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DIGEST



**PETROCHEMICAL AND REFINING
CONGRESS: SYNTHESIS 2024**

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INSTITUTION OF HIGHER EDUCATION

EMPRESS CATHERINE II
ST. PETERSBURG MINING UNIVERSITY

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*On the cover: Chest with a collection of petroleum products (fragment).
Vocational school of Crown Prince Nikolai, Saint Petersburg, 1888.
From the collection of the Mining Museum*

Abstract

The current issue of the digest of the "Journal of Mining Institute" – one of the oldest leading Russian and international peer-reviewed periodicals – is timed to coincide with the Petrochemical and Refining Congress: Synthesis 2024, which will be held in St. Petersburg on October 28-29, 2024. The digest presents the articles from recent years devoted to the problems of localization of reserves and hard-to-recover raw materials, carbon control, development of petrochemical industry and import substitution, issues of digitalization and artificial intelligence in production.

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Ponomarenko T.V., Gorbatyuk I.G., Cherepovitsyn A.E. Industrial clusters as an organizational model for the development of Russia petrochemical industry // Journal of Mining Institute. 2024. P. 1-13. EDN DESOAU. <https://pmi.spmi.ru/pmi/article/view/16368>



Abstract. The article explores the challenges facing Russia petrochemical industry over the past decade and examines the reasons behind its significant lag compared to other industrialized nations. It presents a review of academic research on clusters accompanied by a comparative analysis, generalization, and consolidation of factors influencing the development of the petrochemical industry in Russia. It is argued that advancing the petrochemical industry from production plants to integrated production complexes necessitates a shift towards clustering, which will improve resource utilization efficiency, bolster product competitiveness, and reduce production costs. The article examines and consolidates key cluster concepts, encompassing definitions, characteristics, composition, and constituent elements. It also examines strategic documents guiding the development of the petrochemical sector, assesses the progress made in forming petrochemical clusters in Russia, and draws upon European and Asian experiences and government support tools in the domain of petrochemical clusters. The successful development of petrochemical clusters in Russia is argued to be strongly dependent on state initiatives and support for infrastructure development. Additionally, the presence of research organizations within clusters is crucial for fostering high-tech product innovation and forming an efficient value chain that integrates research and development with specific assets. When establishing petrochemical clusters in Russia, it is essential to consider the unique characteristics of each cluster, including the types of raw materials and resources used, the necessary infrastructure, and the specific support measures and incentives provided by the state.

Pashkevich N.V., Khloponina V.S., Pozdnyakov N.A., Avericheva A.A. Analysing the problems of reproducing the mineral resource base of scarce strategic minerals // Journal of Mining Institute. 2024. P. 1-20. EDN HNTQBF. <https://pmi.spmi.ru/pmi/article/view/16430>



Abstract. The results of studying the scarcity of strategic minerals in the Russian Federation are presented, domestic consumption of which is largely provided by forced imports and/or stored reserves. Relevance of the work is due to aggravation of the geopolitical situation and a growing necessity to meet the demand of national economy for raw materials from own sources. Analysis of the state of mineral resource base of scarce minerals in the Russian Federation was accomplished, problems were identified and prospects for its development were outlined taking into account the domestic demand for scarce minerals, their application areas and the main consumers. Reducing the deficit through the import of foreign raw materials and the development of foreign deposits does not ensure the reproduction of the domestic mineral resource base, independence of the country from imported raw materials



Graphite. From the collection of the Mining Museum

as well as additional competitive advantages, economic stability and security. It was ascertained that a major factor holding back the development of the mineral resource base is insufficient implementation of new technological solutions for the use of low-quality ore. Improving the technologies in the industry is relevant for all types of scarce minerals to solve the problem of reproducing their resource base. Taking into account the prospects for the development of the resource base for the minerals under consideration (manganese, uranium, chromium, fluor spar, zirconium, titanium, graphite) requires a set of legal and economic measures aimed at increasing the investment attractiveness of geological exploration for subsoil users at their own expense without attracting public funding. The proposed measures, taking into account the analysis of positive experience of foreign countries, include the development of junior businesses with expansion of the “declarative” principle, the venture capital market, various tax incentives, preferential loans as well as conditions for the development of infrastructure in remote regions. The proposed solution to the problem of scarcity of strategic minerals will make it possible in future to present measures to eliminate the scarcity of certain types of strategic minerals taking into account their specificity.

Burkhanov R.N., Lutfullin A.A., Raupov I.R., Maksyutin A.V., Valiullin I.V., Farrakhov I.M., Shvydenko M.V. Localization and involvement in development of residual recoverable reserves of a multilayer oil field // Journal of Mining Institute. 2024. Vol. 268. P. 599-612. EDN DKXZSP. <https://pmi.spmi.ru/pmi/article/view/15996>



Abstract. During waterflooding of a multilayer oil field there is a constant deterioration of the structure and composition of residual reserves due to geological and technological reasons. The largest share of residual reserves is localized in pillars, which arise from uneven development of the production facility and are undrained or poorly drained zones. The results of a quantitative assessment of the distribution of residual oil reserves in the Middle and Upper Devonian deposits of the Romashkinskoe oil field of the Republic of Tatarstan are presented. A retrospective method is proposed to identify reserves by analyzing and summarizing historical exploration data and the long history of reservoir

development, and a calculation algorithm is proposed to quantify them. It has been established that residual oil reserves are localized in rows of dividing and injection wells, as well as in the central rows of producing wells in a three-line drive, in abandoned and piezometric wells, in the areas adjacent to the zones of reservoir confluence, pinch-out, oil-bearing contours, distribution of reservoirs with deteriorated porosity and permeability properties. Depending on geological conditions, algorithms for selecting geological and technical measures to include localized reserves in development and forecasting production profiles were proposed. According to the proposed method, residual recoverable reserves were identified and a number of wells were recommended for experimental works on their additional recovery: in well 16 (hereinafter in the text, conventional well numbers are used) after isolation of overlying high-water-cut formations, the additional perforation was carried out and oil flow was obtained. Additional perforation in well 6 resulted in oil recovery during development as well. Thus, the developed approaches to identifying residual recoverable reserves and patterns of their spatial distribution can be recommended in other multilayer oil fields with a long history of development.

Pshenin V.V., Zakirova G.S. Improving the efficiency of oil vapor recovery units in the commodity transport operations at oil terminals // Journal of Mining Institute. 2024. Vol. 265. P. 121-128. DOI: 10.31897/PMI.2023.29



Abstract. In this paper the problem of losses from evaporation of light fractions of hydrocarbons during loading operations of tanker fleets vessels is considered. It was found that there is no unified approach to modeling the system “tanker – gas phase pipeline – vapor recovery units” in open sources. The absence of a generally recognized model makes it impossible to scientifically justify the application of instruments to reducing losses and the development of corresponding measures. In work it is showed that the dynamics of growth of pressure in the inner tanker capacity is described by a differential equation, considering for non-stationary essence of the process. This equation is converted to a non-dimensional form and investigated in relation to the similarity criteria of this system. This research has allowed to establish unambiguously the general character of pressure changes in the inner

tanker capacity, and to predict the peak values of its growth at the initial stage of the loading operation. The obtained equations were tested on real tanker loading data and showed satisfactory convergence with the experimental data. At different stages of the loading operation the component composition of vapor changes, which is shown by chromatographic analysis of the gas mixture. With the availability of a model of hydrocarbon vapor displacement from the inner of tanker, it is possible to propose measures to minimize the negative impact on the environment and return valuable vapors of the product to the technological chain of transportation.

Tomskii K.O., Ivanova M.S. Optimization of the location of a multilateral well in a thin oil rim, complicated by the presence of an extensive gas cap // Journal of Mining Institute. 2024. Vol. 265. P. 140-146. EDN XOVEYF. <https://pmi.spmi.ru/pmi/article/view/15985>



Abstract. The specific share of the reserves of hard-to-recover hydrocarbon raw materials is steadily growing. The search for technologies to increase the hydrocarbon recovery factor is one of the most urgent tasks facing the oil and gas industry. One of the methods to expand the coverage of oil reserves and increase oil recovery is to use the technology of drilling multilateral wells with a fishbone trajectory. In the Russian Federation, the most branched well was drilled in the Republic of Sakha (Yakutia) at the Srednebotuobinskoye oil and gas condensate field. The main object of development is the Botuobinsky horizon (Bt reservoir). About 75 % of the geological reserves of the reservoir are concentrated in a thin oil rim with an average oil-saturated layer thickness of 10 m with an extensive gas cap. This circumstance is one of the main complicating factors in the development of the Srednebotuobinskoye oil and gas condensate field. For such complex wells, one of the most important design stages is to determine the optimal location of the fishbone well in an oil-saturated reservoir. The article shows the results of sector modeling in the conditions of the Srednebotuobinskoye field to determine the optimal location of multilateral wells using Tempest simulator.

Bolshunov A.V., Vasilev D.A., Dmitriev A.N., Ignatev S.A., Kadochnikov V.G., Krikun N.S., Serbin D.V., Shadrin V.S. Results of complex experimental studies at Vostok station in Antarctica // Journal of Mining Institute. 2023. Vol. 263. P. 724-741. EDN WQNJET. <https://pmi.spmi.ru/pmi/article/view/16308>



Abstract. Scientific research in the area close to the Russian Antarctic station Vostok has been carried out since its founding on December 16, 1957. The relevance of work to study the region is steadily increasing, which is confirmed by the Strategy for the Development of Activities of the Russian Federation in the Antarctica until 2030. As part of the Strategy implementation, Saint Petersburg Mining University solves the comprehensive study issues of the Vostok station area, including the subglacial Lake Vostok, related to the development of modern technologies and technical means for drilling glaciers and underlying rocks, opening subglacial reservoirs, sampling water and bottom sediments, as well as carrying out comprehensive geological and geophysical research. For the successful implementation of the Strategy, at each stage of the work it is necessary to identify and develop interdisciplinary connections while complying with the requirements for minimizing the impact on the environment. During the season of the 68th Russian Antarctic Expedition, the staff of the Mining University, along with the current research works, began research of the dynamic interactions between the forces of the Earth, from the deepest depths to the surface glacier. Drilling and research programs have been completed. The drilling program was implemented jointly with colleagues from the Arctic and Antarctic Research Institute at the drilling complex of the 5G well. The research program included: shallow seismic studies, core drilling of snow-firn strata, study of the snow-firn strata petrostructural features, studies of cuttings collection filters effectiveness when drilling snow-firn strata and the process of ice destruction in a reciprocating rotational method, bench testing of an acoustic scanner. As a result of drilling in 5G well at the depth range of 3453.37-3534.43 m, an ice core more than 1 million years old was obtained.



*Silicified wood. Beaver Lake, Eastern Antarctica.
From the collection of the Mining Museum*

Yushkova E.A., Lebedev V.A. Enhancement of energy efficiency of the vacuum oil distillation unit using pinch analysis // Journal of Mining Institute. 2023. Vol. 261. P. 415-427. EDN LXDVDP. <https://pmi.spmi.ru/pmi/article/view/16179>



Abstract. The actual task of the state is to increase the energy efficiency of the oil refinery. The object of research is a vacuum distillation unit, including a preheating unit for raw materials and a furnace for heating fuel oil before the column. Pinch analysis allows to analyze and optimize a large number of heat flows. In this study the analysis and enhancement of efficiency of the research object is carried out by enthalpy pinch analysis. In order to reduce the heat load of the furnaces, the additional flows were introduced into the heat exchange system of the oil heating unit. Parametric optimization of the new heat exchange system was carried out. The minimum needs of the heat exchange system in external energy carriers are determined. An enthalpy cascade of the heat exchange system has been constructed, which clearly shows the distribution of heat between each heat flow of the system. In the analysis of the energy efficiency of a furnace, an important point is the determination of the optimal heat capacity of the combustion products. In this work, we have determined the optimal flow heat capacity, at which the heat loss with the exhaust gases is minimal. As a result of the studies carried out, the efficiency of the fuel oil preheating unit has been increased by maximizing heat recovery, and the cost of external energy carriers has been minimized. By reducing heat loss with flue gases, it was possible to increase the efficiency of the furnace.

Cherepovitsyn A.E., Tretyakov N.A. Development of new system for assessing the applicability of digital projects in the oil and gas sector // Journal of Mining Institute. 2023. Vol. 262. P. 628-642. EDN QYBHMC. <https://pmi.spmi.ru/pmi/article/view/15795>



Abstract. Digital transformation is one of the global trends that has covered most sectors of the economy and industry. For oil and gas companies, the introduction of digital technologies has become not just a trend, but one of the factors for ensuring competitiveness and

maintaining a stable position in the market in a rapidly changing macro environment. At the same time, despite the positive effects achieved, digital transformation is a complex process from the point of view of implementation and is associated with high technological, financial, and economic risks. The work aims to develop and test a new system for evaluating the applicability of digital projects in the oil and gas sector. The research methodology includes the application of the Gartner curve, methods of expert assessments, and tools for assessing the economic efficiency of investment projects. The developed assessment system is based on a comprehensive accounting of four components: the level of digital maturity of the company; compliance of the implemented technology with the goals and objectives of the organization; the level of reliability of the implemented technology; the level of innovation of the implemented project. Particular attention is paid to the practical testing of the proposed methodology based on the evaluation of a digital project implemented by a Russian oil and gas company.

Litvinenko V.S., Petrov E.I., Vasilevskaya D.V., Yakovenko A.V., Naumov I.A., Ratnikov M.A. Assessment of the role of the state in the management of mineral resources // Journal of Mining Institute. 2023. Vol. 259. P. 95-111. DOI: 10.31897/PMI.2022.100



Abstract. Mineral resources as natural capital can be transformed into human, social and physical capital that guarantees the sustainable development of a country, exclusively through professional public management. Public management of a country's mineral resource potential is seen as an element of transnational governance which provides for the use of laws, rules and regulations within the jurisdictional and sectoral capabilities of the state, minimising its involvement as a producer of minerals. The features of the ideology of economic liberalism, which polarises the societies of mineral-producing countries and denies the role of the state as a market participant, have been studied. The analysis of the influence of the radical new order of neoliberal world ideology on the development of the extractive sector and state regulation has been presented.

Gerasimov A.M., Ustinov I.D., Zyryanova O.V. Use of clay-containing waste as pozzolanic additives // Journal of Mining Institute. 2023. Vol. 260. P. 313-320. DOI: 10.31897/PMI.2023.33



Abstract. Growing productivity of mining and processing enterprises entails an increase in the volumes of liquid tailings impoundments and upstream impoundments of ore processing waste. Enterprises face the challenge of minimizing the environmental impact of waste and guaranteeing the sanitary and epidemiological safety of population. The article presents a possibility of recycling one type of such waste (clay-containing concentration tailings of apatite-nepheline and sylvinitic ores, coal beneficiation tailings) by using them after preliminary thermochemical treatment as pozzolanic additives to cements and concretes, including concrete mixtures used for soil stabilization, development of territories, reclamation of mine workings, as a component of the insulating layer of landfills for the disposal of municipal solid waste. An analysis of the phase changes of kaolinite, one of the main minerals that make up clay-containing waste, in the temperature range of 200-1,000 °C showed that a change in its mineral form during heat treatment is the main factor in changing its pozzolanic activity. The effect of heat treatment of clay minerals at temperature of 700-800 °C on their pozzolanic activity, estimated by the ability to absorb calcium hydroxide (0.7 g Ca(OH)₂ per 1 g of modified kaolinite), is considered. It is shown that the addition of heat-treated samples (20 % by weight) improves the quality of cement increasing its activity by 15 %, in comparison with the use of unmodified clay minerals. It was proved experimentally that partial replacement of Portland cement with thermally modified kaolinite increases the strength of consolidating stowing mixture by up to 15 %. This approach to processing of ores containing layered silicates, which provides for thermochemical modification of run-of-mine ore, intensifies the processes of tailings thickening and filtering.

Rudko V.A., Gabdulkhakov R.R., Pyagai I.N. Scientific and technical substantiation of the possibility for the organization of needle coke production in Russia // Journal of Mining Institute. 2023. Vol. 263. P. 795-809. EDN KYNHWL. <https://pmi.spmi.ru/pmi/article/view/16246>



Abstract. Russia is one of the world's leading steel producers, while about 33 % of production comes from the scrap remelted in arc steelmaking furnaces. The graphitized electrodes of SHP and UHP grades, mainly consisting of needle coke, are used for high current loads and temperatures in furnaces. USA, Japan, Korea, and China are focused on needle coke production, where coal (tar and pitch) and petroleum (decantoil), by-products of metallurgical factories and oil refineries, are used as raw materials. Russia's annual demand for needle coke is approximately 100 thousand tons, but all of it is covered by imports. Russia's raw material potential, established by the authors of the article, is more than 5 million tons per year and includes decantoil, coal tar and pitch, and heavy pyrolysis tar. The results of obtaining needle coke from decantoil and heavy pyrolysis tar are given below. The prototypes of needle coke were produced on specially designed delayed coking laboratory units (loading up to 0.25 and 80 kg). Raw materials were modified according to the original technology of Saint Petersburg Mining University, the convergence of target properties of which is confirmed by the results of quality analysis of the obtained needle coke, including after 100-fold scaling. The electrodes were molded from the obtained coke. After standardized stages of firing, mechanical processing and graphitization at 2,800-3,000 °C, the coefficient of linear thermal expansion was less than $1 \times 10^{-6} \text{ K}^{-1}$, and the value of specific electrical resistance was 7.1-7.4 μOhm, which proves that the obtained carbon material corresponds in quality to Japanese analogues and Super Premium needle coke.

Kondratev S.A., Khamzina T.A. Assessment of collecting activity of physically sorbed reagents on the example of easily floatable coking coal sludge // Journal of Mining Institute. 2022. Vol. 256. P. 549-559. DOI: 10.31897/PMI.2022.52



Abstract. The article presents one of the new approaches to theoretical assessment of collecting ability of reagents. The efficiency of reagents-collectors with different chemical composition used for flotation of coking coals was studied. A comparative assessment of the flotation activity of kerosene, mineral oil, thermal gas oil, KETGOL and FLOTEK is given. The criteria of collecting activity of the above reagents-collectors for coal sludge flotation were specified. A correlation was established between the indicators of coal sludge flotation by the above reagents and their physical parameters. It is shown that the rate of spreading over water surface can characterize the flotation activity of reagents. Based on dependence of the collecting activity of a reagent on its rate of spreading along the “gas – liquid” interface and surface pressure, the main approaches to determining the structure and composition of molecules of an effective flotation collector can be determined. A new concept of the function performed by a physically sorbed collector in the elementary act of flotation and a criterion for the flotation activity of reagents used in coal sludge beneficiation are proposed. It is shown that the collector used in coal flotation, in addition to hydrophobizing the surface of the extracted particles, should reduce the induction time and remove the kinetic constraint on formation of a flotation aggregate.

Zhdaneev O.V. Technological sovereignty of the Russian Federation fuel and energy complex // Journal of Mining Institute. 2022. Vol. 258. P. 1061-1078. DOI: 10.31897/PMI.2022.107



Abstract. The review to achieve technological sovereignty of the Russian fuel and energy complex (FEC) in the ongoing geopolitical situation is presented in the article. The main scope has been to identify

the key technology development priorities, restrictions and internal resources to overcome these utilizing the developed by the author the innovative methodology that consists of novel approaches to calculate level of local content, digitalization, business continuity and interactions with military-industrial complex. Some organizational changes have been proposed to intensify the development of hi-tech products for the FEC and related industries, including establishment of the state committee for science and technology and the project office of lead engineers for the critical missing technologies. Two successful examples to utilize the described in the paper methodology is presented: the first domestic hydraulic fracturing fleet and polycrystalline diamond compact cutter bit inserts.



*The coal is banded. Peat bog facies.
From the collection of the Mining Museum*

Zemenkova M.Yu., Chizhevskaya E.L., Zemenkov Yu.D. Intelligent monitoring of the condition of hydrocarbon pipeline transport facilities using neural network technologies // Journal of Mining Institute. 2022. Vol. 258. P. 933-944. DOI: 10.31897/PMI.2022.105



Abstract. The national strategic goal of the Russian Federation is to ensure the safety of critical technologies and sectors, which are important for the development of the country's oil and gas industry. The article deals with development of national technology for intelligent monitoring of the condition of industrial facilities for transport and storage of oil and gas. The concept of modern monitoring and safety control system is developed focusing on a comprehensive engineering control using integrated automated control systems to ensure the intelligent methodological support for import-substituting technologies. A set of approved algorithms for monitoring and control of the processes and condition of engineering systems is proposed using modular control robotic complexes. Original intelligent models were developed for safety monitoring and classification of technogenic events and conditions. As an example, algorithms for monitoring the intelligent safety criterion for the facilities and processes of pipeline transport of hydrocarbons are presented. The research considers the requirements of federal laws and the needs of the industry.

Ulanov V.L., Skorobogatko O.N. Impact of EU carbon border adjustment mechanism on the economic efficiency of Russian oil refining // Journal of Mining Institute. 2022. Vol. 257. P. 865-876. DOI: 10.31897/PMI.2022.83



Abstract. The carbon border adjustment mechanism (CBAM) leads not only to the expected environmental changes, but also to the transformation of market environment. The study estimates the losses of the oil refining sector from the introduction of CBAM for the export of oil products from Russia to the countries of the European Union. An approach to assess the impact of CBAM on the cost of oil products has been formed and the mechanisms of its impact on the economy of Russian oil refineries have been identified. The study was carried out on the basis of actual data on the volume of greenhouse gas emissions in accordance with the current rules of the European emissions trading

system. Decomposition of assessments of the CBAM impact was carried out into direct and indirect effects, as well as the effect of adaptation. It is shown that with the introduction of the CBAM mechanism, the prices of oil products in the domestic market will be determined not only by the logistical factor, but also by the requirements for environmental friendliness of oil refining. The introduction of CBAM will have a significant impact on the economics of oil refining, including refineries that do not export to the EU. The total impact of CBAM on the economy of Russian oil refineries will be about 250 mln dollars.

Zakharov L.A., Martyushev D.A., Ponomareva I.N. Predicting dynamic formation pressure using artificial intelligence methods // Journal of Mining Institute. 2022. Vol. 253. P. 23-32. DOI: 10.31897/PMI.2022.11



Abstract. Determining formation pressure in the well extraction zones is a key task in monitoring the development of hydrocarbon fields. Direct measurements of formation pressure require prolonged well shutdowns, resulting in underproduction and the possibility of technical problems with the subsequent start-up of wells. The impossibility of simultaneous shutdown of all wells of the pool makes it difficult to assess the real energy state of the deposit. This article presents research aimed at developing an indirect method for determining the formation pressure without shutting down the wells for investigation, which enables to determine its value at any time. As a mathematical basis, two artificial intelligence methods are used – multidimensional regression analysis and a neural network. The technique based on the construction of multiple regression equations shows sufficient performance, but high sensitivity to the input data. This technique enables to study the process of formation pressure establishment during different periods of deposit development. Its application is expedient in case of regular actual determinations of indicators used as input data. The technique based on the artificial neural network enables to reliably determine formation pressure even with a minimal set of input data and is implemented as a specially designed software product. The relevant task of continuing the research is to evaluate promising prognostic features of artificial intelligence methods for assessing the energy state of deposits in hydrocarbon extraction zones.

Rogachev M.K., Aleksandrov A.N. Justification of a comprehensive technology for preventing the formation of asphalt-resin-paraffin deposits during the production of highly paraffinic oil by electric submersible pumps from multiformation deposits // Journal of Mining Institute. 2021. Vol. 250. P. 596-605. DOI: 10.31897/PMI.2021.4.13



Abstract. Production of highly solidifying abnormal oils (with a paraffin content of over 30 % by mass) in the Far North is complicated by the intensive formation of asphalt-resin-paraffin deposits (ARPD) in the bottomhole zone of the productive formation, well and surface equipment. Existing methods and technologies for countering the formation of organic deposits in well equipment have many advantages. However, their application in the production of highly paraffinic oil does not fully prevent the formation of ARPD in the tubing string. This leads to a significant reduction in oil production, reduction of turnaround and intertreatment periods of production wells operation, an increase in specific operating expenses for paraffin removal. Results of theoretical and laboratory investigations presented in the article show that one of the promising ways to improve the operational efficiency of wells equipped with electric submersible pumps during extraction of highly paraffinic oil from multiformation deposits is the application of a new integrated technology based on the joint production of highly solidifying abnormal oil with oil, characterized by a lower paraffin content and manifestation of structural and mechanical properties, in conjunction with the regulation of the parameters for the electric submersible pump. Results of numerical modeling using the PIPESIM steady-state multiphase flow simulator, physical, chemical and rheological investigations show that with a decrease of highly paraffinic oil from the productive formation D2ef in a blend with Sary Oskol oil from the Kyrtaelskoye field, a decrease in the mass content of paraffin in the blend and the temperature of its saturation with paraffin, depth and intensity of the organic deposits formation in the tubing string, pour point, as well as the improvement of the rheological properties of the investigated

structured dispersed systems is observed. Article describes a promising assembly of well equipment for the single tubing separate production of highly paraffinic oil from multiformation deposits of the Timan-Pechora province, providing separation of the perforation zones in two productive formations using a packer-anchor system at simultaneous-separate operation of the formations by a double electric submersible pump unit.

Zhdaneev O.V., Zaytsev A.V., Prodan T.T. Possibilities for creating Russian high-tech bottomhole assembly // Journal of Mining Institute. 2021. Vol. 252. P. 872-884. DOI: 10.31897/PMI.2021.6.9



Abstract. Development of high-tech well electronic measuring systems is aimed at creating modern equipment: telemetry, well geophysical measurement equipment, the architecture of which is divided into basic (with measurement channels for gamma logging and inductive resistance) and advanced (with radioactive, acoustic, magnetic resonance and thermobarometric measurement channels, including azimuthal methods of investigation). Over-the-bit measurement modules, rotary steerable systems are being developed and channels for transmitting data to the surface are being improved. Vice versa, specialized surface equipment with highly integrated software is being created. Different measurement modules are manufactured by different companies, which creates uncertainties in the possibility of interfacing the manufacturers' measurement modules into a single well measurement system. The article presents an analysis of the readiness of Russian oil service companies to produce well and surface equipment for drilling Russian directional oil and gas wells, meeting modern requirements for accuracy, lifetime and operating conditions. The possibility of creating a fully Russian well high-tech equipment and the required resources, risks and measures to mitigate them when creating a modern well measurement system are considered.

Mukhametshin V.S., Khakimzyanov I.N. Features of grouping low-producing oil deposits in carbonate reservoirs for the rational use of resources within the Ural-Volga region // Journal of Mining Institute. 2021. Vol. 252. P. 896-907. DOI: 10.31897/PMI.2021.6.11



Abstract. A methodology has been developed and a procedure for selecting homogeneous groups has been implemented using a set of parameters characterizing the properties of formation fluids, layering conditions, geological and physical properties of formations at different levels of the hierarchy. An algorithm for identifying deposits for monitoring and justifying measures to improve the efficiency of development management is proposed. A justification for the selection of associative groups of long-term developed objects using the parameters of geological heterogeneity according to different tectonic-stratigraphic elements is presented. To reduce the degree of uncertainty in the evaluation of objects by the degree and nature of geological heterogeneity, the parameters reflecting the degree of uncertainty of the system using complex characteristics are proposed. For different deposit associations, a different influence of the features of the object structure on the degree of their division has been established. In the process of deposit drilling, as additional information about development objects is obtained, it is necessary to specify the nature of the distinguished groups of objects first of all based on the use of characteristics of geological heterogeneity. Comparison of various grouping options shows the need to take into account the geological heterogeneity of objects during their drilling. The identification of groups of objects using a limited number of parameters is approximate, but at the stage of drafting the first design documents, it is possible to solve certain tasks aimed at determining the strategy for the development of deposits.

Razmanova S.V., Andrukhova O.V. Oilfield service companies as part of economy digitalization: assessment of the prospects for innovative development // Journal of Mining Institute. 2020. Vol. 244. P. 482-492. DOI: 10.31897/PMI.2020.4.11



Abstract. The digital transformation of the economy as the most important stage of scientific and technological progress and transition to a new technological structure is becoming one of the determining factors in the development and competitiveness of the domestic upstream sector. Prospects for innovative development of oilfield service companies are the key technological areas within the first project of the Hi-Tech Strategy of the German Government until 2020 – “Industry 4.0”. The purpose of this study is to assess the prospects for innovative development of the domestic oilfield service industry in the context of the digitalization of the oil and gas industry. The subject of the research is the process of the formation of key technological lines of “Industry 4.0” and their impact on the domestic oil and gas sector. The research is based on logical-theoretical and empirical analyses. The main factors that determine processes of digital transformation in the oil and gas industry are considered; the results of digitalization processes in the largest foreign and Russian industry companies of the upstream and oilfield services segments are presented. The information base is made up of data from oilfield service and oil and gas producing companies, presented on the official websites of companies in the public domain on the Internet. It has been proven that, unlike the world’s leading companies in oilfield services segment, independent domestic oilfield service companies provide mainly traditional service technologies in a fairly narrow range. The limited scope of functioning and technological capabilities of Russian companies is explained by the lack of necessary investment in development and expansion of business, as well as interest on the part of the state and corporate sectors in the development and replication of domestic technologies and the formation of a full-fledged oilfield services market in Russia.

Kondrasheva N.K., Rudko V.A., Nazarenko M.Yu., Gabdulkhakov R.R. Influence of parameters of delayed asphalt coking process on yield and quality of liquid and solid-phase products // Journal of Mining Institute. 2020. Vol. 241. P. 97-104. DOI: 10.31897/PMI.2020.1.97



Abstract. Paper studies the effect of excess pressure during delayed coking of asphalt, obtained by propane deasphaltization of tar, on yield and physical and chemical properties of hydrocarbon fuels' components and solid-phase product – petroleum coke. Asphalt was coked at a temperature of 500 °C and excess pressure of 0.15-0.35 MPa in a laboratory unit for delayed coking of periodic action. Physical and chemical properties of raw materials and components of light (gasoline), medium (light gasoil), and heavy (heavy gasoil) distillates obtained during experimental study were determined: density, viscosity, coking ability,



Asphalt. From the collection of the Mining Museum

sulfur content, iodine number, pour points, flash points, fluidity loss and fractional composition. Quantitative group hydrocarbon and microelement compositions and properties of obtained samples of petroleum coke (humidity, ash content, volatiles' yield, sulfur content, etc.) were also studied. Comparative assessment of their quality is given in accordance with requirements of GOST 22898-78 “Low-sulfur petroleum coke. Specifications”. In addition, patterns of changes in excess coking pressure on yield and quality indicators of distillate products and petroleum coke were revealed. With an increase in excess pressure of coking process from 0.15 to 0.35 MPa, content of paraffin-naphthenic hydrocarbons in light and heavy gasoils of delayed coking decreases. Common pattern in asphalt coking is an increase in yield of coke and hydrocarbon gas with an increase in excess pressure from 0.15 to 0.35 MPa.

Zhdaneev O.V., Zaitsev A.V., Lobankov V.M. Metrological support for the logging while drilling and wireline equipment // Journal of Mining Institute. 2020. Vol. 246. P. 667-677. DOI: 10.31897/PMI.2020.6.9



Abstract. The article discusses the problems associated with metrological support of equipment for geophysical research, issues of ensuring the uniformity of well measurements, the creation of Russian standards for calibrating well equipment when determining the porosity coefficients and oil, gas, water saturation, determining the parameters of defects during well cementing and technical condition of casing strings and the water-oil-gas flow. The problems of creating full-fledged methods for measuring the parameters of oil and gas fields with conventional and hard-to-recover reserves have been investigated. The key directions of development of the Russian metrological support of geophysical well measurements were determined. The tasks that need to be solved to create metrological support for geophysical well logging as an industry that meet international standards are indicated. The expediency of creating a Russian Geophysical Center for Metrology and Certification, the need to develop a new and update the existing regulatory framework, which will allow Russian geophysics to reach the level of world leaders in the field of geophysical research, are substantiated.

Yurak V.V., Dushin A.V., Mochalova L.A. Vs sustainable development: scenarios for the future // Journal of Mining Institute. 2020. Vol. 242. P. 242-247. DOI: 10.31897/PMI.2020.2.242



Abstract. Issues of sustainable development began to concern mankind starting from the 20th century, when mass industrialization and the depletion of natural resource potential contributed to the formulation of environmental issues at one of the leading places in scientific discourse.

However, what if the goals of sustainable development would not be achieved to 2030? What other way we can identify for humanity to survive? So, the study is about the problems of studying the understanding of the term “sustainable development”, considering the evolution of the formation of the concept of sustainable development and analyzing the modern goals of sustainable development for attainability. From an analysis of domestic and foreign experience, possible scenarios of the development of mankind are identified (such as 1. Creating an environmental framework, 2. Implementation of sustainable nature management practices in the conditions of natural and man-made objects, 3. Implementation of “geoengineering projects”, 4. Construction of autonomous ecosystems, 5. Space exploration in search of a new planet for life, provided that the goals of sustainable development would not be achieved. It has been established that today probability of achieving all the sustainable development goals by 2030 is too small, and the indicated scenarios require, firstly, the development of science and technology, and secondly, a competent assessment of the value of nature and solving the issue of specifying property rights for natural goods.

Berezikov S.A. Structural changes and innovation economic development of the Arctic regions of Russia // Journal of Mining Institute. 2019. Vol. 240. P. 716-723. DOI: 10.31897/PMI.2019.6.716



Abstract. This article is devoted to problem of assessing relationship of innovative economic development and structural changes in industry of the Arctic regions. Performed analysis showed that change in the structure of industrial production in the Arctic regions from 2010 to

2016 was characterized by significant interregional differences in speed and intensity of transformation processes. It is shown that one of the key

factors that caused structural changes in industry of the Arctic regions of Russia in 2010-2016 was increase in economic role of innovations and change in the pace of innovative processes development. In particular, the results of correlation analysis showed the presence of stable positive links between «science intensity» of economy and transformation of regional industry structure. The presence of a strong positive connection between impact of innovative development factors – an increase in growth rate of innovative goods – and structural changes in industrial production was set. Another factor contributing to structural changes in industry was investment in modernization of production. It is proved that in order to ensure further sustainable economic growth in regions of the Arctic, a necessary condition should be a substantial increase of «science intensity» in economy, including industries related to mining operations.

Ulanov V.L., Ulanova E.Yu. Impact of External Factors on National Energy Security // Journal of Mining Institute. 2019. Vol. 238. P. 474-480. DOI: 10.31897/PMI.2019.4.474



Abstract. The article examines both external and internal threats to national energy security, formulates the tasks of increasing energy security, discloses modern challenges, as well as measures to level them. In recent years, Russian economy has felt the growing influence of external threats and risks: unfair competition in world markets, high politicization of energy issues, and attempts to prevent Russia from monetizing national energy reserves. Influence of the use of renewable energy sources on national energy security, growth of liquefied natural gas production, stricter environmental requirements, changes in the demand for petroleum products, and introduction of anti-Russian sanctions are analyzed. The influence of internal risks is no less significant: quality of hydrocarbon reserves in the Russian Federation is declining, effectiveness of geological exploration is insufficient, and the share of hard-to-recover reserves is increasing. Energy security assessments are recommended taking into account modern challenges and on the basis of parameters such as ratio of the annual increase in the balance values of primary fuel and energy resources to the volume of their production, share of natural gas in the balance structure of primary fuel and energy resources, implementation of investment programs by fuel and energy sectors, change in the specific energy intensity of GDP, prices and etc.

Dubovikov O.A., Brichkin V.N. Directions and prospects of using low grade process fuel to produce alumina // Journal of Mining Institute. 2016. Vol. 220. P. 587-594. DOI: 10.18454/PMI.2016.4.587



Abstract. Power consumption across the globe is constantly increasing for a variety of reasons: growing population, industrialization and fast economic growth. The most widespread gaseous fuel – natural gas – has the low production cost. It is 2-3 times cheaper than liquid fuel production and 6-12 times cheaper than coal production. When natural gas is transported to distances from 1.5 to 2.5 thousand km by the pipeline, its cost with account of transportation is 1.5-2 times less than the cost of coal and the fuel storage facilities are not needed. Plants powered by natural gas have the higher efficiency as compared to the plants operating on other types of fuel. They are easier and cheaper to maintain and are relatively simple in automation, thus enhancing safety and improving the production process flow, do not require complicated fuel feeding or ash handling systems. Gas is combusted with a minimum amount of polluting emissions, which adds to better sanitary conditions and environment protection. But due to depletion of major energy resources many experts see the future of the global energy industry in opportunities associated with the use of solid energy carriers. From the environmental perspective solid fuel gasification is a preferred technology. The use of synthetic gas was first offered and then put to mass scale by English mechanical engineer William Murdoch. He discovered a possibility to use gas for illumination by destructive distillation of bituminous coal. After invention of the gas burner by Robert Bunsen, the illumination gas began to be used as a household fuel. The invention of an industrial gas generator by Siemens brothers made it possible to produce a cheaper generator gas which became a fuel for industrial furnaces. As the calorific value of generator gas produced through gasification is relatively low compared to natural gas, the Mining University studied possibilities to use different types of low grade process fuel at the Russian alumina refineries as an alternative to natural gas, access to which is restricted for some of the regions.

Kondrasheva N.K., Khorkhe A. Effect of chemical composition and quality of heavy Yarega oil on selection of appropriate processing technology // Journal of Mining Institute. 2016. Vol. 222. P. 833-838. DOI: 10.18454/PMI.2016.6.833



Abstract. The paper explores physical and chemical properties and composition of heavy oil from Yarega field and its vacuum residue, i.e. the tar. The capillary chromatography and gas chromatography-mass spectrometry were used to identify specific group hydrocarbon composition of heavy Yarega oil and components extracted therefrom, which has proven its belonging to highly resinous sulfurous naphthenic and aromatic oils. Based on the comparative analysis of composition and quality of feedstock a possibility has been assessed to produce a high-quality needle coke with low content of sulphur and metals from the heavy oil of Yarega field and its vacuum residue. An integrated process flow diagram for heavy Yarega oil refinement has been proposed, including preliminary deasphalting and demetallization, hydrotreatment, delayed coking and thermdestructive processes or gasification.



*Sandy gravelstone impregnated with oil. Yaregskoe deposit, Ukhta, Komi Republic.
From the collection of the Mining Museum*

Scientific edition

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