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EMPRESS CATHERINE II
ST. PETERSBURG MINING UNIVERSITY

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Abstract

The current issue of the digest of the journal "Journal of Mining Institute" – one of the oldest leading Russian and international peer-reviewed publications – is timed to coincide with the Saint Petersburg International Gas Forum, which will be held in St. Petersburg on October 8-11, 2024.

The digest presents articles of the journal devoted to the problems of development of the oil and gas chemical industry and ways of their solution, modern trends in the development of hydrocarbon resources, and the Arctic.

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Issues of development of the petrochemical industry and ways to solve them

Over the years of development, the Russian petrochemical industry has acquired its own traditions, including in the very sphere of production and the creation of the scientific and technological basis of the industry. The main goal of the development of petrochemicals in our country is the growth of economic efficiency.

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.



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

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/index.php/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.

Skobelev D.O., Cherepovitsyna A.A., Guseva T.V. Carbon capture and storage: net zero contribution and cost estimation approaches // Journal of Mining Institute. 2023. Vol. 259. P. 125-140. DOI: 10.31897/PMI.2023.10



Abstract. Carbon capture, utilization, and storage (CCUS) are a combination of necessary and promising technologies that can help reduce CO₂ emissions, which are not used on a large scale due to the high cost of

solutions. This article aims to review and analyze carbon capture and storage (CCS) projects in terms of their net zero contribution and cost estimates. The study identified a wide range of cost estimation methods that can be applied to CCS projects and revealed such issues as a lack of standardization, limited data, and cost data variability. Still, several common trends were found, including the classification of CCS adopters into low-cost and high-cost industries, cost estimation by CCS step (capture, transportation, storage) and industry (power generation, other sectors), and calculation of relative indices to make comparisons with other decarbonization options. The results of the study can serve as a foundation for developing approaches to estimating the costs of CCS in Russia, which are necessary for planning government support measures and involving businesses in the implementation of these initiatives.

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.

Cherepovitsyn A.E., Tevetkov P.S., Evseeva O.O. Critical analysis of methodological approaches to assessing sustainability of arctic oil and gas projects // Journal of Mining Institute. 2021. Vol. 249. P. 463-479. DOI: 10.31897/PMI.2021.3.15



Abstract. Development of hydrocarbon resources in the Arctic is one of the priority tasks for the economy of the Russian Federation; however, such projects are associated with significant risks for the environment of nearby regions.

Large-scale development of hydrocarbon resources in the Arctic should be based on the principles of sustainable development, which imply a balance between socio-economic benefits and environmental risks. The purpose of this study is to analyze the gaps in scientific knowledge on the issues of assessing sustainability of Arctic oil and gas projects (OGPs) and systematize the key problematic elements of such assessments. The analysis was carried out in terms of four key elements that determine the feasibility of implementing Arctic OGP in the context of sustainable development: economic efficiency, social effects, environmental safety and technological availability. The methodology for conducting bibliometric analysis, which included more than 15.227 sources from the Scopus database over the period of 2005-2020, was based on PRISMA recommendations for compiling systematic reviews and meta-analyses. Methodological problems of assessing sustainability of Arctic OGP were mapped and divided into four key sectors: consideration of factors that determine sustainability; sustainability assessment; interpretation of assessment results; sustainability management. This map can serve as a basis for conducting a series of point studies, aimed at eliminating existing methodological shortcomings of the sustainable development concept with respect to Arctic OGP.

Ilinova A.A., Romasheva N.V., Stroykov G.A. Prospects and social effects of carbon dioxide sequestration and utilization projects // Journal of Mining Institute. 2020. Vol. 244. P. 493-502. DOI: 10.31897/PMI.2020.4.12



Abstract. The issues of global warming and occurrence of the greenhouse effect are widely discussed on a global scale. Various methods of reducing greenhouse gas emissions are actively being investigated and tested, including technologies for sequestration of carbon dioxide, the implementation of which is carried out in the form of CC(U)S (carbon capture,

utilization and storage) projects related to capture, disposal and, in some cases, use of CO₂. In Russia, CC(U)S technologies are not yet used, but there is a significant potential for their development and distribution. CC(U)S technologies acquire a special role in the context of the development of the energy and industrial sectors of Russia, which are key sources of emissions, and the geological objects belonging to them are potential carbon storages. The purpose of this study is to conceptually analyze the CC(U)S technological cycle and typify such projects, assess the prospects for their implementation in Russia, and identify social effects from the implementation of CC(U)S projects. The main results of the study are presented in the form of a typology of CC(U)S projects, a strategic analysis of the prospects for introduction of such technologies in Russia, as well as development of approaches to assessing social effects with systematization and highlighting a set of indicators for their assessment, which can serve as a basis for re-estimation of the values of CC(U)S projects. The main research methods used were methods of decomposition, systematization and typology, as well as strategic analysis with a focus on relevant practical materials on the topic of the work. Directions for further research are related to the substantiation of the methodology for assessing social effects of CC(U)S projects, including for the conditions of Russia, based on the principles of balancing the interests of key participants.



Asphalt. From the collection of the Mining Museum

Tcvetkov P.S., Fedoseev S.V. Analysis of project organization specifics in small-scale LNG production // Journal of Mining Institute. 2020. Vol. 246. P. 678-686. DOI: 10.31897/PMI.2020.6.10



Abstract. Gas industry plays an important role in the global energy sector, and in the coming decades amounts of natural gas production will only increase. One of the fastest growing trends in gas industry is the production of liquefied natural gas (LNG), which is associated with the necessity to organize flexible systems of gas supply to the regions, remote from gas extraction sites. Industrial structure of LNG production includes projects, belonging to several different groups depending to their scale, in particular, small-scale production (SSLNG), cumulative production capacity of which is approximately 10 % from the industry-wide one. Economic aspects of implementing such projects remain underexplored, which does not allow to draw objective conclusions regarding the prospects of their implementation in particular regions. This paper contains a review of publications, devoted to SSLNG project studies, aimed at identifying specifics of their organization compared to projects of greater scale. The results demonstrate that the majority of international companies classify projects as SSLNG, if their annual production capacity is below 0.5 million tonnes per annum. Specific capital costs, as well as implementation timelines of such projects, are several times lower than that of projects with greater production capacity, which reduces their risks and minimizes barriers to market entry. Furthermore, SSLNG is the most decentralized subsector in gas industry, aiming to cover the market due to a growing number of projects, not their specific production capacity. These specific features define significant prospects of SSLNG development in Russia, both in the context of energy supply to remote regions and diversification of export deliveries.

Fedoseev S.V., Tcvetkov P.S. Key Factors of Public Perception of Carbon Dioxide Capture and Storage Projects // Journal of Mining Institute. 2019. Vol. 237. P. 361-368. DOI: 10.31897/PMI.2019.3.361



Abstract. One of the major challenges of the modern world is the problem of global warming, the solution of which requires the implementation of a set of strategic projects in the field of transition of the energy sector to the path of environmentally balanced development. One of the ways to

implement this transition is the development of technologies for capturing and storage of technogenic carbon dioxide, which is recognized as the main one of greenhouse gases. At the same time, in the Russian context, the most expedient is the implementation of technological chains for capturing and storing CO₂, which are aimed at enhanced oil recovery, the effectiveness of which has been proven by world practice. Implementation of these projects requires consolidation of efforts of many parties, including government agencies, enterprises-issuers (power generating facilities and energy-intensive industry), oil-producing enterprises, non-state environmental organizations, media and public. World practice has many examples when uncoordinated actions of one of the stakeholders led to the closure of such a project, and therefore it is necessary to develop a mechanism of interaction between them, taking into account the specifics of Russian conditions. One of the least studied and controversial aspects of this interaction is to involve the public in the implementation of national carbon intensity programs and the local population in the implementation of a specific project. Research in this field has been conducted in the world over the past 14 years, which allowed the current research base to be used to develop fundamental principles for the development and promotion of CO₂ capture and storage technologies in Russia. Key factors affecting the perception of such projects by public were also analyzed and systematized. The research identified the main arguments for and against the development of CO₂ capture and storage technologies. The analysis made it possible to formulate key principles that should be considered when developing a strategy for the development of these technologies in Russia.



Gas coal. Donets Coal Basin. From the collection of the Mining Museum.

Modern trends in the development of hydrocarbon resources

The strategy for the development and use of the mineral resource base of our country implies the modernization of the economy by involving hard-to-recover oil and gas reserves in the exploitation, reducing the negative impact of subsoil development on the environment, introducing automated monitoring and management systems in the field of subsoil use, and developing information technologies.

Shapovalov A.A. Methodology for managing energy development of production facilities in the gas industry // Journal of Mining Institute. 2024. P. 1-10. EDN XWKKKQ. <https://pmi.spmi.ru/pmi/article/view/16378>



Abstract. The current stage of Russia's development is characterized by dynamic changes in the operating conditions of gas industry enterprises, which leads, among other things, to significant adjustments in approaches to the development of energy production facilities.

The article examines on the system level the ways to improve energy supply, taking into account the goals and objectives of the development of production facilities from the conditions of solving a single technological problem of the gas industry – high-quality gas supply to consumers. The optimal functioning of energy supply systems, taking into account the peculiarities of technological processes at production facilities, presupposes the development models coordination of production facilities energy complexes with the gas industry enterprises parameters based on an integrated unified information space at all stages of their life cycle. The structure of production facility energy complex and the connections of its elements with related systems are justified taking into account the purposes of their creation and the requirements for production facilities. Problem solving for each system element as well as the exchange of information between equivalent systems is done

on the basis of a developed hierarchy of optimization problems adjusted depending on the type of tasks of energy supply improvement of a production facility. Determining the values of parameters and indicators of energy complexes, as well as optimizing the lists and content of work to improve the energy supply of production facilities, is planned to be carried out in accordance with the methodology under consideration using a set of mathematical models.

Tokarev I.S. Development of parameters for an industry-specific methodology for calculating the electric energy storage system for gas industry facilities // Journal of Mining Institute. 2024. P. 1-10. EDN UIZSOQ. <https://pmi.spmi.ru/pmi/article/view/16516>



Abstract. The issue of determining the main parameters of electric energy storage systems – power and energy intensity – is being considered, the determination of which is a fundamentally important task when introducing such devices into the power supply systems of enterprises for both technical (technological) and economic reasons. The work analyzes problems that can be solved by installing electricity storage systems at gas industry facilities. An industry-wide methodology has been developed for calculating the parameters of an electricity storage system based on traditional methods and methods aimed at minimizing the standardized cost of electricity with adaptation to the conditions of the gas industry. A distinctive feature of the presented methodology is the ability to determine the power and energy intensity of electricity storage systems when performing several functions. The methodology was tested at a typical gas industry facility – the Yarynskaya compressor station of OOO Gazprom Transgaz Ukhta, a characteristic feature of which is an autonomous power supply system. An example is given of calculating the electricity storage normalized cost using an improved LCOS indicator, which takes into account the effect of changing the fill factor of the electrical load schedule on the amount of gas consumption by a power plant for its own needs. To confirm the economic efficiency of introducing electricity storage systems calculated using the above methodology, calculations of the integral effect, net present value and efficiency index are presented.



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

Shaposhnikov N.O., Golubev I.A., Khorobrov S.V., Kolotiy A.I., Ioffe A.V., Revyakin V.A. Autoclave modeling of corrosion processes occurring in a gas pipeline during transportation of an unprepared multiphase medium containing CO₂ // Journal of Mining Institute. 2022. Vol. 258. P. 915-923. DOI: 10.31897/PMI.2022.92



Abstract. The problem of selecting a method for ensuring the reliability of the unprepared fluid transport facilities of an unprepared fluid in the presence of carbon dioxide is considered. Carbon dioxide corrosion is one of the dangerous types of damage to field and main pipelines. It has been shown that dynamic autoclave tests should be carried out during staged laboratory tests in order to determine the intensity of carbon dioxide corrosion and to select the optimal method of protection. A hypothesis about the imperfection of the existing generally accepted approaches to dynamic corrosion testing has been put forward and confirmed. A test procedure based on the use of an autoclave with an overhead stirrer, developed using elements

of mathematical modeling, is proposed. The flows created in the autoclave provide corrosive wear of the sample surface similar to the internal surfaces elements wear of the pipelines piping of gas condensate wells. The autoclave makes it possible to simulate the effect of the organic phase on the flow rate and the nature of corrosion damage to the metal surface, as well as the effect of the stirrer rotation speed and, accordingly, the shear stress of the cross section on the corrosion rate in the presence/absence of a corrosion inhibitor. The given results of staged tests make it possible to judge the high efficiency of the developed test procedure.

Gasumov R.A., Minchenko Y.S., Gasumov E.R. Development of technological solutions for reliable killing of wells by temporarily blocking a productive formation under ALRP conditions (on the example of the Cenomanian gas deposits) // Journal of Mining Institute. 2022. Vol. 258. P. 895-905. DOI: 10.31897/PMI.2022.99



Abstract. Modern field operation conditions are characterized by a decline in gas production due to the depletion of its reserves, a decrease in reservoir pressure, an increase in water cut, as well as due to the depreciation of the operating well stock. These problems are especially specific at the late stage of development of the Cenomanian deposits of Western Siberia fields, where the anomaly factor below 0.2 prevails, while gas-bearing formations are represented mainly by complex reservoirs with high-permeability areas. When killing such wells, the classical reduction of overbalance by reducing the density of the process fluid does not provide the necessary efficiency, which requires the search for new technical and technological solutions. In order to prevent the destruction of the reservoir and preserve its reservoir properties during repair work in wells with abnormally low reservoir pressure, AO “SevKavNIPGaz” developed compositions of special process fluids. A quantitative description of the process of blocking the bottomhole formation zone is proposed by means of mathematical modeling of injection of a gel-forming solution into a productive horizon. The well killing technology includes three main stages of work: leveling the injectivity profile of the productive strata using three-phase foam, pumping the blocking composition and its displacement with the creation of a calculated repression. Solutions obtained based on a mathematical model allow optimizing technological parameters to minimize negative consequences in the well killing process.

Hosseini A., Najafi M., Morshedy A.H. Determination of suitable distance between methane drainage stations in Tabas mechanized coal mine (Iran) based on theoretical calculations and field investigation // Journal of Mining Institute. 2022. Vol. 258. P. 1050-1060. DOI: 10.31897/PMI.2022.106



Abstract. A large amount of gas is emitted during underground mining processes, so mining productivity decreases and safety risks increase. Efficient methane drainage from the coal seam and surrounding rocks in underground mines not only improves safety but also leads to higher productivity. Methane drainage must be performed when the ventilation air cannot dilute the methane emissions in the mine to a level below the allowed limits. The cross-measure borehole method is one of the methane drainage methods that involves drilling boreholes from the tailgate roadway to an un-stressed zone in the roof or floor stratum of a mined seam. This is the main method used in Tabas coal mine N 1. One of the effective parameters in this method is the distance between methane drainage stations, which has a direct effect on the length of boreholes required for drainage. This study was based on the measurement of ventilation air methane by methane sensors and anemometers placed at the longwall panel as well as measuring the amount of methane drainage. Moreover, in this study, the obtained and analyzed data were used to determine the suitable distance between methane drainage stations based on the cross-measure borehole method. In a field test, three borehole arrangements with different station distances in Panel E4 of Tabas coal mine N 1 were investigated. Then, the amounts of gas drained from these arrangements were compared with each other. The highest methane drainage efficiency was achieved for distances in the range of 9-12 m between methane drainage stations.

Drozдов N.A. Filtration studies on cores and sand packed tubes from the Urengoy field for determining the efficiency of simultaneous water and gas injection on formation when extracting condensate from low-pressure reservoirs and oil from oil rims // Journal of Mining Institute. 2022. Vol. 257. P. 783-794. DOI: 10.31897/PMI.2022.71



Abstract. Oil rims as well as gas condensate reservoirs of Russia's largest Urengoy field are developed by depletion drive without formation pressure maintenance, which has led to serious complications in production of oil, gas and condensate. In addition, field development by depletion drive results in low values of oil and condensate recovery. These problems are also relevant for other oil and gas condensate fields. One of the possible solutions is simultaneous water and gas injection. Rational values of gas content in the mixture for affecting gas condensate fields and oil rims of oil and gas condensate fields should be selected using the data of filtration studies on core models. The article presents the results of filtration experiments on displacement of condensate and oil by water, gas and water-gas mixtures when simulating the conditions of the Urengoy field. Simultaneous water and gas injection showed good results in the experiments on displacement of condensate, residual gas and oil. It has been ascertained that water-gas mixtures with low gas content (10-20 %) have a better oil-displacement ability (9.5-13.5 % higher) than water. An experiment using a composite linear reservoir model from cemented core material, as regards the main characteristics of oil displacement, gave the same results as filtration experiments with sand packed tubes and demonstrated a high efficiency of simultaneous water and gas injection as a method of increasing oil recovery at oil and gas condensate fields.

Drozдов A.N., Gorelkina E.I. Development of a pump-ejector system for SWAG injection into reservoir using associated petroleum gas from the annulus space of production wells // Journal of Mining Institute. 2022. Vol. 254. P. 191-201. DOI: 10.31897/PMI.2022.34



Abstract. Implementation of SWAG technology by means of water-gas mixtures is a promising method of enhanced oil recovery. The use of associated petroleum gas as a gas component in the water-gas mixture allows to significantly reduce the amount of irrationally consumed gas and carbon footprint. Relevant task is to choose a simple, reliable and convenient equipment that can operate under rapidly changing operating conditions. Such equipment are pump-ejector systems. In order to create water-gas mixture it is proposed to use associated gas from the annulus space. This solution will reduce the pressure in the annulus space of the production well, prevent supply disruption and failure of well equipment. The paper presents a principal technological scheme of the pump-ejector system, taking into account the withdrawal of gas from the annulus space of several production wells. The layout of the proposed system enables more efficient implementation of the proposed technology, which expands the area of its application. Experimental investigations of pressure and energy characteristics of the ejector have been carried out. Analysis of the obtained data showed that it was possible to increase the value of maximum efficiency. The possibility of adapting the system in a wide range of changes in operating parameters has been established. Recommendations on selection of a booster pump depending on the values of working pressure and gas content are given.

Zemenkova M.Y., Chizhevskaya E.L., Zemenkov Y.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.

Schipachev A.M., Dmitrieva A.S. Application of the resonant energy separation effect at natural gas reduction points in order to improve the energy efficiency of the gas distribution system // Journal of Mining Institute. 2021. Vol. 248. P. 253-259. DOI: 10.31897/PMI.2021.2.9



Abstract. Maintaining the gas temperature and the formation of gas hydrates is one of the main problems in the operation of gas pipelines. Development and implementation of new effective methods for heating the gas during gas reduction will reduce the cost of gas transportation, solve the problem of resource and energy saving in the fuel industry. Study is aimed at increasing the energy efficiency of the natural gas reduction process by using a resonant gas heater to maintain the set temperature at the outlet of the gas distribution station (GDS) and prevent possible hydrate formation and icing of the station equipment. Paper considers the implementation of fireless heating of natural gas and fuel gas savings of heaters due to the introduction of a thermoacoustic reducer, operating on the basis of the Hartmann – Sprenger resonance effect, into the scheme of the reduction unit. By analyzing the existing methods of energy separation and numerical modeling, the effectiveness of the resonant-type energy separation device is substantiated. Modification of the reduction unit by introducing energy separating devices into it will allow general or partial heating of natural gas by its own pressure energy. Developed technology will allow partial (in the future, complete) replacement of heat energy generation at a gas distribution station by burning natural gas.

Didmanidze O.N., Afanasev A.S., Khakimov R.T. Natural gas methane number and its influence on the gas engine working process efficiency // Journal of Mining Institute. 2021. Vol. 251. P. 730-737. DOI: 10.31897/PMI.2021.5.12



Abstract. The natural gas usage as a vehicle fuel in the mining industry is one of the priority tasks of the state. The article pays special attention to the component composition of natural gas from the point of view of its thermal efficiency during combustion in the combustion chamber of a power plant on a heavy-duty vehicle in difficult quarry conditions. For this, domestic and foreign methods for determining the main indicator characterizing the knock resistance of fuel in the combustion process – the methane number – are considered. Improvement of technical and economic indicators will be carried out by changing the composition of the gas mixture based on methane to fit the design features of the gas power plant, the methane number will be the determining indicator. A theoretical analysis of the influence of the methane number on such engine parameters as the compression ratio and the maximum speed of the flame front propagation in the second phase



Bituminous shale. North-Eastern Ciscaucasia, the Chanty-Argun River. Grozny Oil Institute. 1955. From the collection of the Mining Museum

of combustion in the engine cylinder, expressed through the angle of rotation of the crankshaft, is presented. Based on the results of theoretical and experimental studies, the dependences of the influence of the methane number on the efficiency of the working process of the engine and its external speed characteristic were obtained.

Bosikov I.I., Maier A.V. Comprehensive assessment and analysis of the oil and gas potential of Meso-Cenozoic sediments in the North Caucasus // Journal of Mining Institute. 2021. Vol. 251. P. 648-657. DOI: 10.31897/PMI.2021.5.4



Abstract. At the present stage, the development of the oil and gas industry in the Russian Federation is impossible without replenishing the raw material base, so the urgent task is to conduct investigations, prospecting and evaluation of oil and gas bearing capacity prospects in undiscovered areas. The purpose of the investigations is to analyze facies and thicknesses, choose the methodology of prospecting and exploration in reservoirs, make a comprehensive assessment of oil and gas bearing capacity prospects based on experimental investigations and construct a map of oil and gas bearing capacity prospects of the studied sediment structure. The methodology of the conducted investigations was to identify and trace zones of increased fracturing by qualitative interpretation of time seismic sections. Methods for qualitative interpretation of time seismic sections, the model of physical, chemical and geochemical criteria developed by I.A. Burlakov, gas and geochemical surveying and correlation analysis were used in the investigations. A number of prospecting criteria, established based on the analysis of reference seismic materials on well-studied areas in comparison with the results of well tests, were also used. Structural plan for forecast prospects of oil and gas bearing capacity in the studied area was made; zonal and local objects with prospects for oil and gas were identified. Graphical plotting of Eh and pH concentrations distribution and various gas and geochemical indicators allowed identifying zones of possible oil and gas accumulations and starting their detailed survey. Processing of gas and geochemical materials by means of software allowed efficient assessment of prospects for oil and gas bearing capacity of the investigated objects.

Gasumov R.A., Gasumov E.R., Minchenko Y.S. Features of the underground storages construction in depleted oil and gas condensate fields // Journal of Mining Institute. 2020. Vol. 244. P. 418-427. DOI: 10.31897/PMI.2020.4.4



Abstract. The paper considers the features of the underground storages (US) construction in depleted oil and gas condensate fields (DOGCFs). The requirements for the structure of the formation, corresponding to the parameters of the object for possible US creation are presented. The influence of geological, hydrogeological, mining and technical rock formation conditions on the reliability and tightness of underground storages, including underground gas storages, has been evaluated. The necessary conditions for the US design are analyzed at the example of the Ach-Su oil and gas condensate field, in the presence of a well-explored trap with acceptable parameters for the construction of an underground storage. An important aspect is the geological conditions that meet the criteria for selecting the object: the required structure, the absence of fracturing faults, high reservoir properties of the formation, a sufficient volume of the deposit for the storage. Geological conditions lay the basis for determining the individual characteristics of the US construction technology at each DOGCF. The refined results for the current gas-saturated pore volume and the rate of pressure drop in the formation are presented, which makes it possible to select improved technological indicators in the course of operation of the created US. In order to select the optimal option for the design and construction of the US, the results of economic and geological scenarios analysis were studied concurrently with the capabilities of the technological operation of the object and transport system, which can ensure the maximum daily production of the storage.

Ponomarev A.I., Yusupov A.D. Effect of shear stress on the wall of technological pipelines at a gas condensate field on the intensity of carbon dioxide corrosion // Journal of Mining Institute. 2020. Vol. 244. P. 439-447. DOI: 10.31897/PMI.2020.4.6



Abstract. The object of the study is a section of the gas and gas condensate collection system, consisting of an angle throttle installed on a xmas tree and a well piping located after the angle throttle. The aim of the study is to assess the impact of the flow velocity and wall shear stress (WSS)

on the carbon dioxide corrosion rate in the area of interest and to come up with substantiated recommendations for the rational operation of the angle throttle in order to reduce the corrosion intensity. In the course of solving this problem, a technique was developed and subsequently applied to assess the influence of various factors on the rate of carbon dioxide corrosion. The technique is based on a sequence of different modeling methods: modeling the phase states of the extracted product, three-dimensional (solid) modeling of the investigated section, hydrodynamic flow modeling of the extracted product using the finite volume method, etc. The developed technique has broad possibilities for visualization of the obtained results, which allow identifying the sections most susceptible to the effects of carbon dioxide corrosion. The article shows that the average flow velocity and its local values are not the factors by which it is possible to predict the occurrence of carbon dioxide corrosion in the pipeline section after the angle throttle. The paper proves that WSS has prevailing effect on the corrosion intensity in the section after the angle choke. The zones of corrosion localization predicted according to the technique are compared with the real picture of corrosion propagation on the inner surface of the pipe, as a result of which recommendations for the rational operation of the angle throttle are formed.

Drozдов A.N., Gorbyleva Y.A. Improving the Operation of Pump-ejector Systems at Varying Flow Rates of Associated Petroleum Gas // Journal of Mining Institute. 2019. Vol. 238. P. 415-422. DOI: 10.31897/PMI.2019.4.415



Abstract. Application of pump-ejector systems for the utilization of associated petroleum gas reduces the negative environmental impact of its flaring, and also allows the implementation of a promising method of water-gas stimulation of the formation, which effectively increases oil recovery. Equally feasible is the use of pump-ejector systems in the operation of oil wells with a high gas factor, low bottomhole pressures to increase production rates and increase the turnaround period. A significant change in the flow rate of associated petroleum gas over time is a serious problem for the efficient operation of pump-ejector systems for the utilization of associated petroleum gas. To ensure the rational operation of the pump-ejector system under the condition of a variable flow rate of associated petroleum gas, experimental studies of liquid-gas ejector characteristics were carried out. The article presents the results of the research, obtained pressure-energy characteristics of the investigated jet apparatus at various values of the working stream pressure before the ejector nozzle. The possibility of adapting the operation of pump-ejector systems to changes in the flow rate of the pumped gas, regulated by the working pressure and fluid flow rate through the nozzle is revealed. To successfully change the operation of the pump-ejector system, the possibility of frequency regulation of the pump shaft's rotation at changing gas flow rates in a small range of values is considered. With a large difference in the values of the possible flow rate of associated petroleum gas, it is recommended that frequency regulation should be supplemented by periodic short-term operation. The possibility of increasing the efficiency of the pump-ejector system when using salt solutions with a concentration that contributes to the suppression of bubble coalescence is noted.

Ilyushin Y.V., Afanaseva O.V. Development of Scada-model for trunk gas pipeline's compressor station // Journal of Mining Institute. 2019. Vol. 240. P. 686-693. DOI: 10.31897/PMI.2019.6.686



Abstract. Nowadays, at all levels of created automated control systems for technological processes, programmable technical means are used that require specific software within framework of necessary functional tasks. This software should include a set of software tools that communicate with technical devices and organize «human-machine interface» (HMI) in the form of application software for AWP with assigned communication tasks for persons, responsible for management decision-making: operators, dispatchers, managers. However, hardware architecture is unique for each particular case, so it is necessary to refine or create a new control system. This is a rather laborious process. To simplify creation of such systems SCADA-systems are used. Article is devoted to development of SCADA-component for trunk gas pipeline's compressor workshop. Developed component allows tracking the characteristics of gas transportation process selected by operator. Development is based on «Windows» operating system and integrated environment TRACE MODE (SCADA/HMI).

Development of the Arctic and Antarctic

Russia's economic development will be largely determined by the resources that are found both in the Arctic and Antarctic. The melting of glaciers and the development of technologies for the passage of ships along the Northern Sea Route provide an excellent opportunity for the development of the Arctic zone and previously inaccessible oil and gas deposits. The study of Antarctica is of great scientific importance – it helps to solve problems related to climate change on Earth. In addition, the continent is promising in terms of economic development.

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.



*Shell limestone. The north-east of the Pre-Caucasian region. 1955.
From the collection of the Mining Museum*

Gusev E.A. Results and prospects of geological mapping of the Arctic shelf of Russia // Journal of Mining Institute. 2022. Vol. 255. P. 290-298. DOI: 10.31897/PMI.2022.50



Abstract. The results of compiling the sets of the State Geological Map at a scale of 1:1,000,000 for the Arctic continental shelf of Russia are analyzed. Results are summed up, and the main problems of geological mapping are outlined. The results of geological and geophysical studies of the Arctic Ocean are of great importance for deciphering the geological evolution. The Arctic shelf is the widest shelf in the world, while the spreading ocean basin is one of the narrowest and is characterized by anomalous structural features. The main problems of geological mapping include identification the sedimentary cover/folded basement boundary, interpretation the geodynamic evolution of the shelf and adjacent ocean, determining the rates of sedimentation and stratigraphic subdivision of the sedimentary cover due to a small number of key boreholes. It is promising to further study problem areas with unclear features of geological structure as well as small-scale mapping in areas of industrial development on the Arctic continental shelf.

Bolshunov A.V., Vasiliev N.I., Timofeev I.P., Ignatiev S.A., Vasiliev D.A., Leichenkov G.L. Potential technological solution for sampling the bottom sediments of the subglacial lake Vostok: relevance and formulation of investigation goals // Journal of Mining Institute. 2021. Vol. 252. P. 779-787. DOI: 10.31897/PMI.2021.6.1



Abstract. The subglacial Lake Vostok in Antarctic is a unique natural phenomenon, its comprehensive study involves sampling of water and bottom surface rocks. For further study of the lake, it is necessary to drill a new access well and develop environmentally safe technologies for its exploration. This article discusses existing and potential technologies for sampling bottom surface rocks of subglacial lakes. All these technologies meet environmental safety requirements and are conducive for sampling. The authors have proposed an alternative technology, using a walking device, which, due to its mobility, enables selective sampling of rocks across a large area from a single access well. The principal issues, related to the implementation of the proposed technology, are investigated within

this article. This report is prepared by a team of specialists with many years of experience in drilling at the Vostok Station in Antarctic and in experimental work on the design of equipment and non-standard means of mechanization for complicated mining, geological and climatic conditions.

Gusev E.A., Krylov A.A., Urvantsev D.M., Goremykin Y.V., Krynitsky P.I. Geological structure of the northern part of the Kara Shelf near the Severnaya Zemlya archipelago according to recent studies // Journal of Mining Institute. 2020. Vol. 245. P. 505-512. DOI: 10.31897/PMI.2020.5.1



Abstract. Until recently, the North of the Kara Shelf was completely unexplored by seismic methods. Seismic and seismo-acoustic data that have appeared in recent years have made it possible to decipher features of the regional geological structure. This study solves the urgent problem of determining the prospects for the oil and gas potential of the North Kara sedimentary basin. The relevance of the research is associated with determining the prospects of the oil and gas potential of the North Kara sedimentary basin. The aim of the study is to clarify the age of the reflecting horizons using data on the geology of the island, as well as to determine the tectonic position of the sedimentary cover and basement structures in the north of the Kara shelf. The sedimentary cover is divided into three structural levels: Cambrian-Devonian, Middle Carboniferous-Cretaceous, Miocene-Quarter. The Cambrian-Devonian complex fills the deep troughs of the North Kara shelf. The most noticeable discontinuity is the base of Carboniferous-Permian rocks, lying on the eroded surface of folded Silurian-Devonian seismic complexes. The blanket-like plate part of the cover is composed of thin Carbon-Quarter complexes. The authors concluded that the fold structures of the Taimyr-Severozemelskiy fold belt gradually degenerate towards the Kara sedimentary basin and towards the continental slope of the Eurasian basin of the Arctic Ocean. A chain of narrow uplifts within the seabed relief, which correspond to narrow anticlines is traced to the West of the Severnaya Zemlya islands. Paleozoic rocks have subhorizontal bedding further to the West, within the Kara shelf. Mesozoic folding in the North of the Kara Sea is expressed exclusively in a weak activation of movements along faults. At the neotectonic stage, the shelf near Severnaya Zemlya was raised and the Mesozoic complexes were eroded. The modern seismic activity of the North Zemlya shelf is associated with the ongoing formation of the continental margin.

Mustafin M.G., Balandin V.N., Bryn M.Y., Matveev A.Y., Menshikov I.V., Firsov Y.G. Topographic-geodetic and Cartographic Support of the Arctic Zone of the Russian Federation // Journal of Mining Institute. 2018. Vol. 232. P. 375-382. DOI: 10.31897/PMI.2018.4.375



Abstract. A version of the project of the concept of topographic, geodetic and cartographic support of the Arctic zone of the Russian Federation based on the use of modern means and tools is presented, including its content.

The results of the development in the Arctic carried out with the participation of the authors in 1961-1967 and 1975-1992 are presented in detail. The strategic importance and great attention of the state structures to the development of the Arctic zone is underlined. The key moments of the development of topographic, geodetic and cartographic support for this region are given. The role of leading research institutes in this process is shown. The proposed concept includes six stages. When creating a planimetric geodetic base, the authors recommend an alternative innovative algorithm for determining the height H without first calculating the latitude B and use only satellite measurements. The extremely important question of converting geodetic coordinates B, L into rectangular plane coordinates x, y is considered. For the territory of the Russian Federation new developments are proposed, they use data from satellite determinations, a new approach to the determination of normal heights and the conversion of rectangular space coordinates into rectangular plane coordinates necessary for mapping. The required regulations of reference documentation for the topographic survey of the shelf are shown. The importance of implementing the concept in connection with the definition of the outer boundary of the continental shelf of the Arctic Ocean is shown.

Egorov A.S., Vinokurov I.Y., Telegin A.N. Scientific and Methodical Approaches to Increase Prospecting Efficiency of the Russian Arctic Shelf State Geological Mapping // Journal of Mining Institute. 2018. Vol. 233. P. 447-458. DOI: 10.31897/PMI.2018.5.447



Abstract. A rationale for the set of theoretical and methodological techniques of mapping and deep modeling in the Russian Arctic shelf and adjacent sedimentary basins in continental Russia is based on

the materials for the Barents and Kara Seas region. This article provides the factual basis of the research and shows how to apply zonal-block model of the crust and generalized models of geodynamic settings in terms of the different geophysical data inconsistency. The necessity and approach for global and regional paleo-reconstructions are also discussed. It is shown that localization of the principal structural and compositional units of the lithosphere being a consequence of geodynamic processes at the boundaries of lithospheric plates, form at the basis of sedimentary cover and crystalline basement layered maps as well as cross-sections of the continental crust. The identified parameters of the deep structure and milestones of the regional tectonic history open new opportunities to explore the regularities of ore deposits distribution. The shown example of the forecast and metallogeny problems solution within Western Siberia and Khatanga-Vilyui petroleum provinces is made using the parameters of known industrial oil and gas fields for training the pattern recognition system.

Vasilev N.I., Dmitriev A.N., Lipenkov V.Y. Results of the 5G borehole drilling at Russian Antarctic station «Vostok» and researches of ice cores // Journal of Mining Institute. 2016. Vol. 218. P. 161-171 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5094>



Abstract. We produce an information about results and features of the 5G borehole drilling in Antarctic layer at Russian station Vostok. Main regularities of the change structured and physical properties by Antarctic ice layer depth, which determine mechanical and reological properties if ice, which influence to sinking of a borehole and to the maintaining of it in a working condition, the safe and competitive technologies creation for drilling of strong ice layers and the environmentally safe technology of the subglacial reservoirs unsealing. We also produce results of the ice cores researching and the paleoclimatic raws construction, which are reconstructed by the ice cores researching from Vostok station, which is compared with isotopic graph. This graph describes changes of World ocean level.



Kyanite. Antarctic. From the collection of the Mining Museum

Archegov V.B., Nefedov Y.V. Oil and gas exploration strategy in evaluation of fuel and energy potential of Russian arctic shelf // Journal of Mining Institute. 2015. Vol. 212. P. 6-13 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5223>



Abstract. Oil and gas are the most important resources of the Arctic region. Oil and gas prospecting, exploration and development in the Arctic region is associated with solving complex technical and technological problems. One of the most important achievements was the discovery of the global Arctic zone of oil and gas occurrence. Numerous local objects were mapped and 22 hydrocarbon deposits were found on the shelves of the Barents, Pechora and Kara Seas. In connection with the prospects of developing oil and gas exploration in other Arctic waters (the Laptev Sea, the East Siberian Sea, the Chukchi Sea) geophysical surveys and deep drilling were proposed to be carried out. In the area of transit shallow water it is advisable to use jack-up platforms with retractable legs. Deep drilling from islands is suggested for other parts of the seas with increasing depth and difficult ice conditions (icebergs, drifting ice fields, storms) and other climatic characteristics that increase the risk of drilling from offshore platforms. For performing hydrological

and geophysical studies (studies of temperatures in layers, salinity, density, gas hydrates, and other characteristics of water in marine basins) it is possible to use «point» drilling and submarine fleet to study bottom sediments and geological section in promising areas.

Kholmyanskii M.A., Pavlov S.P., Putikov O.F. Application of the geoelectrochemical method for prospecting of oil and gas deposits in the Barents and Kara seas // Journal of Mining Institute. 2015. Vol. 215. P. 25-28 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5179>



Abstract. The use of the geoelectrochemical method of ion-selective electrodes for continuous recording of hydrocarbon micro-components – heavy metals – during the vessel movement to search for oil and gas deposits on the shelf is justified theoretically and experimentally. The existence of «jet» halos in the water column above the shelf oil and gas deposits is discovered experimentally and the method of geoelectrochemical ion-selective electrodes as well as the developed instrumentation for recording these halos is described. The application of a new geoelectrochemical method for prospecting in motion (without sampling) both structural and non-structural oil and gas deposits on the shelf is justified.

Evdokimov A.N., Smirnov A.N., Fokin V.I. Mineral resources in Arctic Islands of Russia // Journal of Mining Institute. 2015. Vol. 216. P. 5-12 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5160>



Abstract. There is an increased interest in the Arctic regions of the planet in recent years. Russia has the longest Arctic shelf with great prospects for hydrocarbons under its jurisdiction. So, the Arctic Islands will play a major role as an infrastructural base for development of oil and gas resources on the shelf in the Arctic Ocean in the near future. Minerals of major islands and archipelagos of the Russian Arctic: Novaya Zemlya, Franz-Josef Land, Severnaya Zemlya, the New Siberian Islands and the Wrangel Island as well as the Spitsbergen archipelago (Norway) where Russia has its own territory formally enshrined for the extraction of coal and other minerals are considered in the article.

Litvinenko V.S. Unique engineering and technology for drilling boreholes in Antarctic ice // Journal of Mining Institute. 2014. Vol. 210. P. 5-10 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5259>



Abstract. As the result of many years of research into the processes of the transfer of ice as a rock mass on a global scale, concerning the Antarctic ice sheet at the ultra-deep 5G borehole, a discovery has been made that is of international significance in the areas of glaciology and geodynamics.

Those who created the theory of thermal and mechanical penetration into ice and loose sediments have developed unique technology and engineering processes in order to drill boreholes using thermal and mechanical methods.

Kalashnik A.I. Scientific and technical bases of geodynamic safety of development of hydrocarbonic resources of the Western sector of the Russian Arctic // Journal of Mining Institute. 2013. Vol. 201. P. 261-267. (in Russian). <https://pmi.spmi.ru/pmi/article/view/5756>



Abstract. The concept of basic researches of geodynamic safety oil and gas objects, consisting that the oil and gas object with the geological environment containing it is considered as the difficult open natural-technical system which geomechanical evolution is carried out by cyclic alternation of stages of linear and nonlinear deformation, with probability of spasmodic transition or bifurcation is developed. Methodical approaches to the analysis and an estimation of geodynamic risks are offered. The system structure of geodynamic monitoring of extraction, storage and pipeline transportation of the hydrocarbonic raw materials is developed for the western sector of the Russian Arctic, considering tectono-physical features of region and including complexes of natural measurements, modelling and expert estimations.

Fadeev A.M. Development of Shtokman gas and condensate field – pioneer project on the Russian Arctic shelf // Journal of Mining Institute. 2013. Vol. 201. P. 272-276 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5758>



Abstract. Article shows spectrum of questions related to the development of Shtokman Gas and Condensate Field at Barents sea. Basic technical and economical issues, main approved technological solutions same as the role of

Shtokman project for providing of energetic security are highlighted. Main priorities for involving suppliers and contractors into the project are specified and basic criteria for participation of suppliers into tender procedures are formulated. The considerable attention is paid for ecological safety same as security of life and health of the employees, participated into project realization.

Shkatov M.Y., Sigitova N.V. Institutional aspects of a regional geological survey on the continental shelf of the Russian Federation // Journal of Mining Institute. 2013. Vol. 201. P. 277-281 (in Russian). <https://pmi.spmi.ru/index.php/pmi/article/view/5759>



Abstract. Comprehensive analysis of different institutional models of investments is given for regional geological survey of the Continental Shelf of the Russian Federation. Specific risks of any specific investment model is described. State, general corporate and junior companies' models are discussed. National Operator of Marine Petroleum Geological Surveys (NOGS) model is suggested as a reasonable pathway to decline risks and achieve mutual effectiveness of state and private investments. NOGS mission and some functional features as a state-owned public limited company opened for both portfolio and project private investments are shown.



*Malachite. Copper green coat on gneiss. Gorrsson Archipelago, Antarctic.
From the collection of the Mining University*

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