar energy would allow tens of times to cut off the power of any of the existing or projected power plants. A gradual transition from burning fossil mineral fuels to direct conversion of solar energy will help purify the Earth's atmosphere from harmful impurities and stabilize carbon dioxide and oxygen in it. In other words, the life of mankind will become more prosperous and comfortable.

Every person individually can do a lot to ensure that our planet has a future: after all, each saved and "caught" energy joule is a reduction in tree cutting, a reduction in carbon dioxide emissions.And the use of solar dishes is one of the ways to use safe solar energy.

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APPLICATION OF THE GASIFICATION PROCESS AS A MEANS OF UTILIZATION OF SOLID CARBON-CONTAINING WASTE ALONG WITH GENERATION OF A VALUABLE PRODUCT

In Russia mining enterprises extract about 400 million tons of coal annually. A significant amount of coal dust iswasted. Woodworking facilities produce sawdust which is to be recycled.

Both coal dust and sawdust are highly combustible. Their storage areas are being poured up with water which demands capacities and resources.

There is an up-to-date problem of waste utilization aimed at prevention of a negative impact on ecology, economy and the social sphere of the country.A way to dispose of solid waste (household garbage, coal dust, sawdust etc.) has been suggested, consisting in its gasification and further application of the synthesis gas which can be used as a fuel or a chemical raw material [1].

The goal of the work is to proposemodular-type construction methods of the solid waste gasification facilities family with production of a valuable product.

The prototype of the proposed facility is the one designed by LLC “Novaya Energiya”. The facility provides generation and further incineration of pyrolysis gas from sawdust.The working process meets modernair emissions standards.

Objectives which are considered in the paper: 1) proposition and reasoning of a fundamental scheme of a facility for solid waste utilization through its gasification along with production of a valuable product; 2) calculation of geometrical dimensions of the facility and selection of additional equipment; 3) calculation of the cost price of the valuable product (hot water, electrical energy, liquid fuel).

Application of the gasification process may resolve the problem of utilization of solid waste [2]. This kind of waste is a free-of-charge fuel for the suggested facility. Theresulting valuable product can partially cover the demand for natural gas and oil, solve the issue of heat supply of remote industrial establishments [3], replace the traditional fuel with the one obtained via the gasification process.

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RESULTS OF ENVIRONMENTAL ENGINEERING AND HYDROGEOLOGICAL STUDIES IN THE CONSTRUCTION AREA OF THE GROZNY TES

The purpose of designing a complex of observations and research was a comprehensive assessment of the ecological state of the construction site of the Grozny TPP and the adjacent territory with a view to the possibility of performing construction and installation works taking into account the identified deep pollution of soils with oil products and its transformation products in the construction area.

A distinctive feature of the hydrogeological regime in which the city of Grozny is located is the “suspension” of the riverbed. Sunzha in the most part of the city (the river bed is 4m above the groundwater level) and the groundwater is fed in free filtration mode, which determines the relatively stable temporal character of the groundwater level in the central part of Grozny.Sunzha, as well as due to infiltration of precipitation and leaks from water-carrying communications.

In terms of chemical composition, groundwater is heterogeneous and refers to hydrocarbon-magnesium-sodium, chloride-bicarbonate magnesium-sodium, bicarbonate-sulphate sodium-calcium, chloride-sulphate magnesium-sodium. According to the degree of salinity of the water is brackish. In terms of water pH, they are alkaline, and in terms of total hardness, they are very hard.

In order to create an observation network of piezometric wells, drilling operations were carried out at the construction site. The design location of the observation piezometric wells is determined in accordance with their conditional purpose, the location of the structures and areas of contamination with oil products.

According to the conducted studies, the degree of protection of groundwater is estimated by the sum of conventional points calculated by the following gradations: depth of groundwater (H), thickness of low-permeability sediments (m) and their lithological groups (a, b, c): Sum of points - 5, which corresponds to the II category of security. Qualitatively protected groundwater can be described as "poorly protected." In accordance with paragraph 4.38 of SP 11-102-97, the state of groundwater within the survey area can be described as “relatively satisfactory”. No excess of pollutants has been identified.

Based on the research results, it is recommended to provide for the project to reclaim contaminated soil. The method of reclamation should be chosen in accordance with the available resources and the availability of specialized landfills in the area of the object under study.

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JUSTIFICATION OF THE USE OF ASH AND SLAG WASTE IN THE RECLAMATION OF OPEN PIT COAL MINES

The main sources of solid waste in the energy sector are the products of burning coal and brown coal [1]. Coal generation facilities use lower grade coal than, for example, in metallurgical enterprises. As a result, thermal power plants (TPPs) are a powerful source of environmental pollution by coal combustion waste (ash, slags, oxides of carbon, sulfur, nitrogen and other pollutants. At many TPPs, the capacity of existing ash dumps is almost exhausted [1] development of methods and technologies for the use of ash and slag waste (ASW).

It is necessary to make calculations for the equipment for the production of granulate in the hydraulic ash disposal system. To do this, it is necessary to develop a technological scheme for the production of granules from ash and slag waste based on the use of a hydraulic ash disposal system. For reclamation pit walls, it is necessary to assess the coefficient of stability margin in various engineering geological conditions. It is necessary to investigate how the use of ash and slag materials upon receipt of a reclamation material in the conditions of mixing will change the geomechanical situation at the section.

In the conclusion of the work will be submitted proposals on the use of ash and slag waste in the reclamation of coal mines in the form of guidelines. The obtained recommendations will help the complex reduction of the negative impact of ash and slag waste on the environment.

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MODIFICATION OF POLYETHERSULFONE MEMBRANE BY ZNO-APTES NANOPARTICLES TO MITIGATE BIOFOULING

Membrane biofouling is a serious problem leading to a decrease in hydraulic performance, changes of membrane properties, and costly cleaning [1]. Membrane modification through metal oxides in form of nanoparticles is one of the promising options for biofouling mitigation [2]. This work was, therefore, focused on development of new method for membrane modification by ZnO nanoparticles (NPs). As ZnO NPs showed strong antimicrobial properties [3], they were chosen for this study.

The aim of this work was to achieve stable covalent bonding between functional groups of -NH_2 covering ZnO NPswith functional groups of -SO_2Cl present in the membrane polymer chain, therebykeeping their stable antimicrobial properties and mitigating membrane biofouling. The modification of polyethersulfone (PES) was performedin 3 steps. First one consisted of using chlorosulfonic acid to prepare sulfonated PES (SPES) polymer. Then, SPES reacted with thionyl chloride to prepare chlorinated PES (SPES-Cl) polymer. The third step was accomplished through anchoring the SPES-Cl polymer by surface modified ZnO-APTES NPs, i.e. ZnO NPswhich were surface-modified by silane coupling agent as 3-aminopropyltriethoxysilane (APTES).FTIR analysis confirmed modification of ZnO NPs as well as modification of PES.

Since membrane prepared from pure SPES showed weak mechanical properties, mixture of 75% PES and 25% SPES was used. The PES-SPES-ZnO-APTES membrane (modified ZnO NPs) was compared with PES-SPES-ZnO membrane (unmodified ZnO, i.e. without chemical anchoring of ZnO NPs). The PES-SPES-ZnO-APTES membranes showed permeability about 400 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$ similarly to reference membrane (PES/SPES). On contrary, membrane doped by unmodified ZnO NPs exhibited significantly lower permeability,about 50 $L \cdot m^{-2} \cdot h^{-1} \cdot bar^{-1}$. This could be due to fact that casting solution with modified ZnO-APTES nanoparticles was more homogenous than casting solution with unmodified ZnO NPs. SEM and EDX analysis proved presence of ZnO NPsin the modified membranes. All membranes will be further tested on their long-term antimicrobial properties and stability in detail.

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ECOLOGICAL EDUCATION OF CHILDREN AND YOUTH BY THE DESIGN AND THE CONSTRUCTION OF ELECTRIC RACING VEHICLES

Education in the ecolytic spirit is now a very important aspet. Young people should be educated in anecological spirit from anearlyage. Shape somekind of beliefs in them to change the world for the better. The activities of our project group come with the help. Classesat the Silesian University of Technology aim to instill an ecological spirit among children and young people. They are also interested in their technical sciences, technology and ecological motorsports. Classes are conducted from a widerange of techniques. They start with working with learning technical drawing. Subsequently, in CAD environments, where teenagers learn to design subassemblies and entire structures along with 2D documentation.Then they createas semblies and carry out motions imulations of deveices and vehicle riding on a virtual race track. Then they create real constructions made of composites. These are structures of ultralight car bodies. Next, the students pass a part of the lecture, with eminent professors from the Silesian University of Technology, where they canget to know the academic environment. There are also classes in the field of vehicle calculation, eco-efficiency as well as innovation and entrepreneurship. Subsequently, on the basis of their projects, young people build real-life exitvehicles, constructing electrical and mechanical parts. Then the vehicles are prepared for electric car racing. Such prepared young people become great candidates for the job market. Interests acquired during work in the project translate into their pupils after school hours. Also it does not go to waste assimilated ecological knowledge that young people canuse in everyday life [1, 2, 3, 4].

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STUDY OF THE EQUILIBRIUM PARAMETERS AND LABORATORY EXPERIMENTS OF HEAVY METAL(Cu2+) ADSORPTION FROM AQUEOUS SOLUTION BY NANOCLAY

Abandoned mines and mine wastes include heavy metals which are the causes of surface and groundwater contamination. So, researchers are trying to find a new, effective and economic wastewater treatment method in order to remove heavy metals from aqueous solutions. These days, adsorption of heavy metals by natural materials is considered as a cost-effective method to remediate acid mine drainage and polluted surface and groundwater [1]. Numerous researches has been done in order to remove toxic metals from wastewater by using adsorption method. For example, clay minerals, zeolites, activated carbons and graphene oxide nanocomposites were used for adsorption of heavy metals from wastewaters [2,3].

Clays are widely used as the natural environment-friendly adsorbents in order to remove organic pollutants and toxic metals due to their high specific surface area [4]. In this article, adsorption mechanism of copper(Cu2+) from aqueous solution onto nano-montmorillonite was investigated. The effect of several operational parameters such as adsorbent dosage, pH, agitation speed and temperature was studied. The adsorbate distribution between the liquid phase and solid phase is assessed by different isotherm models. So, equilibrium isotherms were analyzed by Langmuir, Freundlich and Temkin adsorption models. In order to figure out the nature of copper(Cu2+) adsorption onto nanoclay, the thermodynamic parameters containing changes in standard enthalpy (ΔH0), standard entropy (ΔS0) and standard Gibbs free energy (ΔG0) were determined. The laboratory experiments showed that the copper (Cu2+) adsorption was dependent on adsorbent dosage, pH and temperature. It was observed that the equilibrium data fitted well with the Freundlich adsorption model. In addition, the adsorption capacity, Q0, was calculated 37.04 mg.g-1 for adsorption of copper on nano-montmorillonte. Also, thermodynamic parameters suggest that the adsorption of copper on nanoclay is spontaneous and endothermic.

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NANOFIBERS FOR IMMOBILIZATION OF MICROORGANISMS USED FOR ADVANCED NITROGEN REMOVAL FROM WASTEWATER

Nanomaterials can be employed for immobilization of microorganisms (biofilm formation) utilizing their specific surface.With varying material compositions, preparations and modifications, the microorganisms (MO) can behave differently. For instance, MO metabolic processes can be promoted or suppressed. The properties of the nanofibrous biomass support (surface structure, wettability, charge and others) have a significant impact on the rate of microbial colonization and biofilm functionality[1]. Bacterial strains can adapt to varying conditions according to their metabolism (nutrition). A suitably prepared and modified (physically, chemically, additively) nanomaterial can support the growth and reproduction of bacteria. There is, however, lack of studies on application of nanofibers and their modifications for preferential growth of bacteria.

In this study, nanofiber carriers were prepared by direct (DC) and alternating (AC) electrospinning, using several polymersaspolyvinyl butyral, polyurethane, polyamideand polyacrylonitrile. Nanofiber propertieswere evaluated using different methods – SEM, confocal microscopy, thermal methods, BET and respirometry. The results showed large differences in fiber morphology, surface roughness, pore size, layer homogeneity, strength, size and fiber arrangement, depending on the spinning method and polymer used.The most suitable method for preparing nanofiberswith required properties was Nanospider^{TM}, i.e. DC electrospinning. Moreover, modification of PVB nanofibers through addition of Fe_3O_4 nanoparticles showed as a very promising option for biotechnological applications, particularlyfor growth of specific bacteria (for examplefor nitrifying and denitrifying bacteria).

The PVB nanofibers doped by Fe_3O_4 nanoparticles were tested in a lab-scale bioreactor, and the results were unexpected.Respirometric tests showed approximately 2 times higher bacterial activity during the ammonia nitrogen removalwhen using composite carriers compared to activated sludge. In addition, large number of nitrifying bacteria was detected on these carriers by FISH analysis. Nanoparticles Fe_3O_4inside PVB polymer allow efficient binding of ammonia nitrogen to the carrier (biofilm) [2], thereby accelerating its removal.Applying these materials would increase the efficiency of removing nitrogen related substances from water without major modifications to existing plants.

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DEVELOPMENT OF ADVANCED MEMBRANE TECHNOLOGY FOR INDUSTRIAL WASTEWATERS TREATMENT

Treatment of industrial wastewaters using processes based on conventional activated sludge is usually difficult due to large variations in their composition, high organic matter content and presence of poorly biodegradable compounds. Recent treatment of industrial wastewaters is, therefore, economically demanding, and specific treatment conditions are necessary to fulfil discharging limits. Moreover, an increasing water stress results in tendency to recycle and reuse treated wastewaters within various production processes.

Main goals of this study were to develop an advanced treatment technology consisted of two main segments, i.e. efficient pre-treatment step and membrane separation unit which will allow an effective treatment ofindustrial wastewaters coming, for instance, from textile industry. Entire technology is designed with respect to its variability and flexibility enabling easy process and operation modification based on the character of incoming wastewaters.

To design the membrane technology, different laboratory experiments focused mainly on the wastewater pre-treatment were performed. The sufficient pre-treatment is required to prevent membrane fouling during its operation.Based on the chemical analysis of textile wastewater, ferric chloride ($FeCl_3$) was chosen as a suitable coagulant. Besides the content ofpoorly biodegradable dyes, the raw textile wastewater differed significantly in colour (black, dark purple, green, grey, red), pH value (6.0 – 8.6), COD concentration (320 – 600 mg/l), BOD concentration (60 – 170 mg/l), conductivity (440 – 1600 μS/cm) and other features according to the ongoing production process in factory.Based on the number of performed coagulation tests, optimal dose of ferric chloride was found,ranging from 40 to 50 mg/l of Fe. In all cases, clear supernatant, significant decrease in COD concentration as well as dyes, and low residual iron concentrations were achieved. The resulting supernatant could be, therefore, further used as a feed for membranes in order to remove residual organics. Filtration tests with several types of ultrafiltration membranes (ceramic and polymer) were also conducted in this study.

Based on the results of laboratory tests, an advanced membrane pilot plant unit was designed, parameterized and constructed in close cooperation with ENVI-PUR Ltd. company. Final pilot plant unitconsists of mechanical pre-treatment (sieve 2x2 mm), two coagulation chambers, lamella sludge separator and two different membrane compartments (ceramic vs. polymer membrane). The unit allows to change the operational mode and conditions of coagulation process as well as membrane filtration according to the features of the raw and pretreatedwastewater. The pilot plant is currently under long-term testing and optimizing at the locality in the south of the Czech Republic.

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ECONOMICEFFICIENCY OF RECLAMATION OF TERRITORIES AFTER EXTRACTION OF POTASH SALTS

The problem of ecological deformation of territories under the influence of man-made factors is becoming increasingly important. Intervention in natural processes through the extraction of potash fertilizers leads to environmental pollution. Thus, there is a problem of ways to restore the territories after the extraction of the natural resource and reduce the harmful effects of this human activity.

Reclamation is a set of measures for the ecological and economic recovery of land and water resources, the fertility of which as a result of human activity has decreased significantly. In the Republic of Belarus land reclamation after the extraction of potash fertilizers is not carried out, since this process occurs at great depth and cannot be recovered. But during the mining of potash fertilizers, nearby territories are damaged, where heaps of waste (terricones)are located.Terriconesare dumps, artificial mounds of waste rock extracted from underground mining of coal and other minerals, mounds of waste from various industries and the burning of solid fuels.

Despite the fact that terricones have become a landscape feature of the Soligorsk region (Republic of Belarus), the problem of processing of these rocks is quite acute, as mine dumps have a negative influence on the environment and human activity, while also occupying large areas of fertile land. The sulfurous anhydride released from the heaps produces sulfuric acid, which, together with the rains, falls on the ground. Many of the waste heaps are burning, and this contributes to a significant change in the composition of atmospheric air and acid rain. On the lands occupied under the heaps, the acid-base balance and physico-mechanical properties are changed. This makes the chernozem soils that are nearby, unsuitable for all living things. Thus, it is obvious that the need to develop technologies for the disposal of heaps is the most important problem in the process of mining of potash ores.

Programs of reducing the negative effects of heapsare actively developed. One of the ways to reduce the volumes of mine dumps is to launch waste from natural resources and raw materials into new production process, since they do not always completely lose their national economic importance and can be used as raw materials. Such recycling methods are known as obtaining building materials and fertilizers, separating magnetic iron-containing compounds from waste heaps, separating germanium and rare-earth elements from waste heaps, adding asphalt and concrete products to the composition as a filler. Also it’s very important to continue developing the methods of mining and processing not only with the aim of decreasing the risks of environmental pollution, but also minimizing the costs of pollution at the present time.

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ASSESSMENT OF HEAT POWER PLANTS EMISSIONS IMPACT ON AIR BASED ON THE SNOW COVER STUDY TO ENVIRONMENTAL PROTECTION DEVELOPMENT (KEMEROVO CITY)

Kuznetsk Basin (Kuzbass, Russia) has one of the world's biggest hardcoal reserves, especially cocking ones. According to Kemerovo large industrial facilities analysis, the coal-fired power plant activity affects environment and public health. The snow cover study determines anthropogenic or naturally occurring solid airborne particles emissions as well as their sources.

The aim of the article is an assessment of Kemerovo coal-fired power plant emissions impact on air quality. Snow samples collection and preparation were made according to normative technique in February 2016 [1]. A dust load estimate was determined after the fieldwork [2]. Analyses of solid airborne particles deposited in snow are as follows: X-ray crystallography and scanning electron microscopy for mineral and phase composition study, instrumental neutron activation analysis and cold vapor atomic absorption spectroscopy for chemical composition study.

A dust load value is 199 mg· $(m^2 \cdot day)^{-1}$ which corresponds to average pollution level. The snow sample mineral composition includes quartz, feldspars, iron sulphide, and aluminosilicates with Fe and Ca admixture. The anthropogenic particles consist of Al-Si spheres, Fe-O spheres, carbon-bearing particles, aluminosilicate slag particles, lead oxide. The samples are dominated by anorthite, quartz, and mullite content. All studied mineral and anthropogenic particles have a size of from 5 to 20 μm and according to the classification belong to medium and large ones [2]. These particles may affect human respiratory organs. Snow cover indicator elements reflecting the Kemerovo coal-fired power plant impact specificity are identified. To decrease the emissions, it is recommended to use best available technique and improve industrial environmental control.

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TECHNOLOGICAL ASPECTS OF REDUCING ECOLOGICAL RISKS FROM INDUSTRIAL WASTEWATER POLLUTION

As a result of the mining enterprises work the large volumes of the wastewater, containing harmful impurities, are dumped into the natural water bodies [1]. This entails increasing the ecological load on the environment and the additional costs of the industrial enterprises for the penal sanctions, as well as the huge costs of the environmental protection. The wastewater treatment of the mining enterprises is an important part of a measures complex to reduce the negative impact of the man-made factors on the water bodies.

To solve the problem of the reducing environmental pollution in the discharged waters, the Mining Institute of the Kola Science Centre of the Russian Academy of Science has developed a method of the wastewater treatment, based on a synergistic effect when concentrating pollution in a multiphase system [2]. This method includes coagulation, sorption and flotation in an activated water dispersion of air (AWDA). The basic device for the implementation of a new method for wastewater treatment is a flotation machine for the extraction of the contaminants in AWDA. The operating principle of the proposed device for the wastewater treatment is based on the ability of the activated gas bubbles to interact with the hydrophobic flocculating pollutants presented in industrial wastewater [3].

The advantage of the new method is to increase the efficiency of water treatment from undesirable impurities, due to a combination of several processes implemented in one volume, which is achieved by introducing a modified natural sorbent and activated water dispersions of air into the working volume of the device, increasing the surface area at the interface and increasing the specific sorption surface.

On the basis of the studies performed and the results obtained, it can be concluded that this technology of the wastewater treatment allows achieving high performance and effectively removing multicomponent impurities without significant capital expenditures with the required high degree of the purification. It should be noted that the advantages of the developed technology also include eliminating the need for preliminary sedimentation of the suspended solids and coagulated dissolved impurities and reducing the amount of waste to be disposed of, which in turn makes the proposed method more effective compared to other known methods.

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GEOCHEMICAL EFFECTS OF KHOLODNINSKOE LEAD-ZINC DEPOSIT IN AQUATIC LANDSCAPES OF NORTHERN BAIKAL

There are both natural and anthropogenic source of pollutants which can transport to Baikal. Mining can be one of the most dangerous source of pollutants, for instance, heavy metals[1]. Kholodnenskoe poly metallic mine is one of the large in region and in Russia in general (it is not developed now) and it's impact to the quality of water partly have been researched but not enough[2,3]. In the authors' research the features of pollution of aquatic environments (rivers and lake) in the area of impact of Holodnenskoe polymetallic mine, located in the water basin of the lake Baikal (north-western part of the Republic of Buryatiya) is considered.

For the territory between Kholodnenskoe mine and lake Baikal the main existing sources of pollution, the degree of toxicity and the scale of the impact on the drainage watercourses, as well as the peculiarities of transportation of pollutants were determined. Several field expeditions were organized which permit us to take necessary water samples both from rivers and lake Baikal. They were analyzed in laboratory. Existing spatial zones of ecological risk for aquatic landscapes associated with modern geochemical impact of Kholodnenskoe mine were revealed over. Today, it is part of the basin of the river Kholodnaya, which flows near the mine and takes water streams flowing from abandoned tunnels. In the waters of these streams very high concentrations of pollutants for a number of heavy metals have been revealed. They in the hundreds and thousands of times higher than the maximum allowable concentration. After the confluence of streams in r. Kholodnaya pollution zone have been formed, within which the concentration of zinc in the waters of the river exceeds the normative values. For the Tyya river, which drains the ore body, but does not receive streams from the tunnels, significant excess standards for the content of heavy metals have not been found. Directly in the water area of lake Baikal, including the Gulf of Angarskiy Sor, where the Holodnaya river flows, exceeding the permissible values are also not identified.

Based on the analysis of the selected samples, conclusions are made about the peculiarities of migration of chemical elements in the "Cold river – lake Baikal" system at the present time with the current intensity of economic activity, as well as for the long term. Now the situation with pollution of the Baikal at the area of research is acceptable, however the further research is necessary especially in case of resumption of ore mining

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SIMULTANEOUS ECONOMIC DEVELOPMENT OFINDUSTRIALAGGLOMERATIONS IN THE REPUBLIC OF BELARUS

Agglomerations, characterized with high density of population and high concentration of enterprises promoting extensive innovation activity, are becoming attractive for investment, including foreign, goods which are produced in agglomerations are in demand either on domestic market or external market.It is expediently to consider ways of agglomerations territorial arrangement improvement in order to grade negative environmental impact and provide ecologically-sinergistic economic growth, keeping Minsk industrial agglomeration competitive, to increase the efficiency of industrial policy of The Republic of Belarus.

Merging of separate industrial systems into agglomerations allows to reduce unit costs,but excessive concentration of industry can cause risks of over population and severe pollution of environment, also workforce, resources and premises cost increases. Large industrial agglomerations usually consist of large city as a center surrounded by the so-called satellite towns. Towns located not far from Minsk (upto 60 km), where building ofhousing development districts, new industrial objects and development of infrastructure are planned, can be considered as its satellite towns [1]. That is how more equal distribution of workforce and simultaneous economic development of towns will be reached.

Nowadays industrial development is impossible without ecological part of economic growth consideration. Now industrial enterprises are built outside the city limits,for example, in satellite towns suburbs (for instance, СООО «ХенкельБаутехник», СЗАО «Белджи»). Besides, displacement of most operating enterprises production out of Minsk is planned and performed («Горизонт» holding company, partly ОАО «Минск Кристалл»). These measures allow to reduce concentration of harmful emissions in the city. Besides directions mentioned above, there are such targets as “maximally involve waste products in recycling and maximally use renewable resources, etc.”[2]. For example, “Target 99” activity, which is directed to make people separate and recycle as much waste as possible.

So, in the Republic of Belarus complex of measures and issues, aimed to make industry more ecological and to provide industrial agglomerations sustainable development is planned and performed. Strategies of economic growth including reduction of harmful industrial impact on belorussian ecology and health of its people, increasing of industrialand consumer sustainability, including efficient renewable andnon-renewable resources management and reduction the volume of industrial and consumer waste are developed.

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USE OF VIBROACOUSTICS IN FINE CLEANING OF DRILLING FLUIDS

A reuse of drilling fluids is an urgent problem in the modern well drilling. The issue is caused by high cost of drilling fluid and the complexity of its disposal. The high-quality cleaning from solid particles according to the class of 0.04–0.07 mm is needed to reuse drilling fluid. An analysis of existing technologies and equipment showed that schemes of drilling fluid regeneration are expensive and difficult in operation [1-4]. In the domestic drilling practice, a three-stage cleaning system is used, consisting of a vibrating sieve, a battery of hydrocyclone-sand separators, a battery of hydrocyclone-desilter; however, development of universal equipment that provides cleaning of drilling fluids from fine particles in a single cycle is a modern trend. We propose an innovative vibroacoustic module to clean drilling fluids from sludge. The impact of vibroacoustic oscillations on the drilling fluid, which passes through a mesh, is the constructive element of the VAM. Emergence of specific effects around the mesh results in the increase of the process productivity and efficiency. The principle of module operation is based on the hydroacoustic effect of low-frequency oscillations on the fluid flow. The process of drilling fluids filtration is carried out in one stage.

The industrial tests of the VAM revealed the dependence of the productivity and efficiency of the BU-75-BrE drilling rig on the amplitude of oscillation. We determined the optimum dynamic range of impact as from 5.5 mm to 6.5 mm. The results showed that the maximum particle size of the solid phase in the cleaned drilling fluid composition was less than 0.04 mm. The use of vibroacoustics opens wide opportunities to find solutions for a range of challenges related to qualitative separation of slurries. In addition, vibroacoustic technologies allow creating high-performance installations to clean circulating waters, mine waters and filter industrial waste drains.

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TO THE PROBLEM OF ISOLATION OF ENVIRONMENTAL SAFETY MARKERS

Currently, the focus of research is on technologically disturbed areas. The data obtained by chemical analysis lead to a comparison with the maximum permissible concentration (maximum allowable concentration) of this substance. Undisturbed areas are studied in order to replenish the data bank, to study the mechanisms of accumulation, transformation of substances. Technogenically weakly disturbed territories remain without due attention. Meanwhile, it is these territories that make it possible to assess the degree of technogenic load increase, comparing the data obtained with "standard" - PAs (specially protected areas) In this regard, the problem of identifying environmental markers is particularly relevant.

Our research is devoted to technologically weakly disturbed landscapes. Soil, soil-forming rocks, vegetation, silt and water have been studied. Studies were conducted on the territory of the Sura-Sviyazhsky interfluve of the Volga Upland [1]. The objects of the study are the weakly disturbed and technogenically unchanged landscapes in the territory of the GPP "Prisursky". As markers of the environmental situation, heavy metals were identified: Lead, copper, cadmium, and others.

The obtained data allow us to conclude that the maximum values of the concentrations of heavy metals in water in the "reference" ecosystem are many times smaller than the average values of concentrations of technogenically disturbed ecosystems. Comparison of the content of heavy metals, technologically disturbed and "reference" landscapes showed that: lead is 25 times; zinc 50 times; copper - 128 times more in disturbed ecosystems than "reference" [2]. This is due to the processes of accumulation of heavy metals by the waters of the lakes of disturbed ecosystems.

Thus, all water and vegetation samples retain the tendency of accumulation of heavy metals in the technologically disturbed landscapes. Weakly disturbed landscapes can be used as indicators of the quality of the territory's environment, since the extent of the anthropogenic load can be traced across their territory. Ecological markers of the degree of increase in the anthropogenic load of the territory can serve as heavy metals.

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MODIFICATION OF CATALYTIC PROPERTIES OF THE FLY ASH FROM CRUDE OIL BURNING

During last decades there was noticeable significant development in industrial sector and connected with it increase in pollution emission. In connection to this, there is a need to put more effort in environment protection. The issues to cope with are numerous. A large number of researches have been conducting many studies about the alternative utilization of the fly ash to decrease the environmental impact of solid wastes originating from the energy industry. Moreover, there is still a need to develop methods of flue gases purification. Converting nitrogen oxides (NOX) into diatomic nitrogen (N2) is one of them. In the process of Selective Catalytic Reduction (SCR), catalyst of high selectivity, efficiency and low-cost are needed [1]. The main aim of this research was to modify the surface of fly ash obtained from crude oil, characterize catalytic properties of samples and prepare catalyst, which can be used in SCR. In this work, the samples of tested material were purified with mixture of acids to remove heavy metals. As next steps, activation with CO2 has been applied to increase the specific surface area by developing a micro-porous structure. Finally samples were impregnated with solutions of 3 selected salts [2]. The following analytical methods were used: X-ray fluorescence and X-ray diffraction with aim to study the chemical composition of the catalysts and crystalline phases analysis. As method used to determine the specific surface area of the catalysts was lowtemperature N2 sorption.

It has been proved that the specific surface area of the samples has increased few times when compared with starting material sample. Moreover, using a mixture of various acids had impact on the chemical composition of the fly ash. The number of elements, which are known from poisonous properties for the catalysts, has decreased and the content of elements, which are active in SCR [1], has increased. This study has shown that it may be possible to prepare active and selective eco-friendly catalysts from the fly ash for SCR.

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ELIMINATION OF OIL POLLUTION USING SORBENTS

The rate of accumulation of petroleum products as a result of anthropogenic pollution in water and soil ecosystems is far ahead of their rate of biodegradation in a natural way, and existing technologies do not allow to cope with such contamination quickly and efficiently. Sorbent materials can provide a useful resource in a response to a spill of oil, allowing oil to be recovered in situations that are unsuitable for other techniques [1,2]. The hit of oil and its products into the environment, either in air, water or soil, causes a change in their physical, chemical and biological characteristics, disrupting the natural course of biochemical processes. Elimination of oil pollution is not without the use of various types of sorption materials. Oil sorbents are materials that can absorb oil products in large quantities, however preventing their migration in the surrounding environment [3]. A special interest is the research and study of materials that have high sorption characteristics and have an organic basis. This fact is very important, since by solving problems of recycling and (or) regeneration of sorbents, in the case of their organic basis, their rational use, for example, for obtaining thermal energy, without secondary pollution of the environment, is possible.

In recent years, a search has been actively carried out in the field of obtaining nonexpensive oil sorbents for the collection of hydrocarbon spills. Despite the development in this direction, the issues of research of the collection of oil and oil products from various surfaces and the estimate effectiveness of the usage of sorbents on the basis of the agroindustrial complex's residual are not given enough attention, which determined the purpose of this research. For the research, the following residual samples of agroindustrial complex are considered: Buckwheat husk Fagopyrum esculentum, Buckwheat husk Fagopyrum esculentum, Peanut pericarp Arachis hypogaea and Pericarp of radis Raphanus.

These sorbents are not inferior in oil sorption known industrial sorbents. The offered sorbents can be dissipated during cleaning of various polluted surfaces of water, concrete, asphalt, metals, soil (clay, sand) from the pollutant by hand, by mechanical or pneumatic devices, further assembled conglomerate of hydrocarbon impregnated sorbent can be subjected to extraction of oil (oil product) by compression methods. The residue can be used as fuel briquettes with an increased calorific value. Petroleum sorbents from agroindustrial residual have the ability to biodegrade under the influence of aboriginal soil or artificially introduced microorganisms. It should be noted that it is advisable to obtain data sorbents in environmental and economic terms, due to the low cost of materials, easy manufacturing, high sorption properties, the possibility of recycling of secondary raw materials.

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DOUBLE-COLUMNDOUBLE-FILTER WATERWELL

Currently, groundwater is extracted in most European countries through water wells, which are the most common type of water intake facilities. To ensure the uninterrupted supply of water to the consumer, it is often provided for the arrangement of two water wells: the main and the reserve, with individual buildings of pumping stations, as well as a zone of sanitary protection of strict regime with an external fence. Such a scheme of placement of working and reserve wells involves significant material costs for the construction of individual wells with halls and networks, and also requires the alienation of land for the territory of sanitary protection zones.

To reduce capital costs for the construction of reserve wells in BNTU, the design of a two-column two-filter water well located in one common conductor, performing the functions of both working and reserve wells [1], is proposed. Each of the two columns has its own head, filter pipe to accommodate the pump, filter and sump. The columns are hydraulically connected to each other by means of upper and lower connecting bridges placed above and below the filters. In a well in each column on water-lifting pipes submersible pumpsthat can work both together, and alternately are mounted. Thus, we have a pumping station of the first lifting with a generahall having one water intake structure in the form of two-column well equipped with two identical pumps. During operation of one pump, two filters connected by crossbars work in parallel. This reduces operating costs for waterlifting, because the specific yield of the two-columnwell is higher than ofone-filter one-column well. In case of failure of one of the pumps,the otherimmediately turns on, which ensures uninterrupted water supply to the consumer. In case of failure of one filter or its current or major repairs, another filter can work. This significantly improves the reliability and performance of the proposed well.

To study the hydraulics of a two-column two-filter well, a number of laboratory and field studies were carried out [2]. According to their results, we can conclude that the application of the proposed wells will help to increase the specific yield and lifetime in comparison with a one-column well; to carry out uninterrupted supply of water to the consumer have a separate pump unit in each barrel; significantly reduce the area expropriated for the construction land and the length of communications; provide reduction of capital investments in comparison with construction of two separately located wells at the expense of one drilling platform and arrangement of one hall instead of two.

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THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN THE CONTEXT OF MODERNIZATION OF THE MINING INDUSTRY OF THE REPUBLIC OF BELARUS

The strategy of sustainable development of the economy of the Republic of Belarus for the near and long-term perspective is based on the development of the natural-resource potential, in which the most important place is occupied by mineral raw materials. The mineral resource complex is a unified system of geological exploration, mining and processing of minerals, their transport and sale.The challenges of the mining industry are the following: the low level of the development of the manufacturing industry; there isn't enough innovation activity; the imitational nature of innovation; the wasteful use of raw materials; increased energy intensity and metal intensity of production; increased environmental pressure; high dependence of budget revenues on price fluctuations in raw materials on the external market; lack of a clear policy in the field of staff retraining and development [1]. At the present stage of the modernization of the mining industry, they intensify the integration of mining enterprises into the innovation environment, and mechanisms for planning intra-company education are being developed, as well as a set of measures that stimulate innovative development not only in the mining industry, but also in the sectors and industries adjacent to it.

The demand for qualified engineering and technical personnel, especially mining andchemical, has increased dramatically with the growth of industrial production.Institutions of higher and secondary education raise and advance the level of training and retraining of employees [2].The most important factors in the modernization of the mining industry are the design of mines, making economic contracts with the mining industry and its departments, the execution of orders for conducting expertizes, consultations, scientific, technical and experimental research work.Green technologies whose purpose is to reduce the environmental burden and protect the environment also deserve great attention.

The expansion of the industrial mineral resource base largely depends on the development of non-traditional mining and processing technologies, which make it possible to economically master hard-to-reach (geographically and technologically) deposits. Practicing geologists and scientists of our country have not a sufficiently developed modern laboratory and analytical base, and what is more important, previously made scientific and methodological developments have not been properly applied.There is possibility and feasibility of a resource-innovative strategy for sustainable development in this sphere. The existing concept of the mining industry suggests that in the resource sectors it is possible to obtain new products, with the help of which the domestic market will be close to saturation.

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URBAN ECOLOGICAL FOOTPRINT AS A TOOL FOR SUSTAINABLE MANAGEMENT – CONCEPT OF A REGIONAL COMPARISON STUDY IN POLAND

Human development leads to exploration of many domains that for centuries were not controlled and managed by society. Nowadays, we are more aware of effects of our actions and their impact on the whole socio-environmental system. In order to build knowledge-based economy, there is a need to incorporate also environmental metrics in the strategic management of the development of cities.

One of the world-known indicators used for the purpose of measuring environmental impact of human activity if the Ecological Footprint (EF). The methodology for that mertic is developed by the Global Footprint Network, which every year publish a report on the global EF. These reports enable to compare countries between themselves, as a total EF of each country is the level of precision of the report. However, taking into account the main motto of sustainable development „think globally, act locally", there is a need to develop the methodology to measure separate cities in order to assess their individual impact on the environment.

The aim of this research is to develop the concept of a comparison study for regional Polish cities, to calculate the Urban Ecological Footprint (UEF). The study covered the review of the EF methodology at the national level and downscaling of the components to the urban level, the review of the accessable data based as well as data that can be obtained from municipal units on request, and finally, the integration of all components of the UEF. The results of the reseach constitute an utilitary outcome, which might be used in practise to support local governments to implement environmental management processes for the sustainable development at the local scale.

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PROBLEMS OF COAL COMBUSTION BY HOUSEHOLDS IN POLAND

In Poland, the amount of brown and stone coal consumed is about 100 mln tons. The most of it is used by corporate energy companies, even though there is still a significant amount being used in households as fuel for boilers. These types of coals are characterized by their low efficiency at creating energy and their significant emission of toxic gasses, contributing greatly to the air pollution. The need to protect natural environment and reduction of carbon dioxide emissions to the atmosphere, caused introduction of serious restrictions on the possibility of using low power coal boilers by households, especially in urban agglomerations. this article presents current state of heating economy in households and direction of changes in context of current regulations and low-emission energy policy. Discussed basic conditions, heating systems and permissible emission values of pollutants by heating boilers allowing further use of coal fuels in low power boilers and alternative solutions based on biomass fuels. Also focused attention on economic aspects related with implementation of natural environmental improvement strategy.

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MATHEMATICAL MODEL OF WATER QUALITY CHANGES IN SELECTED RIVERS INPOLAND

Water is an excellent solvent. In nature, it does not exist as a chemically pure compound of oxygen and hydrogen. It is a dilute solution of salts, acids, alkalis and gases[1].The article is devoted to chemical processes taking place in the flowing waters and causing changes in their quality. As research objects were taken three sections of watercourses varied in terms of the river regime.Urban river *PotokTyski*, mountain river *BystrzycaDusznicka* and lowland river *Stobrawa*.

Formulating water quality models requires combination of kinetics, stoichiometry of biological and chemical reactions with known physical relationships. The possibility of practical application of models in combination with the complexity of phenomena in the ecosystem enforces the introduction of some simplifications that result primarily from the availability of information[2].Those must be acquired in the scope of geometry and hydrometry of the studied objects, meteorology and the current amount of organic and non-organic matter dissolved in water.For this purpose, it was necessary to analyze the datafrom measurement stations, which are available in the offices and hydrographic annuals, obtained from digital elevation modeland to test water samples.On each river, the water temperature and the dissolved oxygen content were measured and samples were taken to determine the concentrations of nitrogen and phosphorus.

The nitrogen and phosphorus compounds are crucial in the processes occurring in natural waters. Nitrogen and phosphorus species most commonly found in river water are dissolved organic nitrogen (OrgN), ammonium nitrogen (NH_4), nitrite nitrogen (NO_2), nitrate nitrogen (NO_3)organic phosphorus (OrgP) and inorganic orthophosphate (PO_4).Within natural aerobic waters there is a constant transformation of organic nitrogen and phosphorus into inorganic particles[3].

To create the model, the HEC-RAS program was used. Inserting all the previously collected data enabled a tabular and graphical presentation of the results of long-term analysis of changes in water quality. Thanks to them, it is possible to determine the pace of changes and whether they are progressing in the direction that threatens the correct ecological status of the examined surface waters.

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GLAUCONITIC ROCKS ARE A SOURCE OF POTASSIUM FERTILIZER IN WESTERN SIBERIA

The application of fertilizers is crucial for meeting the world's current crop demand due to the population growth and decreasing of arable land [1]. Traditional fertilizers release excess nutrients than that can be absorbed by plant roots. This results enrichment of chemicals (mainly N) in soil for environmental pollution [2]. As plants absorb about 2% potassium from the soil in a season [3], the application of highly concentrated potassium salts contributes to the excessive accumulation of non-exchangeable K in the soil. The application of slow release K-fertilizer, on the contrary, serves dual purpose by providing nutrients for the plant growth and by maintaining the low level of chemicals in the agricultural soils. A few studies explores mining wastes for the purpose of environment friendly, alternate fertilizers. The fertilizer potential of glauconite is indicated in recent studies[4]. Glauconite is a dioctahedral micaceous phyllosilicate mineral with a variable chemical composition and a high content of interlayer potassium (up to 8–9%).This study examines the effectiveness of glauconitic products by conducting field experiments on wheat plants. Separate experiments using glauconitolite, potassium salts and original soil compare the effectiveness of different products for agronomic applications.

The conclusions of this study on alternate potassium fertilizer potential of glauconite are as follows.(1) Glauconite undergoes distinct structural and chemical changes in soil conditions within 120 days of growing season of wheat. The glauconite develops an increasing sinuosity of flakes, and a decreasing content of K_2O with time. (2) Glauconite reduces its original K_2O content by 25% during one growing season of durum wheat indicating its effectiveness as a fertilizer for the next 2 or 3 cycles.(3) Potassium sulfate, extracted from the glauconite sample results a comparatively better yield than glauconite sample. While the potassium sulfate is prepared after rigorous treatment of glauconitic rock, simple grinding of glauconitolite to < 2 mm fraction makes it suitable as an alternate fertilizer.(4) The introduction of glauconite improves the physico-chemical properties of soil by increasing the concentrations of K, P, Ca, Mg. The soil pH changes from acidic to near neutral after using a glauconite rock in 120 days. The increased concentrations of K, P, Ca, Mg in soil is marked by the complex interactions of glauconite with soil.(5) The addition of glauconitic products results an increase in grain yield and also improve physico-chemical properties of the soil.

Further, the incomplete leaching of potassium and enhanced moisture saturation makes glauconite of Bakchar deposit as an environment friendly and slow release fertilizer.

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ARTIFICIAL GROUND MIXTURES FOR THE MINING LAND RECLAMATION

According to the Land Register of properties in the Russian Federation, there are 317.5 thousand hectares of anthropogenicallydisturbed lands, of which more than 30.7 thousand hectares of land is used for industrial landfills (2018).

Lands are a valuable state resource.All territories occupiedfor waste storage should be restored and brought back to the economic activity.In this regard, one of the most critical tasks of the state remains the reclamation of disturbed industrial and mininglands.

For the complete formation of the anthropogenic soil profile, it is necessary to provide a sufficient amount of mineral and organic nutrients.During the research of existing methods of reclamation was found an obvious drawback: soils absorb all the most affordable organic fertilizers in one or two seasons. Without repeated fertilization, it leads to nutrient deficiency, the death of soil microorganisms. These adverse effects prevent the formation of a stable ecosystem.

For the solution of this problem, it is necessary to choose the soil amendment with prolonged action. Furthermore, it has to be easily accessible and low-cost. According to these criteria, was selected a previously unused waste of a pulp and paper mill – lignin-sludge (LS).

The work aim is to research the suitability of artificial soil mixtures based on the LS for the reclamation of disturbed lands.The tasks of research: 1) the literature review of the artificial soils with the addition of various amendments; 2) the formation of an optimal potting soil mixture with the LS and loamy soils; 3) the evidence of reasonable use of the LS by the analysis of the absence of toxicity and the availability of essential nutrients.

The selected lignin sludge samples are a mixture of raw sediments and excessive activated sludge in a ratio of ~1:4. Dehydrated waste contains organic matter, phytogenic fiber (lignin), with a pH level of ~ 6.

For determining the suitability of the LS for the fertile composition creation, were analyzed: moisture content (70-75%), ash content (4%), concentrations of heavy metals, and organogenic elements – nitrogen (0.36%), phosphorus (0.155%), carbon (47.21%), hydrogen (5.78%), calcium (7.78%). The studies were conducted to compare the results with the existing indicators regulated in normative documents.As a result, of a comparative analysis, the possibility of using LS for addition to the soil was proved.

The experiment was conducted to determine the optimal composition of fertile artificial soils by analyzing the vegetation of plants. There were created five models of potting soil mixtures with different ratios of components on which were planted: Trifolium praténse, Festuca pratensis,Phleum pratense,Lolium perenne, Festulolium and Agrostis tenuis. Regular measurements of plant growth and the presence of external indicators of oppression were carried out. During the experiment, no external signs of disease symptoms, chlorosis and necrosis were observed on plants.At the end of the experiment, the aerial part of the biomass was weighed.

The result of the experiment proved that the artificial soil created (loam and 15-30% LS) improves fertility, helps to accelerate plant growth (by 15%) and increases aerial biomass (by 25%), which will improve the process of reclamation of mine disturbed lands.

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AN EFFICIENT MINE WATER RECYCLING TECHNOLOGY IN INDIAN MINES

Mining is an imperative segment of Indian economy as it raises thesocio-economic status of country. Minimizing the impact of mining operations on localwaterresources is one of the top priorities of the industry. Water has to be pumped awayfrom a mine site, to reduce the water level, and cause pollution in the form of tailings.

Minimizing the impact of large runoff streams and metals-laden wastewater on the localenvironment is the major challenge faced by the developers today. Of all the pollutantsfrom the mining industry, 60–70% is emitted into water; so the removal of thesecontaminants prior to discharge should be given significant attention. The paper aims atcreating awareness about mine water recycling and the various processes to recycle itwitha case study of the mine water recycling plant at A mine, of Wardha Valley Coal Fields.

One of the major environmental impacts due to mining industry is the waste water disposalinto the natural water body. The extraction of minerals necessitates extraction below theground water table. Heavy duty pumps are hence installed to extract the groundwater.Minimizing the impact of large runoff streams and metals-laden wastewater on the localenvironment is the major challenge. A water treatment plant has been set up underCorporate Social Responsibility (CSR). The RO plant provides pure, clean drinking waterto the villagers. This plant purifies water at the rate of 1000 liters per hour. Waterdischarged from the underground mine is being transported through half a kilometer longpipeline, where the RO plant has been installed. Apart from making available drinkingwater, water from mines is being supplied to villagers free of cost.

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CORRECTION FACTOR TO IMPROVE THE ECONOMICS OF CLASSIFYING SECONDARY RAW MATERIALS

An elementary process step in treatment processes is the classification. Not only salable products are produced by sieving classifications. It is also necessary to run processes such as sorting or shredding under optimal conditions and to analyze process engineering processes. In sieve classifications, a square hole shape (sieve mesh) is mainly used. The passage criterion, however, is based on a circular hole shape. Especially in the field of recycling materials with complex geometrical shapes are to be handled. In contrast to the mineral area, this can lead to false assumptions and distortions of the particle size distribution [1]. Especially in plastic shredding products are formed with platy particle shapes. These move in a screening, diagonally through the square mesh of the sieve. However, the general criterion for the screening criterion is, that the mesh size corresponds to the maximum particle width. This assumption is a good approximation for cubic particles. When screening plastics, it should be noted that the particle shape is usually not cubic but plate-like. This has an effect on particle size distribution when using square mesh screens. For this purpose, a correction factor is introduced in the paper. To validate the correction factor, secondary carbon fiber and fiberglass plastic materials from bicycle frames were used. These parts were shredded in practice and prepared for trial sieving. These were crushed in two stages. In the first stage with a rotary shear and in the second with a granulator. The crushed material was analyzed several times by means of sieve plates with square mesh and circular mesh [2], [3].

As can be seen from the evaluation of the sieve analyses in the paper, the sieve analysis using a square mesh could be adapted to the real particle size distribution by means of a hole mesh with the aid of the correction factor. Of course, there is no exact coverage but strong alignment. As a result of these experiments it can be stated that the formula of the correction factor for this material is confirmed. On the basis of this knowledge, classification processes can be made more efficient and one can continue to rely on normal sieve trays with square mesh. With the help of this formula, it is possible to get to the desired and for the subsequent process important screening-cut faster in a new material flow. Thus, subsequent processes such as crushing or sorting run faster at the plant optimum and obtained by the better process, a higher quality and quantity yield of the desired concentrate. This ultimately increases the costeffectiveness of the entire process and helps to close the raw materials cycle better.

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ALTERNATIVE WAYS OF REDUCING CARBON DIOXIDE EMISSIONS - THE MAIN OBJECTIVES OF THE GREENPOWER POLAND CHARITY

Despite the increasingly stringent emission regulations, the purity of the ecological environment is deteriorating day by day. The situation is much worse in the case of large cities or urban agglomerations. The increasing number of vehicles powered by internal combustion engines causes an increase in carbon dioxide emissions to the atmosphere. The situation is even worse when factors related to heating of residential buildings, which in Poland are still mostly heated with boilers powered by hard coal are added to the increasing number of vehicles. The combination of these factors causes that the condition of air in Polish cities is the worst since the records of its state began to be maintained.

It is not easy to solve such a difficult situation. This problem should be solved on many levels. One of them is to educate young people according to ecological guidelines. The task of the Greenpower Poland Charity is to conduct workshops and lectures for young people. These lectures are related to the direct environmental and educational activities of the charity. The workshops are aimed at the construction of electric vehicles, which, thanks to common constructional features and common regulations, can compete in electric car races organized by the global organization which is Greenpower.

The paper titled “Alternative ways of reducing carbon dioxide emissions - the main objectives of the Greenpower Polska charity” raises problems related to the environmental problems that in the long run can be reduced by proper preventive action consisting in raising awareness of young people and reaffirming them in ecological ideas.

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BENEFICIAL UTILISATION OF URBAN SEWAGE SLUDGE

One of the most pressing problems in the metropolis is the issue of disposal and recycling of the ever-increasing amount of waste in in a limited capacity of the objects of their placement. In particular, in order to reduce waste generation, State Unitary Enterprise (SUE) «Vodokanal of St. Petersburg» uses incineration of sewage sludge in fluidized bed furnaces [1]. The most promising ways of beneficial using sewage sludge ash (SSA) in agriculture, land reclamation, or as a component in building materials [2, 3]. However, if the acidic environment affects the waste, the transition of heavy metals into a soluble form and their migration into the environment becomes possible. For this reason, due to the high content of heavy metals in the SSA of the Vodokanal of St. Petersburg, the supervisory authorities do not recommend the beneficial use of ash, despite the established IV hazard class. The continuous growth of waste generation, which is accompanied by a shortage of free space for its storage, determines both the relevance of the study and the interest of the Vodokanal St. Petersburg in actively addressing the issue of ash disposal.

The study focused on the topical issue of sewage sludge utilization with the prospect of using waste in the national economy. The purpose of the study is to assess the possibility of beneficial use of sewage sludge. The practical significance of the study is the development of the SSA-based organic-mineral mixture taking into account the possibility of its further use for the improvement of urban areas and land reclamation. The scientific novelty of the study is the establishment of a positive effect, which has the introduction of incinerated sewage sludge ash (SSA) within 20% by weight as a component of the waste-based soil mixture (at the rate of 28.53 t/ha per year), on plant growth (by example *Trifolium praténse*). SSA-based soil mixture can be used as fertilizer for planting trees along the roads, for recultivation of disturbed lands, slopes of roads, landfills for municipal solid waste. All of these ways are extremely relevant in the metropolis. In the long term the use of product has a significant resource saving effect by recycling waste and reducing the amount of initial soil required for reclamation processes, as well as the economic benefit, because the cost of wastebased soil mixture is significantly lower than the market value of soil. The study is realized on the basis of laboratory and experimental base of the accredited Center for the collective use of high-tech equipment of the Saint-Petersburg Mining University.

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LIQUIDATION OF THE URANIUM MINE ROŽNÁ I IN DOLNÍ ROŽÍNKA

Liquidation of the mine Rožná I in Dolní Rožínka is a topical issue, because in 2017 was the extraction of uranium oreterminated and the deposit will have to bedisposed of to terminate all mining activities in this locality.

At present, the uranium mine is no longerused, but mining area is still used for non-mining activities of predominantly research character. Once a mining area is not used, the mine goes into the liquidation. Liquidation starts by stopping the pumping of mine water and the mine is being gradually flooded. The uranium mine, as s non-gaseous mine, will be disposed by the complete back filling of the introduct orymining works to the surface, with unpaved backfilling material. After filling up the introductory mining works, a pit headatashaft topisbuilt. Pit headisthen secured against unauthorized intrusion.

In thenext part, I dealwiththeproblemof mine water during gradually flooding. At present thre evariants of flooding are created. These variants are strictly related to using of mining area for non-miningactivities. During the flooding process, there will be change in water chemistry due to the dissolution of oxidising minerals from the old mine workings.

In the last part I briefly discuss the decontamination of mine waters. Once the deposit is flooded, mine water will be pumped and cleaned for certain time horizon. When water contamination will no longer exceed permitted limits and the water will be freely discharged into the local water line with no previous cleaning.

There sultis a proposal for the liquidation of the deposit by the back filling of introduct ory mining works and the subsequent assumption behavior of the deposit during flooding and after stopping all mining activities at the given location.

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PROJECT WORK WITH PUPILS AIMED AT INCREASING INTEREST IN ENVIRONMENTAL PROTECTION MEASURES

Social media platforms have established themselves as an elementary part of people' s social lives worldwide [1]. Russia's inhabitants are one of the most active groups among social media users by global comparison [2]. In Germany, 97.6 % of 14 to 19-year-olds are online every day [3]. Consequently, social media have a major impact on the reality of life of children and young people; on the other hand, topics such as nature, environment, biodiversity and the extraction of raw materials are scarcely discussed. As a result, researchers are calling for consistent and interdisciplinary communication of biodiversity and sustainability in school education [4, 5, 6].

SOCIAL NATURE is a project that meets this demand and furthermore includes the use of social media to increase the audience. With the help of personalised social media storytelling, teenagers accompanied the life of a bird. The adolescents' predominant interest for social media was used to motivate them to increase their knowledge about raw materials/energy and nature/environment. Their content was based on their own research, on-site observations at a local quarry and expert interviews, emphasizing personal access to the relevant knowledge.The pupils presented the gathered information in class and using Facebook and Youtube in an informative and entertaining manner and thus reduced the existing gaps in knowledge for themselves and for the specific target groups reached by their social media activities.

The project resulted in a verified increase in knowledge and interestin the areas of raw materials / energy, nature / environment and digital / social mediaamong the participating pupils.SOCIAL NATURE therefore proved that biodiversity, environmental protection and raw material extraction are not fundamentally uninteresting topics for adolescents if they are illustrated using specific examples and communicated in a way that is appropriate for the target group

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REMOTE SENSING OBSERVATIONS SENTINEL-2 AS A SOURCE OF INFORMATION ON NATURAL GAS LEAKAGE

Major natural gas pipes are part of critical infrastructure that is of special attention to the authorities. However, most of the time this infrastructure was built in 80's and some may leak. The major reasons for leaks are aging and accidents. If these leaks are large or undiscovered for a long time, large quantities of explosive gases can develop in the soil, giving rise to potentially dangerous situations. It is known that natural gas in the soil affects vegetation health and reflectance. There is a hypothesis that variations in vegetation reflectance could serve as an indicator for a gas leakage [1].Previous research, carried out by Smith, Steven and Collins in 2005 has shown that high values of the ratio of red and green spectral bands may indicate that plants are poisoned with a natural gas [2].

We have investigated the possibility of using spectral data obtained from the Sentinel-2 constellation to detect gas leakage from the gas pipelines. We decided to use these data because of their availability, high frequency with which data is collected for the area and high resolution of the data [3]. Knowing the place of the recent gas pipeline explosion in MurowanaGoślina in western Poland, we examined the variability of the red to green band ratio for satellite images of this area from the year before the explosion. In addition, we make a second study for the gas pipeline in which the pipes were replaced. We investigate how the tested ratio was changing in this area a year before the renovation works, during the work and one year after the work. For comparison, we also obtained data from the flight of a drone with a multispectral camera mounted from the time when the work was carried out.

Based on the conducted research, we found an interesting relationship between the changes in the value of the tested ratio and the condition of the vegetation.

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ENVIRONMENTAL SAFETY MANAGEMENT BY THE OPERATION OF OBJECTS OF THE MINERAL RESOURCE COMPLEX

Environmental safety management is an integral part of national security. Ecological safety is the state of protection of the environment, life and health of citizens from threats arising as a result of anthropogenic influences, as well as factors, processes and phenomena of natural and technological hazards [1]. Mining and chemical enterprises have the following number of factors that affect the state of the environment adversely such as depletion of natural and energy resources, subsidence of the earth's surface as a result of mining, the formation of a significant amount of tailings with the alienation of land for their storage, emissions and discharges of pollutants into the environment.

JSCBelaruskali (Republic of Belarus) is one of the world's largest producers of potash chloride. The company conducts its own environmental policy to manage environmental safety, according to which it is obliged to approve and implement measures of annual and prospective environmental protection programs, as well as to reduce the environmental impact of production and use natural resources rationally, conduct environmental monitoring to obtain information on the effectiveness of environmental protection measures, the state of the environment and its objects: atmospheric air, surface and underground water, soils, etc.The activities aimed at reducing the negative impact on the environment include increased use of selective mining of mine fields, engineering protection of land, settlements and industrial facilities located in the undermined area, halite waste storage, the introduction of highly efficient methods for cleaning chimney gas and the conversion to natural gas of fuel-consuming installations of the company; reuse of aqueous wastes in the technical water supply of the company.JSCBelaruskali (Republic of Belarus) has introduced the ISO 14001 standard since 2002, which establishes the requirements for the environmental management system. This system is used in conjunction with the Quality Management System and the Occupational Health and Safety Management System. Such an integrated system proves that the environment, quality and industrial safety are given strategic importance in achieving production efficiency, reducing production costs and the stable position of the company in the world market [2].

But there are some unresolved environmental problems at the same time. For example, there is an acute need for recultivation of lands for JSCBelaruskali (Republic of Belarus), which is not carried out by it. As a result terriconesare formed. Effective events are held by the USA, Poland and Germany in this field. The application of the method of metal extraction by using an electrostatic separator would also significantly increase the effectiveness of environmental policy. Using this method, the rock is crushed to a state of powder and spilled between two electrodes under high voltage.

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INVESTIGATION OF ANAEROBIC DIGESTION PROCESS FROM PHALARIS ARUNDINACEA WITH SPECIAL FOCUS ON GERMANIUM AND RARE EARTH ELEMENTS IN DIGESTATE

Germanium and rare earth elements (REEs) are very valuable raw materials. The demand of the industry is rising steadily because they are being used in high-tech products. It is predicted that the germanium market will grow at an annual rate of 7% over the period 2018-2022 and demand for rare earths will increase by 3.9% from 120,000 t in 2014 to 150,766 t in 2020. Unlike other raw materials, Ge and REEs occur widespread in soils with concentrations comparable to some essential elements.

Therefore, a promising way to improve supply of these elements is phytomining. Phalaris arundinacea (Reed canary grass) may offer the opportunity to get the elements from soil. This perennial, herbaceous and fast growing plant shows high biomass yield coupled with a moderate to high accumulation potential of these target elements.

The aim of this study was to evaluate process for biogas production from Phalaris arundinacea with focus on the recovery and enrichment of germanium and rare earth elements in the digestates. In a lab-scale experiment hay from the genotype PX 9160013 was used for biogas production in anaerobic digestion (AD) process in a continuous reactor at pH 7-7.3 and temperature of 39 . The effect of different organic loading rates (different mixtures of hay with water and cow manure) on biogas production, methane yield, element amount and concentration before or after AD were studied. The used biogas-digestate was obtained after the anaerobic digestion and concentrations of trace elements were analyzed by ICP-MS. In continuous reactor, anaerobic digestion process affects the biogas production at different organic loading rate. In this study biogas production was 1.64 $m^3/(m^3FV*d)$ and methane yield was 0.33 $m^3/kgVS$ which means 63.8 vol % methane. Increasing the organic loading rates from 20/80 (manure/hay) to a ratio of 40/60 lead to increasing biogas production. Due to the high concentrations of both Ge (0.96 µg/g) and REEs (12.26 µg/g) in the manure used in the experiment, increasing the ratio 40/60 of hay/manure lead to decreasing concentrations of these elements (Ge 0.46 µg/g and REEs 1.6 µg/g) in the digestate. Concentrations of both Ge and REEs were significantly increased by a factor of 2-3 in the digestate and this increase clearly depends on the organic loading rate.

Moreover, the higher the organic loading rate (ratio of hay/manure) the higher was the enrichment of the elements in the digestate, possibly due to differences in the availability of the substrates to microorganisms and changes in the chemical binding forms of elements in the digestate. However, we also observed markedly losses of roughly 50% of the elements during the processes. Based on this, ongoing studies aim to optimize the processes with regard to elemental recovery, enrichment, biogas production and identification of changes in chemical binding forms of the target elements in the digestate.

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METHODOLOGY FOR ASSESSING SURFACE HYDROCARBON DISSIPATION

Abstract

The work presents and validates the methodology for assessing surface hydrocarbon dissipation which is observed in the vicinity of natural sites and technological facilities. The results of the application of this methodology can be employed in the assessment of the potential environmental risks, the degree of environmental pollution, the influence areas of pollution, etc. and in taking adequate actions to prevent possible emergency situations.

Introduction

Surface hydrocarbon dissipation is observed in the vicinity of existing or potential oil and gas accumulations, natural gas repositories, gas pipelines, drilling facilities and other equipment. An important task is the analysis and assessment of the potential risks of dissipation caps being attached to or near the above natural and technological facilities. This task is based on the selection of appropriate research methodology in order to obtain timely information and to take adequate action to prevent possible emergency situations. It is known that hydrocarbon gases of the methane homologous series (methane, ethane, propane, and butane) can be found at a depth of 0.7-1.0 m (Hant, 1982, Deshev, 1991, Peeva, 2012, etc.). The hydrolysis of the organic material sedimented in the precipitate occurs in this range of depth. Methane is generated under reduction conditions after performing various fermentations. The formation of precipitate is controlled by a number of factors some of which are related to the hydrodynamic activity of surface water, the size and the relief of the bottom of the basin, etc.; others are pre-determined by the particle size of the precipitated material, the precipitation rate, the degree of conversion, the type of soil cover, the degree of anthropogenic impact, etc.

The isolation and determining of the number of specialised alkane-oxidizing bacteria has been used as an indirect method for the study of hydrocarbon accumulations (Davis, 1967, Wagner et al., 2002). Short chain hydrocarbons, like ethane, propane and butane, can be used by a large number of bacteria (*Mycobacteria, Flavobacteria, Nocardia* and *Pseudomonas*). The microbial oxidation of ethane, propane, and n-butane takes place step by step, initially to alcohols, then through aldehydes, and finally to acetate which can be assimilated into the cell material. In performing the research activities and in the assessment of the results, the background values of methane in the atmosphere and its change over the years should be taken into account. In terms of the content of gas hydrocarbons on the surface, various criterial indicators and numerical expressions are employed as background values (Howard Mc.Carthy, Reimer, 1986; Ванисов, Клопов, 2005; Stolp et al. 2006; Глаголев, 2016). The former are determined by the specific geological parameters and technological features on the studied territory (e.g. the degree of study of the explored area, the presence of tectonic disturbances on or near the surface layer, the density of the boreholes, etc.). The values of deviations from the background hydrocarbon content vary from several hundred to several thousand ppm. An important element in the research process is determining the genesis of hydrocarbon gases - biogenic (natural rot) or abyssal.

Methodology

Because of the specific properties of gas hydrocarbons and their ability to dissipate over long distances, the gas chromatography and the microbiology methods are suitable for detecting anomalous content of n-alkanes in the surface layers. The methodology of conducting the gas chromatographic method comes down to quality and quantity determination of the amount, composition, and distribution of hydrocarbon gases. For this purpose, the gas chromatograph SCION 456-GC, Bruker is used. The tests include a selection of gas and gas probes from the soil taken at a certain depth (through the special AMS GVP Gas Vapor Probe Kit and the AMS 2 1/4 Professional Soil Sampling Kit, respectively) and the study of their free and adsorbed forms of presence. Sampling is carried out at a predetermined sampling depth. The material is placed in two separate sets: ground and gas samples. The containers for the storage and transfer to the special chromatographic laboratory are vacuum sealed vacutainers with a volume of no less than 10 ml. A methodology has been developed (Zaneva-Dobranova et al., 2017) for the preliminary preparation of samples and for their extraction. This methodology makes it possible to reliably determine the C_1-C_5 content and the subsequent processing of the obtained chromatograms (Fig.2) by means of specialised software. The final result is the building and modelling of maps of the anomalies of distribution and excessive pollution with hydrocarbon components in the surface layers (Fig.3).

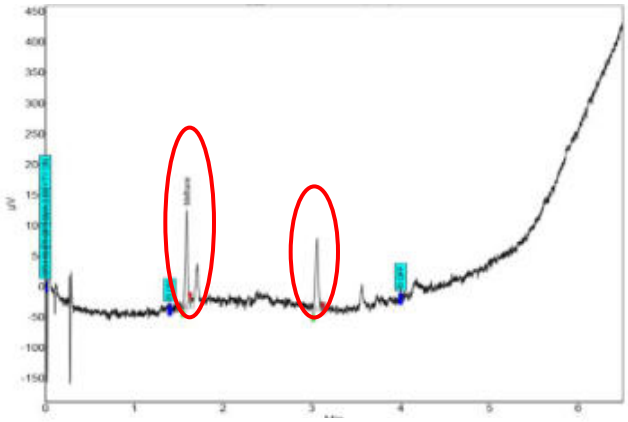

Fig. 2. A typical chromatogram of conducted studies

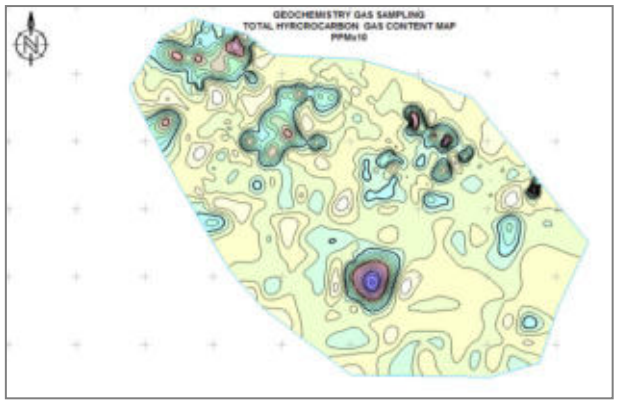

Fig. 3. Example visualisation of the results from the geochemical photo

The identification of the bacteria that oxidize n-alkanes with a chain length of 2 to 8 carbon atoms without a period of adaptation indicates the presence of short-chain hydrocarbons in the soil samples studied which is indicative of the abyssal nature of the hydrocarbon. Determining the number of ethane/propane/butane-oxidising bacteria is conducted by counting the colonies that have grown on solid nutrient media. Molecular and genetic methods are used for a more detailed identification of C_2-C_5 oxidising micro-organisms.

Conclusion

The methodology for assessing surface hydrocarbon dissipation is based on: the choice of the right areas to determine the type and nature of natural sites and technical facilities; the establishment of dependencies between the landscape and the overall background content of hydrocarbons; the assessment of the degree of change in the background content and the effect of anthropogenic

factors on the genesis of hydrocarbon accumulation; working out the details of the type and genesis of hydrocarbon occurrences and assessing the possibilities for geometrisation of anomalies, gradation of risk, and forecasting of potential situations.

Practical applicability is possible in various spheres for action, such as: the rational management of strategic sites connected with hydrocarbon accumulations (underground gas repositories); the rational management and optimum development rate of well-established or potential hydrocarbon sites; sites and facilities associated with the transportation of hydrocarbon products; the assessment of the possible negative impact following earthquakes in areas with proved or potential of hydrocarbon accumulations; the degree of environmental pollution; the zones of pollution impact, etc.

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RESERVOIR ROCK PERMEABILITY PREDICTION USING IMAGE ANALYSIS AND INTELLIGENT SYSTEMS

Characteristics of reservoir including permeability play an important role in management and development of hydrocarbon reservoirs. hydrocarbon production depends on reservoir permeability. There are many ways to determine permeability. Laboratory measurement and well testing are not only time consuming, but also very expensive. Intelligent systems are suitable method to predict permeability without time consuming and high cost. Utilizing image analysis is another way to predict permeability. Also, integrated intelligent systems and petrographic image analysis have been used.

This study includes two main parts. In the first part, petrographic image analysis was employed to measure the types of porosity including intergranular, intragranular, moldic, micro and optical, amount of cement, calcite, dolomite and anhydrite, type of texture and mean geometrical shape coefficient of pores from thin sections of well A. Then, three intelligent systems were used to predict permeability. Two types of committee machine with intelligent systems were used to improve the accuracy of prediction.

In the second part, the NMR permeability was compared with the results of the first part. The NMR permeability of well A was unavailable. Thus, a deep neural network was constructed with the information of well B including GR, NPHI, PEF and RHOB logs as inputs and NMR permeability as output. This model was used for prediction of NMR permeability in well A. The calculated R between the core permeability and predicted NMR permeability shows that the predicted NMR permeability have a good correlation with core permeability. So, the predicted permeability from image analysis and intelligent systems were compared with predicted NMR permeability.

Comparing the results of the first step with the core permeability and predicted NMR permeability, shows that the integration of petrographic data and intelligent systems performed well.

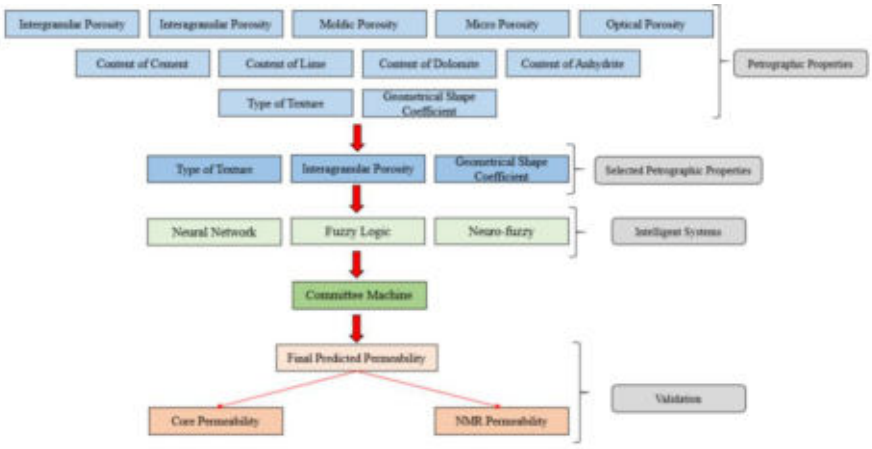

Figure 1. Graphical representation of workflow

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INCREASING ENERGY EFFICIENCY OF OIL PRODUCTION OF WELLS WITH HIGH FREE GAS CONTENT

Well operation in conditions of complicating factors imposes increased requirements to the choice artificial lift technology of oil production. Stable operation of electric submersible pumps with high free gas content becomes problematic [1].

The purpose of this work is to develop technical and technological solutions to optimize the process of energy-efficient oil production from wells equipped with ESP.To achieve this aim, methods of mathematical modeling were used with their subsequent confirmation using additive design systems and full-scale experiment.

Various options for layouts of submersible pumping equipment are considered, taking into account the assessment of the most energy-efficient mode: ESP with centrifugal stages, ESP with centrifugal-axial stages, ESP + jet pump, ESP + by-pass valve, ESP + jet pump + by-pass valve. The optimal variants of downhole equipment for oil production with high free gas content are revealed.

To achieve the aim were set and performed the following tasks:

1. To analyze the scientific literature on existing ESP structures
2. To simulate the interaction of the elements of the pump with the flow of the pumped liquid.
3. To produce laboratory samples of tested stages using additive technologies.
4. To develop a program and conduct laboratory studies of designed pumps.
5. To process and summarize research results.

The performing of the tasks allowed us to conclude the following: the use of electric submersible pumps with centrifugal-axial stages is the most effective option for the production of reservoir fluid with high free gas content. It will also allow to use gas lift, which, consequently, will reduce the cost of oil produced [2].

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SIMULATION OF ORGANIC SOLIDS FORMATION PROCESS IN HIGH-WAX FORMATION OIL

Nowadays, the international petroleum industry is characterized by increasing in wax, asphaltenes, resins content of oil and other problematic factors, which have been causing a considerable amount of obstacles for petroleum engineers and operators working in oil fields. As a result, oil production is continually accompanied by organic precipitation on the surface of the downhole apparatus, and on the sidewalls of wells, and processing system [1]. Wax deposition and its crystallization are considered serious problems during production, exploitation, and transportation, resulting in obstruction of flow strings, formation damage as well as loss of hydrocarbons. Eventually, they lead to dramatic reduction in production and demand a great deal of workforce and money to handle the problems. There are some circumstances and factors resulting in wax deposition such as a decrease in temperature below the wax appearance temperature (WAT), pressure changes, temperature cooling rate, changes in oil composition, surface roughness, the concentration of paraffin, the molecular mass of paraffin, water cut and water-oil ratio [2,3].

Detailed design of production systems is required to improve the efficiency of oil production and exploitation. The novelty of this paper is to provide a detailed study of the effect of oil blend composition on conditions and nature of wax deposition based on a developed formation oil model. In addition, this work also proposes a phase equilibrium diagram for given conditions, which play a pivotal role in predicting and measuring wax formation.The paper presents the results from the modeling of organic depositsformation, through the processes of simulation using the PIPESIM software together with Multiflash Wax module.

The work studies the effect of high-wax oil components on conditions and nature of wax solidification based on the developed formation oil model. Plotting of the phase diagram of the hydrocarbon system allowed us to determine the value of the WAT, which was confirmed by laboratory studies. Changes in the molecular mass of organic deposits during wax crystallization were obtained. It was established that an increase in the content of hydrocarbon gases (methane, ethane, and propane) leads to an earlier transition of wax to the solid phase. The remaining hydrocarbon components from butane to nonane, on the contrary, act as solvents, slowing down the process of wax formation, and with an increase in the number of carbon atoms, their effect on the system increases. Furthermore, with an increase in the content of non-hydrocarbon gases in the oil (nitrogen, hydrogen sulfide and carbon dioxide), a slight increase in the wax appearance temperature can be observed, that can be compared with the effect of ethane.

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ESTIMATION OF THE IN-USE LIFE OF WELDED SEAMS OF PIPELINES BY THE METHOD OF ACOUSTIC EMISSION

Our country has one of the largest pipeline networks in the world. Meanwhile, an average period of working lifespan is near the service lifetime or even longer than it. Since a complete replacement of grid in the short time is out of question, a need to estimate residual in-use life arises. For the realization of it a relevant and reasonable method of receiving primary information and interpretation of it must be used. Nowadays, only risk assessment of defects [1] is performed.

Following the kinetic failure theory [2] a process of failure is dependent on developing microscopic flaws. They grow in quantity in a volume of a material and unite in clusters of that level. Afterwards, there are clusters that grow and unite in the next level and so on until an object breaks apart. Primary measurement parameters could be related with a concentration of microscopic flaws using the multilevel model of acoustic emission [3]. It also incorporates an inhomogeneity of strength of structural elements in the object. These points make it possible to estimate residual in-use life.

An integrality of acoustic emission method itself is one of the most important advantages in comparison with other methods.

In the article, an observation of a possibility of the use of the acoustic emission method for estimation of residual in-use life of control object is accomplished. For example, a data of experimental destruction of steel specimens with defects in their welds [4]was used. Correlation index of expected load of failure with the achieved one is 0.9. That indicates a large potential of practice of the method for estimation of an in-use life of objects.

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RESTRAINING OF WATER SUPPRESSION IN HORIZONTAL WELLS AFTER MULTISTAGE HYDRAULIC FRACTURING

It is no secret that at this development stage of the oil industry is the solution to the extraction problem of hard-to-recover reserves (HTR reserves) of petroleum, due to the fact that the "light" oil is almost gone.

Modern approaches to the intensification of oil production from deposits is reduced to the construction of horizontal wells. The multistage hydraulic fracturing (MHF) is carried out to achieve the maximum filtration connection of the horizontal wellbore with the reservoir.

Water seepage is one of the disadvantages of MHF, which there are still despite all the advantages. Often this problem[4] is found in the first third of the horizontal section of the well and is associated with the formation of an aquatic cone. Another cause of water inflow is the result of incorrectly constructed cracks and its propagation to the water bearing bed.

A technique that allows to determine a specific interval of Water seepage in MHF is the use of a marker pumped individually into each interval or the installation of containers with indicators. On the surface the intervals are personalized by sampling, the water seepage and intensity of their interval are identified.

Two solutions are suggested to trim water flowing interval:

1. Cementation interval flowing. For this purpose,[1] selected in laboratory conditions polymeric reagent SCA-308-B. Cementing carried out from cementing glasses to the head using a selective packer and retrievable bridge plug (RBP). The density of this reagent is 1160 kg/m3. SCA-308-B has a fine structure. The viscosity of the reagent 23.5 centipoise.
2. Restriction of water inflow by means of a water-shutoff agent. As this agent, a gel-forming liquid "Polytech PR" can be used, followed by its destruction in the wellbore area with the help of a destructor. Gelation of the liquid couches in the time interval from 24 to 72 hours.Crosslinked have a long "life time"[3] and very low syneresis.

Thus, this technology limits water consumption, provides high efficiency and allows you to create a reliable water barrier.

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JUSTIFICATION OF A METHOD FOR REDUCING NATURAL GAS LOSSES AND DISPOSAL OF ITS ENERGY BASED ON DETANDER-GENERATOR ENERGY DIVIDEING DEVICE FOR GDS

One of the most important problems in the operation of gas pipelines is the formation of gas hydrates. This leads to the formation of condensate in the form of gas hydrates, a solid snow-like mass that can accumulate inside the gas pipelines, reducing their flow cross-section, and affect the efficiency of the valves. As a result, an emergency stop of the pipeline operation may occur. The costs of oil and gas companies to prevent and eliminate gas hydrate plugs constitute a significant part of the cost of transport and distribution of gas.

The study presents the topical problem of resource and energy saving in the system of transport and distribution of natural gas and proposed a method for its solution based on the introduction of an energy-separation device (ESD) at the gas distribution station (GDS).

The traditional ways of dealing with hydrate formation in the GDS include: general or partial heating of gas; local heating of pressure regulator housings; input of methanol in gas pipeline communications. These methods require external sources of energy and resources: gas for combustion, electricity, methanol.

The use of ESD will allow the gas to be heated by utilizing pressure energy. Based on the analysis of existing methods of energy separation, the Hartmann-Sprenger effect was chosen as the most effective in obtaining high temperatures. Laboratory studies of other authors have shown the possibility of obtaining temperatures several times higher than the initial one [1]. The effect is based on the heating of the gas at the bottom of the muffled cavity, which occurs due to the appearance of resonant pulsations in it under the influence of a high-velocity gas flow to the cavity entrance. Two flows are obtained at the outlet: heated and cooled [2]. Upon their subsequent mixing, it is possible to obtain the effect of quasi-isothermal reduction. This is a phenomenon in which there is a decrease in pressure with a mixture of hot and cold flow, ensuring the constancy or increase in the gas temperature at the outlet of the device.

To implement the method of gas preheating based on the Hartman-Sprenger effect, a scheme of a reduction unit has been developed, consisting of a resonant ED, detander-generator, a control valve and measuring and control devices.

The efficiency of obtaining thermal energy by the resonant method is confirmed by numerical simulation in the software product ANSYS FLUENT.

The development of this study will allow to approach the creation of an autonomous gas-distributing station capable of independently generating electricity for its own needs and associated gas heating to prevent hydrate formation.

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THE SAFETY OF FIXED PLATFORMS LOCATED ON THE CONTINENTAL SHELF: LEGAL ISSUES

The 1969 Report of the UN General Secretary noted that 125 fixed platforms were used in offshore areas for the purpose of the oil industry. “The International Law of the Sea” published in the United Kingdom in 1994 provides that “approximately 6000 fixed platforms have been installed in offshore areas throughout the world”. In 2014 more than 1300 offshore constructions were installed. As for April 2019, 184 constructions are in the North Sea, 175 in the Gulf of Mexico, 159 in the Persian Gulf, 152 of Far East Asia, 152 Southeast Asia, several fixed platformslocated in the Russian Federation. [1]

The Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation is a multilateral treaty by which states agree to prohibit and punish behaviour which may threaten the safety of maritime navigation. [2] The 1988 Protocol for the Suppression of Unlawful Acts against the safety of fixed Platforms located on the Continental Shelf states that for the purpose of the Protocol “fixed platforms” means an artificial island, installation or structure permanently attached to the seabed for the purpose of exploration and exploitation of resources or for other economic purposes and treats them in the same manner for the purpose of the suppression of unlawful acts against their safety.

As it is known, in 2012 Greenpeace activists have climbed aboard Prirazlomnaya offshore ice-resistant stationary platform in the Pechora Sea, offshore Russia. And if the Russian Federation were a party to the mentioned international treaty and ratified the Protocols to it, the case of Arctic Sunrise could have other consequences for the Gazprom Neft. All things considered, the Russian Federation should take measures on implementing theseActs into national legislation. [3]

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DESIGN OF DIGITAL TWIN FOR OIL WELLS, COMPLICATED BY SCALING AND REMOVAL OF SOLID PARTICLES

Today, there are many mathematical models of various oil field equipment, as well as the productive formation and fluid movement along the well length. However, these models are not suitable for creating a full-fledged digital twin of the “productive formation –oil well –oil-well pumping unit” system. The reason is that these models are not consistent. For example, pump models do not take into account time-varying geological formation data.

Based on the above, the development of methodological solutions for the creation of "smart wells" and "smart fields" based on the principle of "digital double", the operation of which is complicated by the removal of salts and / or mechanical impurities, is an important task[1,2].

To create a digital twin of the “productive formation –oil well –oil-well pumping unit” system, methods of mathematical modeling were used with their subsequent confirmation using additive design systems and full-scale experiment.

The laws of motion and interaction of solid particles, scale and formation fluid are formulated for various geological formation data. The patterns of scalingin the well and in oil-producing equipment are determined. The patterns of degradation of pump equipment characteristics are determined. This allows us to determine by calculation the time to failure, the residual resource and the definition of the life cycle scenario of oil-well pumping units. A system for the determination of scalinghas been created. Over the past year, this system has been implemented in 50 wells.The result of the work was the method of creating a digital twin of the “productive formation –oil well –oil-well pumping unit” system.

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THE EXPERIENCE OF USING DRILLING FLUID WITH LOW DENSITY FOR THE OPENING OF PRODUCTIVE HORIZONS WITH ABNORMALLY LOW FORMATION PRESSURE (ALFP)

When opening productive horizons with abnormally low reservoir pressures due to increased repression, there is a reversible and irreversible decrease in the natural permeability of the reservoir, there are difficulties in calling the inflow, which leads to a decrease in the flow rate of wells[1].

In this regard, the task of preserving the natural permeability of productive layers in the development of low-yield low-pressure fields characterized by abnormally low reservoir pressures (ALRP) is the most urgent. The opening of layers in terms of work over traditional drilling fluids have increased repression, became widely implemented gaseous, foam agent and aerated liquid. But the use of foams and aerated liquids requires special technological equipment, high energy and materials costs[2]. In this regard, it became necessary to develop an affordable and effective formulation of low density drilling mud, providing trouble-free wiring and completion of wells. This paper proposes a formulation of a water-based drilling mud with a density of 0.85-0.95 g/cm3. The low density value provided by the content in the solution as the dispersed phase of aphrons. Aphronsare a microscopic gas bubbles with a diameter of 20-100 microns.,in which the gas-liquid interface is a monolayer of oriented surfactant molecules, followed by a layer of thickened liquid and then a bilayer of oriented surfactant molecules, giving a hydrophobic character to the outer surface of the microbubble[3]. Due to the hydrophobic surface of the aphrons, the natural permeability of the bottom-hole zone of the productive formation is preserved, which is one of the main tasks in the opening of the productive horizon.

The proposed formulation of drilling mud has been tested in the oil fields of the Republic. Pilot tests were carried out on the use of aphron-containing washing system at the opening of productive horizons. Based on the analysis of the data obtained, the growth of productivity and production rate of wells, reduction of water cut and preservation of the natural permeability of the formation was established. Reduced costs, time for construction and development of wells. The obtained positive effect from the use of aphron-containing washing liquid makes it possible to recommend this formulation of drilling mud when opening depleted horizons characterized by abnormally low reservoir pressures.

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POLYMER ADDITIVES AS A WAY TO INTENSIFY THE TRANSPORT OF VISCOUS HYDROCARBONS

The most effective way to transport hydrocarbons at the moment is the use of anti-turbulent additives (ATA). The largest manufacturers of ATA in Russia are represented by foreign companies - Baker Hughes. Under these conditions, the direction of import substitution is an urgent task. This paper describes the synthesis and laboratory testing of an anti-turbulent additive based on low molecular weight polymers. A comparative assessment of the effect of additives on a model liquid with industrially used anti-turbulent compositions has been carried out.

One of the most effective solutions is the introduction of polymer additives into the pumped stream. But, in connection with the individual composition of the oils of various fields, the use of a particular composition can be effective for one type of oil and not give positive changes on another [1].

The purpose of research is to develop and synthesize anti-tank drugs, according to the results of testing which the efficiency should be no worse than industrially used anti-tank drugs.The developed anti-turbulent additive was called NAVA7, and in this paper it will be voiced by this designation.[2].

Based on the results obtained, it can be concluded that the Baker Hughes additive has the highest value of the Toms effect and amounts to 13.31% according to the research methodology on the bench tests of the flow characteristics of hydraulic resistances. Additive NAVA 7 has lower efficiency compared with industrial design PTP and is equal to 11.02%.

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ESTIMATION OF THE EFFECT OF GEOLOGICAL AND TECHNOLOGICAL PARAMETRES ON THE EFFICIENCY OF RADIAL DRILLING TECHNOLOGY

At the fields of the Perm region, the largest amount of residual reserves is confined to carbonate reservoirs, which are characterized by heterogeneity and complexity of the geological structure. Development of complex reservoirs can be accompanied by various complications: a sharp decrease in production wells, premature water-cut of well production, low efficiency of the reservoir pressure maintenance system. To increase the productivity of oil producing wells and to involve in the development of undrained interlayers in the fields of the Perm Territory, radial drilling technology is being actively used. This method not only intensifies production, but also increases the degree of oil recovery of reserves, involving non-performing interlayers in production [1]. At the same time, radial channels can increase the productivity of wells 3-4 times. According to experience [2-3], RB technology is more effective in conditions of high-viscosity oils and low-permeability reservoirs, for which the formation of stagnant zones in low-permeable intervals of a geological section is most likely.

In this paper, the statistical methods revealed geological and technological parameters that affect the performance indicators (total additional production, average daily growth, operating time with effect) of the use of radial drilling. The highest efficiency was observed under conditions of a more inhomogeneous section, a greater energy potential of the reservoir and degraded parameters of the bottomhole formation zone.. According to the identified parameters, using a linear discriminant analysis, a statistical model was constructed to determine the increase in oil production in the first year after the application of the technology. The model showed a significantly greater convergence of the predicted results with the actual than the predicted production rate with the standard approach.

According to the presented methodology, prognostic calculations of technology efficiency parameters for the Perm Territory fields were carried out, and recommendations were made for the use of radial drilling on specific wells, results of statistical models are taken into account to improve the accuracy of prediction of hydrodynamic models.

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TO ANALYZE THE ELECTROTHERMAL EFFECT ON THE BOTTOMHOLE FORMATION ZONE

In the process of gas condensate field development and operation there is a decrease in the production well bottom-hole flow pressure. When the bottom-hole pressure drops below the dew point pressure condensate accumulates in the bottom-hole zone of the well, which leads to a formation of the condensate front. This process occurs prior to the dew-point pressure (the pressure at which retrograde condensation stops and with further decrease in the formation pressure the process of direct evaporation of unstable gas condensate dropped out in place occurs [1].

Simulation of the gas condensate system phase behavior is carried out in a phase equilibrium unit with isothermal pressure reduction by a constant volume depletion method (CVD). The method implies the following: at each stage the reduction is firstly achieved by increasing the volume of the working chamber, establishing phase equilibrium and further releasing the gas phase at a fixed pressure until the volume of the working chamber becomes equal to the initial volume [2-4].

In the PVT cell, there is a description of the phase behavior of the formation system without taking its motion into account. However, under real conditions, filtration is accompanied by qualitative and quantitative changes in the fluid moving from high pressure zones (external reservoir boundaries) to low-pressure zones (recovery zones).

The release of high-boiling components from the vapor-gas phase leads to an increase in retrograde condensate saturation and a decrease in phase permeability for gas (Figure 3), which in turn affects the well production capabilities and leads to a decrease in production rates.

There is a wide range of methods to control retrograde condensate accumulation in place. A significant portion of them has only a theoretical description or a singular introduction into field experience. Apart from positive aspects the below methods have a significant number of disadvantages, the efficiency of which is strongly dependent on both the pay zone and the fluid saturating it.

Many of the proposed methods are costly and short-term by their efficiency. The method consisting in periodic heat treatment of bottom-hole well zones will allow increasing the duration of well operation till its complete retirement from the production well stock.

Vaporization of condensate and its transfer into the gas phase can be carried out by electrothermic treatment of the bottom-hole zone. In this case it is necessary to use special equipment – a bottom hole electrical heater which heats near-well zone in the perforation interval.

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ANALYSIS OF WELL TESTING – WELL PR2, PRUŠÁNKY FIELD

Pressure transient well testing plays a significant role at various stages of well's life by assessing both reservoir and well performance.It provides the analyst with information about reservoir properties such as permeability, fracture length, reservoir extent and heterogeneities. Also, itoffers a useful tool to characterize the well itself by providing data such as well bore storage, formation damage, evaluation of the efficiency of completion, and evaluation of workover and stimulation treatments, etc.Many authors have contributed to the pressure transient tests literature, including Matthews and Russel (1967)[1], Earlougher (1977)[2]and Slider (1983)[3], introducing quantitative and qualitative methods to estimate the reservoir and well parameters mentioned above.Finding the most appropriate flow and boundary models that represent the actual reservoir and well behaviours remains one of the key challenges that face the analyst during the well test interpretation.

This paper deals with a pressure build-up test, carried out in a natural gas reservoir,developed by a single vertical well (Pr2). This reservoir belongs toPrušánky field, which ispart of Vienna basin, lying at the border between Austria and the Czech Republic. The goal of this study is to characterise the reservoir and well parameters and investigate selection of the flow and boundary models that correspond to this gas reservoir. Since the studied reservoir has been already depleted at the time of this study, it provided an opportunityto quality check the estimated OGIP of the reservoir (based on interpretation) by comparing it to the actual gas volume that has been recovered from the reservoir.

The paper shows the distinct stages of analysing the data measured during the pressure build-up test, using the Weatherford's Pan System software. This includes preparing pressure and rate data for analysisand using different graphs for data visualisation and interpretation such as type curves, log-log plot, semi-log plot, and test overview plot. This is in addition to simulation of the test behaviour using the interpreted reservoir and well parameters in order to check the validity of the interpretation.

The main outcomes of the study are: 1) estimation of important parameters such as reservoir permeability (125 mD = 1.234E-13 m^2) and skin factor (+6). 2)The positive estimated skin indicated formation damage that might be decreased by acidizing the well and in turn increasing the well´s deliverability. 3) Comparing the estimated OGIP of the reservoir(16.9 MMm^3 of gas) to the actual gas volume that has been recovered from the reservoir untildepletion(14.53 MMm^3) showed thatselection of a two-cell compartmentalized reservoir model instead of a closed system provided better estimation of gas in-place.

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LABORATORY STUDIES OF THE INTERACTION OF HYDROCARBON GAS AND RESERVOIR OIL FOR MINIMIZE THE RISK OF PROJECT IMPLEMENTATION MISCIBLE DISPLACEMENT

The effectiveness of EORbased on the injection of gas into the reservoir depends on the physical and chemical processes of interaction of reservoir oil and reagent, what essentially distinguishes them from other method.The main risks associated with the processes of mass transfer and phase transitions of fluids are the lack of miscibility [1] and the possible of asphaltene flocculation initiated by the saturation of oil by light hydrocarbons [2]. The first can lead to possible gas breakthroughs in production wells, which will have a catastrophic impact on the technological and economic indicators of the project's efficiency.The second is capable to lead to formation damage up to the complete loss of hydrodynamic communication in the "reservoir - well" system. Thus, the laboratory researches directed to selection of optimum composition of injected gas are necessary for development of the project of the miscible displacement.

The paper presents the results of studies of the interaction of reservoir oil from Western Siberia fields and associated hydrocarbon gasby their mixing–a swelling test.Were determined dependence of: bubble point pressure; swelling factor (the coefficient characterizing increase in volume of oil at dissolution of gas in it); compressibility factor; density and viscosity of reservoir oil from concentration of hydrocarbon gas [3]. The results of the phase behavior of asphaltenes in reservoir oil are presented by the number and size of the formed solid particles, the weight content of the destabilized solid phase on the stages of the swelling test.

The research results were used to adjustment the EOS of the composite fluid model when modeling the gas injection process in the geological and hydrodynamic reservoir model and also for assessment of the risks associated with the asphaltenes deposition.

The studies were carried out on the equipment of the Innovation and Technology Center of the Arctic oil and gas laboratory researches of the Northern (Arctic) Federal University named after M.V. Lomonosov.

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ENGINEERING DESIGN OF THE EJECTOR SYSTEM FOR LIQUEFIED NATURAL GAS (LNG) VAPOR DISCHARGE

In accordance with the safety rules that apply to all types of cryogenic tanks, there are numerous requirements related to their operating conditions. One of them is to ensure the discharge of liquefied natural gas (LNG) vapor from the storage facility through the gas discharge pipeline and safety valves. Such discharges are formed both periodically and in emergency cases [2].Dumping of the excess of LNG vapor phase, which becomes burnt in the flare, happens in case of the excess of surplus pressure relatively to nominal by the given number. This leads to significant losses of expensive fuel. In case the reservoir is equipped with treating iron, the separation of vapor phase excess is made by compressors, and that leads to additional energy costs.

Pump-ejector systems are suggested as an alternative to existing control and dumping systems. They are included into the treating iron of the reservoir in purpose of operational pressure maintaining by dumping the fuel to separator using the energy of high vapor phase pressure [1]. Such systems are distinguished primarily by simplicity, small capital investments and the absence of the need for additional expenditure of energy from outside. The purpose of using such systems is to reduce energy costs for operations on periodic and continuous discharge of vapors when filling cryogenic tanks and safe storage of liquefied natural gas (LNG) in them.

The theoretical calculation of the defining indicators was made to substantiate the effectiveness of the use of liquid-gas ejectors, according to which the most efficient aerodynamic scheme was chosen[3]. For a clear analysis of the results, the dependences of the mixture pressure at the outlet from the ejector, the reduced power and the efficiency of the ejection coefficient under consideration are plotted. According to the chosen scheme, the parameters of the ejector were calculated at the limiting and disruptive operating conditions of the liquid-gas ejector and a pressure characteristic was constructed. The calculation of the geometric dimensions of the flow part of the ejector is made and its design scheme is presented.

The effectiveness of the use of ejector systems is theoretically proven in the work. Also, the most efficient aerodynamic scheme of the flow-through part of the ejector unit was chosen, which will significantly reduce capital investment and energy costs in the construction and operation of cryogenic tanks.The efficiency and the principal possibility of implementing a method of vapor discharge with an embedded ejector is confirmed by computational simulation produced in the ANSYS software.

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JUSTIFICATION OF THE PARAMETERS OF THE SYSTEM FOR THE SPEED STABILIZING OF THE PISTON INTERNAL PIPE DEVICES

Natural gas contains a certain amount of impurities, which lead to the formation of deposit sin the form of complex compounds - hydrates. It depends on the composition of the gas. These deposits lead to an increasein hydraulic resistance in main pipeline sand,as a consequence,to a decrease in productivity. The most common method of hydrates removing is the lowering of the pressure below equilibriumat a given temperature, the increasing of temperature, the introduction of in hibitors, sublimation of hydratesand a combination of different methods. These methods have a lot of disadvantages, which associated with their energy and material capacity, low efficiency.

At the same time, for cleaning and diagnosis of oilpipelines we can use in-pipe devices widely,that move by the hydraulic energy of the product. These devices have high economic and environmental performances and provide a high guaranteed cleaning quality from paraffinic and resinous deposits [1-3]. The reason for using this method of gas pipeline cleaning is the high speed of gas flow (upto 25 m / s) and the ability of gas to accumulate energy. The ability of gas to accumulate energy with the using of the piston internal pipe devices in case of a temporary stop will lead to the acceleration of the device with subsequent destruction of the system elements.

The good decision for using of piston internal pipe devices for gas pipelines is the creation of a system for stabilizing the speed of motion. The main purpose of this system is to prevent the device from stopping and excessive over clocking.

The main of this study is to develop and argue of the parameters of the system for the speed stabilizing of the piston internal pipe devices.

For the solution to this problem was developed a mechanical system for speed stabilizing, them ain elements of which are: the mechanical energy battery, the multiplier and the wheel drive. The peculiarity of this system is the partial selection of energy of transport edgases. The partials election of transmitt edgas energy may reduce the speed of the piston internal pipe devices to 1-2 m/s.

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ANALYSIS OF EXISTING MATHEMATICAL MODELS FOR ESTIMATING THE RATE OF EROSION AND CHOOSE MORE APPLICABLE MODEL FOR THE CONDITIONS OF GAS FIELDS IN THE WESTERN SIBERIA

At the design stage of gas networks, only the corrosion rate is taken into account, but this does not suggest that the process of destruction of the internal parts of the pipeline. The erosion process must be included in the calculation.

In domestic practice, the process of erosion wear is regulated by the flow rate of the transported medium (20 m/s) [1]. The regulation of the speed of the transported medium imposes certain restrictions on the volumes of produced products, which in turn directly affects the economic efficiency of the project. However, there is an alternative way to control the erosion process. In foreign practice, this is done by controlling the rate of erosion rate, which should not be exceed 0,1 mm/year [2].

At the gas fields in Western Siberia, the issue of developing a method of safe operation of wells, in particular, to combat erosion wear and tear of the pipeline. The erosion process is rather complicated due to the large number of parameters it contains: the flow rate of the formation fluid, the velocity of the solid flow elements, the fluid properties, the sand properties, the size and shape of its grains, the material of the equipment walls, the geometry of the equipment. Therefore, it is necessary to consider the existing mathematical models for estimating the rate of erosion, in order to choose the most optimal.

The paper deals with such mathematical models for calculating the rate of erosion as:

1) Finnie's
2)Rabinowicz, E
3)API RP14e
4)McLaury, Shirazi
5)Zhang et al.
6)DNV RP O501
7)SPPS

A comparative analysis of the existing mathematical models for calculating the rate of erosion was carried out. And also, on the basis of actual measurements from the gas field, the convergence of analytical calculations with field data was determined, after that was choosing the mathematical model for calculating the rate of erosion, most applicable to the conditions of gas fields, was determined.

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DEVELOPMENT OF THE CONTROL SYSTEM OF THE FREQUENCY OF ROTATION OF THE GAS SUPPLYING AGGREGATE

Gas transportation is one of the main processes of the gas industry of Unified Gas Supply System of Russia. This process is described as gas pressure reduction. Compressor stations are used to maintain gas pressure to ensure the efficiency of the pipeline.

The gas supplying aggregates are the basis of the compressor station.The process of gas compression occurs in the gas supplying aggregate. Inthisway, pressure and flow are maintained at the required level in the pipeline. Researchforthe development of the control system of the frequency of rotation of the gas supplying aggregateare presented.

Centrifugal supercharger is the main element of the gas supplying aggregate. Socentrifugalsuperchargeristhepressureconverter.Compressor stations operate with increased load due to high fuel consumption in winter. This may cause supercharger surging.

Supercharger surge is a periodic abrupt change in its variables (rotation frequency, pressure at the inlet and outlet of the supercharger, axial shifts).This mode arises in connection with the loss of dynamic stability of the gas flow. Thiscausesvariousdamagetothesupercharger [1]. It is necessary to apply anti-surge protection and control to increase stability of the gas supplying aggregate.

The control of the frequency of rotation of supercharger is one way of anti-surge control [2, 4]. Research of the operation of the gas supplying aggregate with this control system in the surge modehas beenconducted. The reference model has been chosen during research. This model has non-linearities [3]. Computer modeling has been confirmed the adequacy of the selected model to the object. The research of the control system on stability showed that it has a margin of stability.

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AN INNOVATIVE WAY TO CREATE FRACTURING

An innovative way to create fracturing through the use of intermetallic compound is considered in this report.

Currently fracturing is the most efficient method to create a system of drainage in the area around a well. This process is very expensive so risks should be decreased to zero. Specialists say that the most dangerous effect of fracturing is an entering of proppant in the wellbore. It causes reduction of cracks width, decrease of potential well flowrate and a breakdown of electric-centrifugal pumps [1].

The proposed fracturing method occurs in two main stages. At the first stage a peripheral fracture part is filled with a small fraction of ceramic proppant. Huge proppant fraction is made from in-built intelligence material and change its form under action of reservoir temperature. It is pumped down at the second stage and forms a filtered layer in the crack of the fracturing [2]. Suspension with proppant flows through the production tubing to the created fracture and keeps the last one in an opened position. Displacement liquid is pumped down until suspension will be fully in the fracture. It can decrease the entering of proppant in the well [3].

As the result a recovery factor and productivity of the reservoir increase and complications that are connected with electric-centrifugal pump and proppant sediments are prevented.

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STRESS ANALYSIS IN STRUCTURAL ELEMENTS OF A CABLE ROD

A downhole pumping units with the cable rod (DPU with CR) is designed for use small and medium production wells with lateral trunks of small diameter. The unit consists of a pumpjack, sucker rods, a cable rod [1] which set in a place with intensive curvature's rate and special design pump. The cable rod reduce a probability of rod parted and tubing crash. It is a result increasing contact area and decreasing tension between tubing and pumping rods. The units with the cable rod exploite about 50 wells and today the actual task is an improvement equipments and an increase probability of failure-free operation [2].

Cable fittings is the most responsible part of the cable rod. They provide reliable connection the cable rod with sucker-rod string. The fittings consist of a locked-coil rope, two cone sleeve and wedge liners. Loading the rope the second cone bush presses on wedge liners which moving at the first bush fix the rope. The structure have to provide uniform loading of all wire rope. In the research was carried out stress analysis different construction of cable fitting in software package Solidworks. As a result is solutions of improving the construction.

Another important part of the cable rod is a rod joint coupling. It provides axial rotation a rod string and uses to prevent separation parts of rod string. Joint coupling is the part of rod string and it is mean that it has the intermittent workloads. According to an operation manual the maximum tensile load on the lower cable fitting is 50кН, minimal load is 5kH. The intermittent workload causes fatigue what can be reason for breaking sucker rods. Strength and fatigue calculations was performed for one of details put under the heaviest tensile loads. As a result of calculations a better construction was selected. It have considered allocation of stresses, the factor of safety and the service life.

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MODELING OF DIAMOND DRILLING TOOL FOR DRILLING WELLS

Earlier studies of the authors revealed significant advantages of single-layer diamond drilling core bits with shortened sectors, which contain no more than four radial rows of diamond cutters [1, 2]. The reduction in the number of radial rows in the sector allows for a significant reduction in the variance of the loads acting on individual diamonds in the sector. Considering the peculiarities of rock destruction by core bits with the same sectors, the emphasis was on using designs with an even number of radial rows of diamonds in the sector, which limited the possibilities for development of a new drilling tool.

The analysis of the interaction of diamond cutters with the bottom hole showed that the reduction in the variation of loads acting on individual diamonds in the sector can also be achieved for diamond core bits with an odd number of radial rows of diamonds in the sector [3]. For this, it is necessary not to use of identical diamonds layouts in adjacent sectors.

To substantiate the prospects of these diamond layouts, computer simulation of the thermal and hydraulic processes in the "core bit — bottom hole" system was carried out using the finite-element method, in which the thermal processes of the core bit was studied taking into account the mechanical loading of individual diamonds and cooling with fluid. The initial data were the design parameters of the core bit, the parameters of the drilling fluid, the regime parameters of drilling, the bottom hole power distribution for each diamond.

Results showed the promise of using single-layer diamond core bits with shorter sectors and an odd number of radial rows of diamonds in the sector.

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STUDYING THE IMPACT OF CURRENT PLUSE EXITATION ON BOTTOMHOLE FORMATION ZONE

Plasma impulse excitation (PIE) is one of the methods of intensifying oil production based on the useof resonant properties of the formation. The essence of this method is that when a specially createdelectric discharge is formed inside the volume of the fluid around its formation zone, ultrahighhydraulic pressures occur that can perform useful mechanical work and are accompanied by a complexof physical and chemical phenomena.

The technology is based on an increase in the hydraulic and hydrodynamic effects and theamplitude of the shock action during a pulsed electric discharge in a conducting liquid.

At the same time, the following processes occur in the formation:heating of the near-well zone;acceleration (up to 1000 times) of gravity aggregation of oil and gas;increase in the relative phase permeabilities for oil to a greater extent than for water;increase in speed and completeness of capillary displacement of oil and water;emergence of seismoacoustic emission in reservoir rocks accompanied by the formation of microcracks;change in the stressed state of reservoir rocks and a related change in the structure of the porespace (dilatancy).

High-voltage current passes through the spark gap electrodes into the working interval inside thewell. An electric arc characterized by a high degree of decomposition of the molecules leads to theformation of an instantaneous increase in temperature. Due to this, within a few microseconds, highpressure develops. An instantaneous shock wave with a speed above the speed of sound is transmittedto the surrounding fluid in the well, which leads to the formation of a compression shock wave.

Currently, the above-described method of stimulating the oil and gas bearing strata is poorly understood, represents a great prospect and requires further study in this area.

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INCREASING THE LIFELENGHT OF CEMENT STONE IN AGGRESSIVE ENVIRONMENT

As in the Russian Federation and beyond its borders, the volumes of drilling of oil and gas fields with a significant content of hydrogen sulfide are increasing annually. It is necessary to improve the old recipes and use new ones of cement compositions for cementing in such zones [1]. In many ways, new formulations of corrosion-resistant compounds are expensive, therefore it's necessary to reduce the cost of corrosion-resistant compounds. The samples of the cement stone were tested in special impermeable reservoir with the hydrogen sulfide. As a result of the interaction of the aggressor with a cement stone, the stone is destroyed. But the treatment of cement with PSS significantly increases the corrosion resistance of the cement stone.

The corrosion process is of a frontal nature and is determined by the diffusion of the aggressive component inside the cement stone [2]. Increasing the corrosion resistance of backfill materials methods to decrease permeability and porosity have always been of interest and being done by different ways, but the most effective way is clogging pore space of the cement stone with inert additives blocking the surfaces of the solid phase, the products of hydration and not passing aggressive components to the hardening products. In fields with a high content of hydrogen sulfide, the sealness of the annular space has a special role, since hydrogen sulfide is the most dangerous of the entire variety of corrosive formation fluids [3]. When dissolved in water, hydrogen sulfide forms an acid, which causes the destruction of the cement stone and casing, being a passivator of metals [4].

In an effort to enhance the corrosion resistance of the cement stone, PSS was investigated as an additive to the cement compound. And various methods of entering PSS into the cement composition were tested. Portland cement-I-G with water-cement ratio of 0.44 without additives, as well as samples made of Portland cement-I-G with water-cement ratio 0.44 of 1%, 3%, 5% of PSS additives got ready for testing as well.

The obtained results showed that the PSS addition increases the corrosion resistance of cement stone, as it alters the structure of pore space and significantly reduces the permeability of the stone. The standard oil well cement, traditionally used for cementing wells, does not always fulfill the tasks. This is especially evident in wells, in the production of which there is a hydrogen sulfide. And soon we are going to realize our technology in some Russian gas field.

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PHYSICAL AND MATHEMATICAL MODELING OF WATERFLOODING OF LOW-PERMEABLE POLYMICTIC RESERVOIRS USING SURFACTANTS

Currently, in our country, most fields with traditional reservoirs are already developed or are in the late stages of development.There is a decrease in reservoir permeability, a rapid approach to the shale threshold of oil reservoirs introduced into the development. Such layers are characterized by low values of oil recovery factor, their development may be unprofitable.One of the ways to increase the profitability of such reserves may be the use of such a method of enhanced oil recovery as waterflooding with the use of surfactants.

To implement this technology, it is necessary to choose the right surfactant composition for effective impact on the oil reservoir. For laboratory experiments, the composition of surfactants was chosen (patent RU 2655685). The selected surfactant leads to swelling of clay minerals contained in the reservoir, only 0.2%, which is an excellent indicator. Also, this composition proved to be predominantly water-soluble [1].

As a result of laboratory filtration studies, it was found that the injection of a surfactant solution can significantly reduce the pressure gradient of fluid injection into the reservoir, effectively inhibit the swelling of clays, and also increase the oil displacement rate by 6-12% [2].

To simulate the injection of a surfactant solution into the oil reservoir, a small reservoir of the N reservoir (Western Siberia) was selected, which is represented by Upper Jurassic deposits.The calculations were carried out using the geological and hydrodynamic model, which was created using all the information on the deposit and adapted to the actual data. After adaptation, a series of calculations were performed according to the prediction of the effectiveness of surfactant injection depending on the different concentration and volume of the bank.

The main results of this work were the predictive parameters of the reservoir, which is watered by the solution developed in SPMU surfactants. These predicted figures confirm the technological and economic efficiency of this method of enhanced oil recovery, even in small areas of waterflooding.Taken together, the results of laboratory studies and hydrodynamic calculations allow us to conclude that the use of technology to inject surfactant solution into the reservoir under the conditions of modern technological challenges will make it possible to develop low-permeability clay reservoirs cost-effectively and increase the final oil recovery.

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CONNECTION OF THE WALL AND BOTTOM OF A VERTICAL CYLINDRICAL STEEL TANK (VST) BY TOROIDAL TRANSITION

It has been established that 30% of all repairs in the tank battery are repairs in the zone of the corner weld joint [1]. The developments of various design solutions for coupling the walls of the tank with the bottom are known. In [2] a tank with a wall freely supported on the bottom is proposed. The authors of [3] believe that the most rational in terms of strength, the shape of the welded joint is a joint that is concave inward. Such a seam guarantees the absence of plastic deformations in the zone of the welding joint. To increase the strength and corrosion resistance of the joint between the wall and the bottom of the VST, in [4], it is proposed to change the tank repeater and perform it in the form of a special T-shaped edge welded to each other and the first ring of the tank.

In this paper, it is proposed to replace the welding joint with a part of a toroidal ring connecting the wall with the bottom. At the same time for the stability of the tank along the entire contour of the wall between the toroidal junction and the edge of the tank it is proposed to lay a thrust bearing with fixing plates. According to the results of calculations performed by the finite element method, it was revealed that the maximum stresses in the console of the edge of the standard corner weld joint exceed the yield strength of the steel used and reach 360 MPa. In the proposed design, the stresses in the interface zone of the wall and the bottom are reduced by 46% and amount to 196 MPa.

In the study of the stress-strain state in the zone of interface between the bottom and the wall, it was found that the proposed design will significantly reduce the stresses arising in the wall from hydrostatic load, significantly increase the time until cracks appear in the places of upwarping and slow down the corrosion processes of the bottom and the tank wall. Also, the proposed solution will improve reliability, increase the period between repairs, and extend the service life of tanks, which will significantly reduce the cost of operating tank farms.

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IMPROVEMENT OF TOOLS FOR ENGINEERING AND GEOLOGICAL DRILLING FOR DEVELOPING OIL AND GAS DEPOSITS ON SHELF

For the development of the offshore oil and gas fields, the UMB-130 and UMB-130M drilling units [1] were developed at our university for drilling engineering and geological wells from non-specialized vessels (including rescue vessels, tugboats). They allow to implement the casingless technology of drilling with hydraulic hammer tools, working on sea water, which significantly reduces the cost of work. The results of operation showed that, in order to increase the efficiency of these drilling units, it is necessary to improve the tool subunits which are switching the modes of its operation at various stages of drilling and ensure the transmission of information from the installation through a low-cost hydroacoustic communication channel.

To address these problems, a number of switching subunits schemes were proposed, which allow switching the operation modes of a drilling tool by controlling the flow of sea water into it without stopping the drilling process [2]. To compare their effectiveness, modeling of fluid flow in these subunits was carried out at different phases of work. The flow simulation was performed using the finite volume method and allowed to substantiate the advantages of each schemes and determine their parameters for operation as part of the UMB-130 and UMB-130M units.

During development of a hydroacoustic communication channel, cost reduction has been achieved through the use of inexpensive and affordable components. This made it possible to realize a wireless communication channel with characteristics sufficient for transmitting the main drilling parameters, in particular, the drilling depth of the well. This becomes possible due to a significant reduction in the requirements for the bandwidth of the hydroacoustic communication channel and the limitation of the communication range [3] in accordance with the technical characteristics of the drilling tool.

Results allow to upgrade the main subunits of the UMB-130 type tools and improve the quality of control of the drilling process. The simulation results showed the promise of single-valve distribution units for use in hydro-percussive drill rigs, which makes it possible to significantly simplify their design and operation.

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DNA LINKERS: THE WEAKEST LINK IN THE ARTIFICIAL NANOMACHINES

DNA linkers in nanomaterials are short oligonucleotides, which connect two or more individual nanoparticles often resulting in a nanomachine with a wider variety of functions than individual nanoparticles. However, the DNA that serves as a linker is a substrate for deoxyribonucleases (DNases), the enzymes that degrade DNA in cells and biological fluids in sake of protecting them from "intruder" DNA.

Development of nanomaterial science and progress in DNA synthesis within last two decades enabled invention of specially-designed DNA linkers (spacers), which are able to connect nanoparticles in a flexible manner, and, in some cases, provide specific recognition capacity for nanoparticle targeting [1]. DNA linkers vary in length from a few nucleotides to several hundred base pairs. Sequence of the linker can vary depending on the role of it.

Because of its simplicity, the most popular method to measure DNA linker degradation is the electrophoresis in agarose or polyacrylamide gel [2, 3]. In addition, transmission electron microscopy (TEM) can be used to demonstrate untangled individual nanoparticles.

In summary, DNA likers are the important part of nanomachines. They provide binding between the elements of nanomachines, and ensure their functionality. They seem to be the "weakest link" in nanomachines because they are open to attacks by DNases, which protect cell and body from the intrusion of "foreign" DNA. However, methods are available to protect DNA linkers by either modifying the linker itself, or by inhibiting the DNases.

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THE METHODS OF INCREASING THE CONDENSATE RECOVERY OF GAS-CONDENSATE DEPOSITS

Condensate recovery enhancing is an important goal from technical and economical point of view during the gas-condensate field development and production phases. However, the given field gas production rate is a significant constraint defined by the gathering facilities and the business terms. Under such conditions, the one of the ways to enhance condensate recovery is the well's gas rates redistribution.

The required distribution of the total production should hit the minimal pressure drop as the gas and condensate reserves are depleted. This follows from the reason, that the decrease of the field pressure leads to the condensate drop out and thus the production loses. There through, the problem could be formulated as following: to find the gas production rates of the interacting wells at the given time moment which produce the minimum reservoir energy loses at the given overall production.

A minimum decrease of the reservoir pressure is realized by minimization of the reservoir energy loses that is equal to the supporting the well's bottom hole pressures at the maximal level [1]. Moreover, the interference of the wells should be taken into account [2]. The realization of conditions above will allow to maximize ultimate gas and condensate recovery. The method of condensate recovery enhancing based on the well gas rates redistribution has the two hypotheses:

1) the wells exert the maximum influence on each other at any time;

2) the maximization of the cumulative well condensate production rates and the cumulative well gas production rates is equivalent to minimizing the loss of reservoir energy, i.e. maximization of the bottom hole pressure [3].

Test calculations were performed on the sector model to define the efficiency of the proposed method.The hydrodynamic model is the fragment of a massive gas reservoir underlain by formation water. Using existing oilfield & gasfiled industry standard simulator we get an optimal solution within 2.5 days [3]; with our algorithm, we got a condensate recovery 0.5% less than optimal within 2 hours.

The application of hypothesizes allows to transform non-linear optimization problem to the linear programming problem. This simplifies solution of the optimization problem essentially. Numerical experiment have justified the proposed hypothesis and the applicability of the method. Moreover, solving the problem at several time moments, one can build up trajectory of the well rate changes in time, i.e. to go to predict production for the certain period. In this case, the solution, which was obtained at the previous step, will become the input for solution at the next time step.

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THE ACOUSTIC OSCILLATION EFFECT ON THE RESERVOIR WITH THE PURPOSE OF OIL RECOVERY IMPROVEMENT AND INTENSIFICATION OF THE FLOW

1. Introduction. The acoustic effect on the reservoir is a promising way to improve the oil recovery and intensify the inflow. The existing theoretical and practical studies in this field indicate the effectiveness of the vibroacoustic effects both from the surface and from the well. [1] The low-frequency surface effects (or seismoacoustic effects), as well as the effect of the downhole wave radiators, contribute to the pressure redistribution and the oil extraction from the blind non-draining areas of the reservoir. [2] While a high-frequency acoustic field leads to a reduction in the oil viscosity, the splitting of the bottomhole zone.

2. Research. As part of the study of existing results on the acoustic effect on the saturated pore medium, the following features are established. In the low-frequency range of exposure, an increase in the absolute permeability of the artificial core samples to 30% is observed, which is explained by the formation of new filter channels and the change in the packing and orientation of the porous grain medium constituents. High-frequency and ultrasonic waves affect the rheological properties of non-Newtonian liquids, including oil. Some studies show a decrease in a shear viscosity by 20-30% immediately after exposure with frequencies up to 4.5 MHz and intensity up to 100 kW / m2. The paper [3] presents data on the reduction in the pour point of oils with a high content of paraffins and resins when they are treated with an ultrasonic field and when the dynamic viscosity of the oil decreases. At acoustic wave frequencies from 1.2 to 2 kHz, the critical pressure gradient, which is necessary for filtering, is reduced. There is an enlargement of oil particles in the pore canals.

3. Conclusion. The study of the acoustic effect on saturated pore media makes it possible to conclude that there are resonance frequencies of the rock skeleton and saturating fluids, the impact on which leads to an increase in the filtration rate and an increase in the oil recovery factor. It is assumed that the complex wave profile elastic oscillations' impact on the oil reservoirs will lead to the mobility factor increase and a more complete hydrocarbons' recovery due to the displacement from the dead-end pores, the surface tension decrease and the pore medium destruction, leading to an increase in the effective porosity.

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DEVELOPMENT OF A SYSTEM FOR AUTOMATED ANALYSIS AND MONITORING OF THE CURRENT STATE OF OIL FIELDS

The waterflooding process optimization is a possibility to increase oil recovery and reduce inefficient costs, which does not require workover activities [1]. Various approaches have been used to reduce inefficient water injection and maintain of oil recovery rates for fields with a great number of wells [2,3].

Results of testing developed tool for achieve the potential of basic production are presented in this paper. The main advantage of this tools compared with commercial simulators is possibility of rapid analysis of a large number of wells with further automated selection of optimal technological parameters. The functional of tools also include the selection of candidates for the bottom-hole treatment, isolation squeeze, geophysical study in well and well hydrodynamic studies.

In order to test the instruments, experimental program had been carried at one of the sections of real field. Results of experimental program presented in the work. According to the results of the pilot survey, a large number of wells were analyzed, according to the results of which wells were allocated: with a recommendation for reducing injection due to high compensation (9%); with inefficient injection of the working agent (40%); with effective injection of the working agent, but requiring its reduction due to the possible influence of the aquifer (6%); with a recommendation for increase injection due to low compensation (9%); with an optimal mode of operation (24%).

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