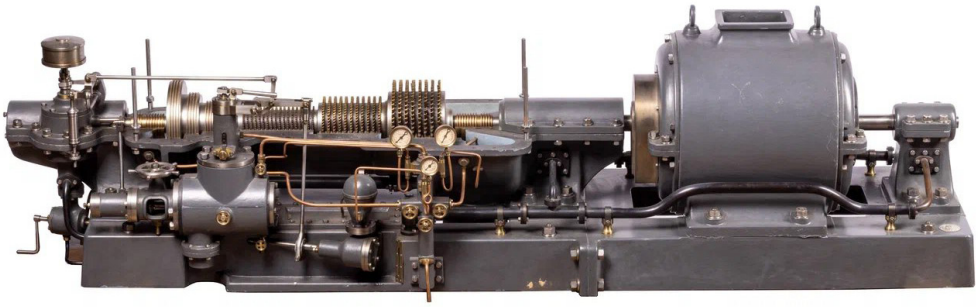
Published by Empress Catherine II
Saint Petersburg Mining University

SINCE 1907

JOURNAL OF MINING INSTITUTE

DIGEST



POWER ENGINEERS' DAY

№ 5 • 2023

PMI.SPMI.RU

FEDERAL STATE BUDGETARY EDUCATIONAL
INSTITUTION OF HIGHER EDUCATION

EMPRESS CATHERINE II
ST. PETERSBURG MINING UNIVERSITY

POWER ENGINEERS' DAY

DIGEST

JOURNAL OF MINING INSTITUTE

№ 5 • 2023

St. Petersburg
2023

Abstract

Electric power industry has always been one of the leading driving forces of progress aimed at improving the living conditions of mankind. The present digest is the first issue in the series of summaries of the fundamental articles about electric power published in Journal of Mining Institute since its foundation in 1907.
The digest presents articles published from 2008 to 2023. The articles are devoted to questions of development of energy in the field of natural resources sector. The main areas of development relate to study and improvement of problems of electric and heat power, including the issues of energy efficiency and preservation, automatic electrical drive, renewable and autonomous power as well as quality of power.

Shishlyannikov D.I., Zverev V.Y., Zvonareva A.G., Frolov S.A., Ivanchenko A.A. Evaluation of the energy efficiency of functioning and increase in the operating time of hydraulic drives of sucker-rod pump units in difficult operating conditions. Journal of Mining Institute. 2023. Vol. 261, p. 349-362. https://pmi.spmi.ru/pmi/article/view/16187

Abstract. The necessity of improving the drives of the sucker-rod hydraulic pump units (SRHP), operated in conditions of marginal and complicated wells, is substantiated. For complicated oil production conditions, it is promising to use the SRHP drive, which makes it possible to select and set rational operating modes for downhole equipment. The results of comparative tests of conventional mechanical and hydraulic actuators SRHP with pneumatic and electrodynamic balancing types are presented. A generalized indicator for evaluating the effectiveness of the advanced SRHP drives functioning, the energy efficiency coefficient, is proposed. It has been experimentally proven that the use of the SRHP drive with pneumatic balancing is characterized by low energy efficiency of the well fluid production process. The use of the tested SRHP hydraulic drive made it possible to successfully eliminate asphalt, resin, and paraffin deposits and minimize the well downtime. The results of the tests of the traditional SRHP mechanical drive and the hydraulic drive with electrodynamic balancing showed a satisfactory energy efficiency of the latter. The advantage of the SRHP drive with electrodynamic balancing is the simplicity of the design of the hydraulic part. The process of energy regeneration during the drive control system operation causes an increase in the reactive power component in the oil field network and the appearance of harmonic interference that adversely affects the consumers operation. Technical solutions aimed at improving the operation energy efficiency and increasing the operating time of SRHP drives in the conditions of marginal and complicated wells are proposed. The methodological bases for assessing the economic efficiency of the introduction of the advanced SRHP drives are given.

Rakhutin M.G., Giang K.Q., Krivenko A.E., Tran V.H. Evaluation of the influence of the hydraulic fluid temperature on power loss of the mining hydraulic excavator. Journal of Mining Institute. 2023. Vol. 261, p. 374-383. https://pmi.spmi.ru/pmi/article/view/16193

Abstract. In the steady state of operation, the temperature of a mining excavator hydraulic fluid is determined by the ambient temperature, hydraulic system design, and power losses. The amount of the hydraulic system power loss depends on the hydraulic fluid physical and thermodynamic properties and the degree of wear of the mining excavator hydraulic system working elements. The main causes of power losses are pressure losses in pipelines, valves and fittings, and leaks in pumps and hydraulic motors. With an increase in the temperature of hydraulic fluid, its viscosity decreases, which leads, on the one hand, to a decrease in power losses due to pressure losses in pipelines, valves and fittings, and, on the other hand, to an increase in volumetric leaks and associated power losses. To numerically determine the level of power losses occurring in the hydraulic system on an example of the Komatsu PC750-7 mining excavator when using Shell Tellus S2 V 22, 32, 46, 68 hydraulic oils with the corresponding kinematic viscosity of 22, 32, 46, 68 cSt at 40 °C, the developed calculation technique and software algorithm in the MatLab Simulink environment was used. The power loss coefficient, obtained by comparing power losses at the optimum temperature for a given hydraulic system in the conditions under consideration with the actual ones is proposed. The use of the coefficient will make it possible to reasonably select hydraulic fluids and set the values of the main pumps limit state and other hydraulic system elements, and evaluate the actual energy efficiency of the mining hydraulic excavator. Calculations have shown that the implementation of measures that ensure operation in the interval with a deviation of 10 % from the optimal temperature value for these conditions makes it possible to reduce energy losses from 3 to 12 %.

Bazhin V.Y., Ustinova Y.V., Fedorov S.N., Shalabi M.E.K. Improvement of energy efficiency of ore-thermal furnaces in smelting of alumosilicic raw materials. Journal of Mining Institute. 2023. Vol. 261, p. 384-391. https://pmi.spmi.ru/pmi/article/view/16128

Abstract. The issues of energy saving in pyrometallurgical production during processing of mineral raw materials in ore-thermal furnaces are particularly important for the development of new energy-efficient technologies. The reduction of the specific power consumption during melting at different stages of heating and melting of charge materials when modeling is related to obtaining kinetic curves in the process of kyanite concentrate regeneration in polythermal conditions. Based on practical data of carbo-thermal reduction the mathematical modeling of reduction processes from alumosilicic raw materials – kyanite was carried out. In this work, the nonisothermal method based on a constant rate of charge heating (i.e. a linear dependence between time and temperature) was used for the reduction of kyanite charge, which saves electrical energy. The experiments were carried out on a high-temperature unit with a heater placed in a carbon-graphite crucible. Based on the obtained kinetic dependences of nonisothermal heating of enriched kyanite concentrates in plasma heating conditions we obtained a number of kinetic anamorphoses of the linear form which point to the possibility of describing the reaction rate using the modified Kolmogorov – Erofeev equation for given heating conditions and within a narrow temperature range. The complex of mathematical modeling makes it possible to create a control algorithm of technological process of reduction of kyanite concentrate to a metallized state within the specified temperature range for the full flow of reaction exchange and to reduce the specific power consumption by 15-20 %. With the help of the received kinetic dependences, taking into account the thermodynamics of processes and current state of the art it is possible to create a universal thermal unit for the optimal carbothermal reduction of charge to a metallized state (alloy) with minimum power inputs compared to existing technologies.

Model of a steam engine equipped with a vertical boiler.
Peterman's machine shop. Saint Petersburg.
Item belongs to the Mining Museum.

Zavyalov V.M., Semykina I.Y., Dubkov E.A., Velilyaev A.-han S. The wireless charging system for mining electric locomotives. Journal of Mining Institute. 2023. Vol. 261, p. 428-442. https://pmi.spmi.ru/pmi/article/view/16188

Abstract. The electric vehicles development has a high potential for energy saving: an energy-saving traffic control can reduce energy resource consumption, and integration with the power grid provides the ability of daily load pattern adjustment. These features are also relevant for underground mining. The critical element of vehicle-to-grid integration is the charging infrastructure, where wireless charging is promising to develop. The implementation of such systems in underground mining is associated with energy efficiency issues and explosion safety. The article discusses the development and research of a wireless charging system for mining electric locomotive A-5.5-600-U5. The analytic hierarchy process is used for justification of the circuitry and design solution by a comparison of different technical solutions based on energy efficiency and safety criteria. A complex computer model of the wireless charging system has been developed that gives the transients in the electrical circuit of a wireless charging system and the high-frequency field density distribution near the transmitting and receiving coils in a 3D setting. An approach to ignition risk evaluation based on the analysis of high-frequency field density in the charging area between the coils of the wireless charging system is proposed. The approach using a complex computer model is applied to the developed system. The study showed that the wireless charging system for mining electric locomotives operating in the gaseous-and-dusty mine is technically feasible and there are designs in which it is explosion safe.

Skamyin A.N., Dobush V.S., Jopri M.H. Determination of the grid impedance in power consumption modes with harmonics. Journal of Mining Institute. 2023. Vol. 261, p. 443-454. DOI: 10.31897/PMI.2023.25

Abstract. The paper investigates the harmonic impedance determination of the power supply system of a mining enterprise. This parameter is important when calculating modes with voltage distortions, since the determined parameters of harmonic currents and voltages significantly depend on its value, which allow the most accurate modeling of processes in the presence of distortions in voltage and current. The power supply system of subsurface mining is considered, which is characterized by a significant branching of the electrical network and the presence of powerful nonlinear loads leading to a decrease in the power quality at a production site. The modernization of the mining process, the integration of automated electrical drive systems, renewable energy sources, energy-saving technologies lead to an increase in the energy efficiency of production, but also to a decrease in the power quality, in particular, to an increase in the level of voltage harmonics. The problem of determining the grid harmonic impedance is solved in order to improve the quality of design and operation of power supply systems for mining enterprises, taking into account the peculiarities of their workload in the extraction of solid minerals by underground method. The paper considers the possibility of determining the grid impedance based on the measurement of non-characteristic harmonics generated by a special nonlinear load. A thyristor power controller based on phase regulation of the output voltage is considered as such a load. Simulation computer modeling and experimental studies on a laboratory test bench are used to confirm the proposed method. The recommendations for selecting load parameters and measuring device connection nodes have been developed.

Shpenst V.A., Belsky A.A., Orel E.A. Improving the efficiency of autonomous electrical complex with renewable energy sources by means of adaptive regulation of its operating modes. Journal of Mining Institute. 2023. Vol. 261, p. 479-492. https://pmi.spmi.ru/pmi/article/view/16177

Abstract. Renewable energy sources are gradually becoming useful in mining industry. They are actively used in remote, sparsely populated areas to power shift settlements, geological and meteorological stations, pipeline equipment, mobile cell towers, helicopter pads lighting, etc. In comparison with diesel generators, systems with renewable sources do not require fuel transportation, have short payback periods and flexible configuration for different categories of electrical loads. The main obstacles to their spread are instability of generation and high cost of produced electricity. One of the possible ways to solve these problems is to develop new technologies, increase power density of generators and energy storage systems. The other way represents energy saving and rational use of affordable resources. The new solutions for implementation of the second method are proposed in this work. The object of the study is autonomous DC electrical complex with photovoltaic and wind power sources. In such systems the generated power from renewable sources is transferred to consumers via intermediate DC bus, the voltage level of which affects the power losses in the process of power transmission. The vast majority of complexes have a problem that their DC bus voltage is constant, while the optimum voltage level with lowest losses varies depending on the generated and consumed power. Therefore, electrical complexes potentially lose a part of the transmitted energy. To avoid this, a special algorithm was added to automatically adjust DC bus voltage to optimum level according to changes in working conditions. An additional contribution to efficiency improvement can be made by dynamic change of operating frequency in power converters depending on their load. The evaluation based on results of computer simulation showed that in a complex with rated power 10 kW active power losses during its lifetime can be reduced by 2-5 %.

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. https://pmi.spmi.ru/pmi/article/view/16179

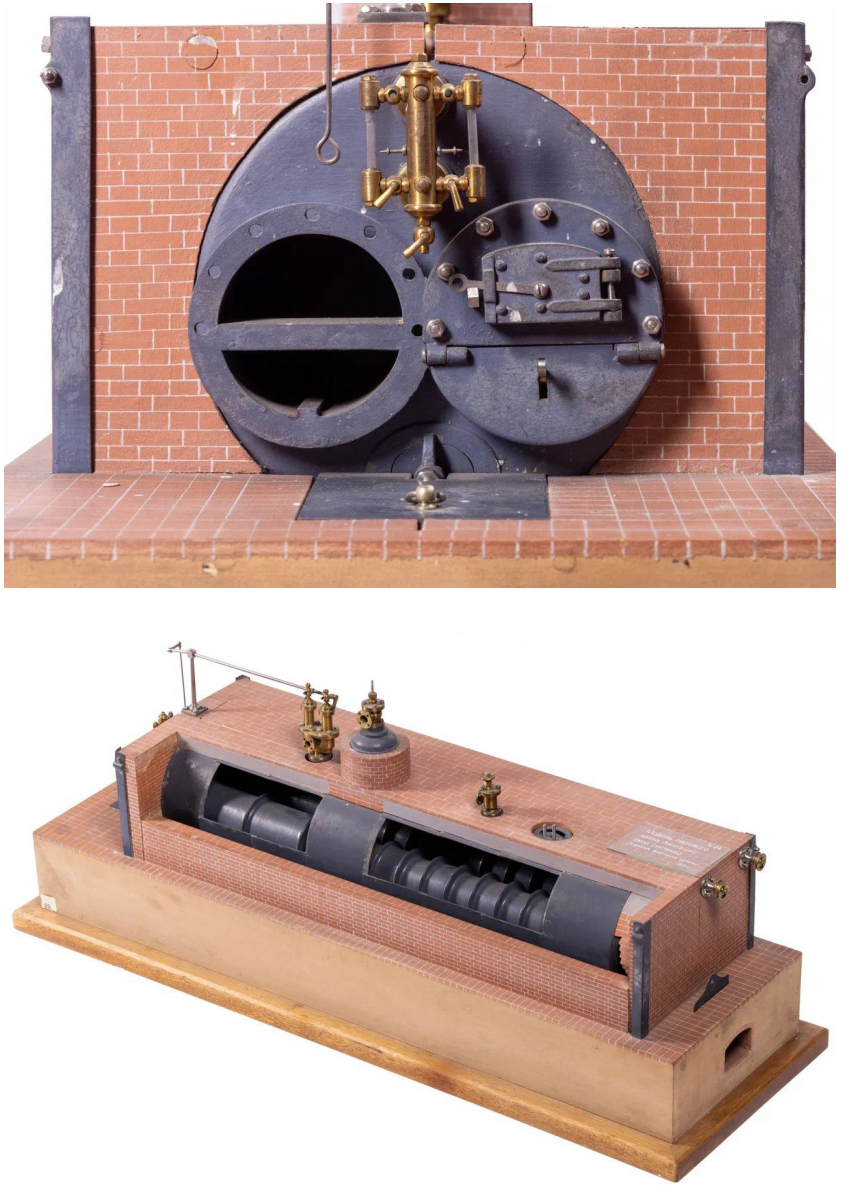
Abstract. The actual task of the state is to increase the energy efficiency of the oil refinery. The object of research is a vacuum distillation unit, including a preheating unit for raw materials and a furnace for heating fuel oil before the column. Pinch analysis allows to analyze and optimize a large 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.

Shklyarskiy Y.E., Batueva D.E. Operation mode selection algorithm development of a wind-diesel power plant supply complex. Journal of Mining Institute. 2022. Vol. 253, p. 115-126. DOI: 10.31897/ PMI.2022.7

Abstract. The power supply system is affected by external disturbances, so it should be stable and operate normally in compliance with power quality standards. The power supply system goes into abnormal modes operation when, after a short-term failure or disturbance, it does not restore normal mode. The electrical complex, which includes a wind power plant, as well as a battery and a diesel generator connected in parallel, is able to provide reliable power supply to consumers which meets the power quality indicators. The article develops an algorithm that is implemented by an automatic control system to select the operating mode depending on climatic factors (wind) and the forecast of energy consumption for the day ahead. Forecast data is selected based on the choice of the methods, which will have the smallest forecast error. It is concluded that if the energy consumption forecast data is added to the automatic control system, then it will be possible to increase the efficiency of the power supply complex. In the developed algorithm the verification of normal and abnormal modes of operation is considered based on the stability theory. The criteria for assessing the normal mode of operation are identified, as well as the indicators of the object's load schedules for assessing the load of power supply sources and the quality standards for power supply to consumers for ranking the load by priority under critical operating conditions and restoring normal operation are considered.

Shklyarskiy Y.E., Guerra D.D., Iakovleva E.V., Rassolkin A. The influence of solar energy on the development of the mining industry in the Republic of Cuba. Journal of Mining Institute. 2021. Vol. 249, p. 427-440. DOI: 10.31897/PMI.2021.3.12

Abstract. Cuba is traditionally considered a country with an underdeveloped industry. The share of the mining and metallurgical industries in the gross industrial production of the republic is small – about 3 % of GDP. The development of deposits and the extraction of nickel ores is an important sector of the economy of the Republic of Cuba, since the largest reserves of nickel and cobalt on the North American continent are located on the territory of the country. The development of the country energy system can serve as a growth factor in this sector of the economy. Due to climatic features and impossibility of integrating new capacities into the energy system through the construction of hydroelectric power plants, solar energy is a promising direction. Determining the feasibility of using solar tracking systems to increase the generation of electricity from solar power plants is one of the main challenges faced by engineers and renewable energy specialists. Currently, there are no solar tracking systems in Cuba that can provide information to assess the effectiveness of this technology in the country. The lack of the necessary technologies, as well as the high cost of developing solar power plants with tracking systems, limit the widespread introduction of such complexes. Hence follows the task of creating an inexpensive experimental model that allows assessing the effectiveness of tracking systems in specific weather conditions of the Republic of Cuba. This model will allow in future to increase the efficiency of electrical complexes with solar power plants, which provide power supply to the objects of the mineral resource complex and other regions.



Model of a Lancashire boiler (with two flues). 1891.
Item belongs to the Mining Museum.

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.

Klyuev R.V., Bosikov I.I., Gavrina O.A. Improving the efficiency of relay protection at a mining and processing plant. Journal of Mining Institute. 2021. Vol. 248, p. 300-311. DOI: 10.31897/PMI.2021.2.14

Abstract. The paper presents the results of constructing effective relay protection in the power supply system of a mining and processing plant (MPP). A brief description of the MPP is given, the power supply and substitution circuits used to calculate the short-circuit currents are given. A statistical analysis of failures in the electric network of the MPP has been carried out, which makes it possible to draw conclusions about the nature of failures ranges. Analysis of the registered faults shows that a significant part of them are line-to-earth faults, which in most cases turn into multiphase short circuits, which are interrupted by overcurrent protection. In order to improve the efficiency and reliability of the relay protection, the power supply scheme of the MPP was refined and analyzed. The calculation of the short-circuit currents was made, which made it possible to calculate the settings of the relay protection and give recommendations on the place of its installation and adjustment in order to ensure the normal operation of electricity consumers. To reduce the number of failures to the cable insert on the line leaving the administrative and household complex (AHC), and to increase the reliability of power supply to consumers, it is advisable to divide the capacities of the existing 10 kV line into two parallel ones by laying a second line. It is recommended to install a current cut-off on the line outgoing to the AHC, the feasibility of the installation of which was shown by calculations. This will reduce the chance of failures to the cable gland. Data on the setting currents of overcurrent protection and current cut-off are given on the selectivity card.

Vorontsov A.G., Glushakov V.V., Pronin M.V., Sychev Y.A. Cascade frequency converters control features. Journal of Mining Institute. 2020. Vol. 241, p. 37-45. DOI: 10.31897/PMI.2020.1.37

Abstract. The structures of systems with high-voltage cascade frequency converters containing multi-winding transformers and low-voltage low-power converters connected in series at each output phase of the load are considered. Low-voltage blocks contain three-phase diode or active rectifiers, DC capacitor filters, single-phase stand-alone voltage inverters and block disconnecting devices in partial modes (in case of failure when part of the blocks are disconnected). The possibilities of operation of cascade converters are determined, equations for correcting tasks to units in partial modes are given, tables of correction of tasks with estimates of achievable load characteristics are proposed. The results of experiments on the model of a powerful installation with a cascade frequency converter are presented, confirming the possibility of ensuring the symmetry of the load currents when disconnecting part of the blocks and the asymmetry of the circuit.

MGS 573/111. Kyanite within crystalline schale, Karelia. Item belongs to the Mining Museum.

Jiménez Carrizosa M., Stankovic N., Vannier J.-C., Shklyarskiy Y.E., Bardanov A.I. Multi-terminal DC grid overall control with modular multilevel converters. Journal of Mining Institute. 2020. Vol. 243, p. 357-370. DOI: 10.31897/PMI.2020.3.357

Abstract. This paper presents a control philosophy for multiterminal DC grids, which are embedded in the main AC grid. DC transmission lines maintain higher power flow at longer distances compared with AC lines. The voltage losses are also much lower. DC power transmission is good option for Russian north. Arctic seashore regions of Russia don't have well developed electrical infrastructure therefore power line lengths are significant there. Considering above it is possible to use DC grids for supply mining enterprises in Arctic regions (offshore drilling platforms for example). Three different control layers are presented in an hierarchical way: local, primary and secondary. This whole control strategy is verified in a scaled three-nodes DC grid. In one of these nodes, a modular multilevel converter (MMC) is implemented (five sub-modules per arm). A novel model-based optimization method to control AC and circulating currents is discussed. In the remaining nodes, three-level voltage source converters (VSC) are installed. For their local controllers, a new variant for classical PI controllers are used, which allow to adapt the values of the PI parameters with respect to the measured variables. Concerning the primary control, droop control technique has been chosen. Regarding secondary level, a new power flow technique is suggested. Unbalance conditions are also verified in order to show the robustness of the whole control strategy.

Belsky A.A., Dobush V.S., Haikal S.F. Operation of a single-phase autonomous inverter as a part of a low-power wind complex. Journal of Mining Institute. 2019. Vol. 239, p. 564-569. DOI: 10.31897/PMI.2019.5.564

Abstract. The article discusses the experience of operating a wind power complex with a low-power wind power installation (5 kW), the use of which is promising for powering remote oil production facilities, exploration and other types of mining operations. The structure of the studied complex and its characteristics, technical problems that have arisen during operation for 6 years are given. The elements of the wind energy complex – the battery charge regulator and the inverter-converter are considered. The consequences of the mechanical regulator failure of battery charge are considered and recommendations for its replacement are presented. The issues of diagnostics and repair of one of the main elements of the complex – the inverter-converter, its component – DC link are highlighted in detail. Oscil- lograms of the output voltage of the inverter-converter are presented for different capacities of the DC link and the images of the repaired inverter-converter are given. Recommendations are given on choosing an inverter-converter and setting up the operating modes of the wind energycomplex.

Pirog S., Shklyarskiy Y.E., Skamyin A.N. Non-linear electrical load location identification. Journal of Mining Institute. 2019. Vol. 237, p. 317-321. DOI: 10.31897/PMI.2019.3.317

Abstract. The article discusses the issues of identifying the location of non-linear loads in electrical networks which makes the main contribution to the distortion of the non-sinusoidal voltage and current in the distribution network of an industrial enterprise, including mining enterprises. The existing methods for determining the location of the source of higher harmonic components in voltage and current are considered, their advantages and disadvantages are revealed. The main disadvantages of the methods used include the low accuracy and

incorrectness of their use in existing enterprises. When developing a new method, the authors were faced with the task of simplicity of its use in the conditions of industrial operation of electrical equipment and the absolute correctness of the results obtained. The proposed method of identifying the source of higher harmonics is based on the variation of the parameters of the power system, in particular, the change in resistance of power transformers taking into account their transformation ratio. It is shown that by varying the transformation ratio during regulation under load, the total coefficient of the harmonic components of the voltage changes. Based on the constructed dependencies, the variation of the derivative of this function with different variations of the parameters of sources of higher harmonics is analyzed and a method is developed that allows determining the share contribution of consumers to the total harmonic component of the voltage.

Solovev S.V., Kryltcov S.B., Munoz-Guijosa J.M. Application of an active rectifier used to mitigate currents distortion in 6-10 kV distribution grids. Journal of Mining Institute. 2019. Vol. 236, p. 229-238. DOI: 10.31897/pmi.2019.2.229

Abstract. The paper addresses issues of using the active rectifier in partially loaded variable frequency drive as active filter in the conditions of non-sinusoidal current and voltage disturbances caused by the presence of high-power non-linear load in the grid. The topology of transformless three-level converter for 6-10 kV suitable for proposed solution has been presented and its mathematical model has been de-rived. Based on the model, the direct power control algorithm with ability to compensate non-linear currents has been designed. The investigation of active rectifier efficiency was performed depending on the relation between linear and non-linear load currents of the grid node, as well as on active power load of the active rectifier. Efficiency analysis was based on the developed computer model of the grid node with connected non-linear load simultaneously with the variable frequency drive with active rectifier.

Shpenst V.A. Complexation of telecommunications and electrical systems in mines and underground facilities. Journal of Mining Institute. 2019. Vol. 235, p. 78-87. DOI: 10.31897/PMI.2019.1.78

Abstract. The possible options for the integration of telecommunications and electrical systems of mining enterprises are considered. Based on an analysis of the current state and prospects for the development of telecommunications systems, various technical solutions are proposed for sharing the power supply networks available in mines and underground structures in order to solve the problems of telecommunication, automate process control and ensure the safety of operations. The analysis of the possibilities of applying the PLC technology in underground structures and mines for solving specific telecommunication problems has been carried out, and examples of their possible technical and hardware implementation are given.

Eshchin E.K. Calculations of dynamic operating modes of electric drives of self-propelled mining machines. Journal of Mining Institute. 2018. Vol. 233, p. 534-538. DOI: 10.31897/PMI.2018.5.534

Abstract. The task of improving the calculations of the dynamic modes of electric drives of self-propelled mining machines, particulary, tunneling machines, is considered. Attention is drawn to the possibility to operate in dynamic modes of a spatial change in the an asynchronous electric motor stator housing position, included in the electric drive, around the axis of its rotor due to the ultimate rigidity of the supports of the mining machine. In connection to this, it is possible to change the absolute angular velocity of rotation of the electromagnetic field of the stator of this electric motor. The necessity of introducing into existing mathematical models that determine the state and behavior of asynchronous electric motors, additional differential and algebraic relations for calculating the absolute speed of the electromagnetic field of the stator and

the nature of the motion of the stator housing of the electric motor as part of the mining machine is noted. The results of calculations of the idle start mode of the electric motor of the executive body of the mining combine are shown, showing the difference in the nature of its electromagnetic moment variation, rotor rotation speed, as well as efforts in individual reducer elements of the driving body driving the stator body from similar calculation results without taking into account the stator body movement. The conclusion is made about the possible discrepancy between the calculated and experimental results in the study of the dynamic modes of self-propelled mining machines.

Kolesnichenko S.V., Afanaseva O.V. Theoretical aspects of the technical level estimation of electrical engineering complexes. Journal of Mining Institute. 2018. Vol. 230, p. 167-175. DOI: 10.25515/PMI.2018.2.167

Abstract. The results of the analysis of methods allowing to evaluate the technical level of the electro technical complex (ETC) are presented and an original technique based on the application of the integral indicator is presented. The characteristic of each stage of the technique is given. The proposed scientific and methodological apparatus for assessing the technical level of the ETC is illustrated by the examples of the executive elements of the ETC comparison (internal combustion engines) using an integral quality index that links both the main characteristics of the samples and the means spent for achieving them. The proposed approach for assessing the technical level and quality of the ETC on the basis of an integral indicator should be carried out already at early stages of the life cycle when solving the following problems: the rationale for the economic feasibility of developing new or improving the quality of the produced ETCs; choice of the best option for the developed ETC; justification of requirements for the ETC; decision-making on the establishment and removal of ETC from production; substantiation of the rules of operation of the ETC in various conditions.

Frolov V.Y., Zhiliglotov R.I. Development of sensorless vector control system for permanent magnet synchronous motor in Matlab Simulink. Journal of Mining Institute. 2018. Vol. 229, p. 92-97. DOI: 10.25515/PMI.2018.1.92

Abstract. In last 20 years segment of electric drives with permanent magnet synchronous motors has increased. This type of motors has better technical characteristics compared to induction motors, but has problems in actual implementation, one of which is the requirement of rotor position data. It is possible to implement with use of sensors or without them by means of motor state observer. The paper describes problems of sensorless vector control system for permanent magnet synchronous motors. The vector control system with state observer for permanent magnet synchronous motors is described. Synthesis of sliding mode observer for rotor speed and position is presented. The algorithm is implemented by development of model in Matlab Simulink environment with support by Texas Instruments processors support blocks. Experimental comparison of results of rotor angle state calculation and the data obtained by rotor position sensors was conducted. Research objective is a development of control algorithm, which has required precision for calculation of rotor start angle, high range of speed regulation and resistance to drift of motor parameters.

Shklyarskii Y.E., Pirog S. Impact of the load curve on losses in the power supply network of the company. Journal of Mining Institute. 2016. Vol. 222, p. 858-863. DOI: 10.18454/PMI.2016.6.858

Abstract. In the recent years, the researchers and experts in the field of energetics often mention in their publications a need to reduce power transmission losses. Among different ways to accomplish this goal the method of the company load leveling stands out due to its simplicity, accessibility and efficiency. The paper proposes a new assessment factor for additional power losses in distribution network. It is known that dispersion of the load curve correlates with the amount of power losses, which is why the proposed factor is put in a position of dependency on the shape of the load curve of the company. It is demonstrated that the proposed factor can help to identify without any strain a need in technical measures for levelling the load curve of the company and to assess efficiency thereof.

The model of a high pressure water turbine designed by Professor I.A. Time. Certified at the World's Fair in Vienna in 1873. F. Elery's machine shop. Saint Petersburg. Presented by Professor I.A. Time. Item belongs to the Mining Museum.

Pankov A.I., Frolov V.Y. Simulation of onboard power supply system for small hydrographic vessel «Vaygach». Journal of Mining Institute. 2016. Vol. 222, p. 852-857. DOI: 10.18454/PMI.2016.6.852

Abstract. Computer simulation is a method resorted to more and more frequently for the development of the prospective power supply systems, in particular the vessel power supply system. It provides valuable insights into the transient processes and indicators of electric power quality in the system without building its physical model, thus significantly improving the efficiency and quality of the physical model. Nowadays MathLab package with Simulink application is used with increasing frequency for simulation of such systems. The paper presents a model of the power supply system of small hydrographic vessel 'Vaygach' built in MatLab environment. The system vulnerabilities and their remedies have been identified. Changes in sinusoid before and after the non-linear load on the network have been demonstrated and solutions for improving the non-linear distortion factor are proposed. The model developed for the vessel power supply system can be used for building models of different vessels.

Kozyaruk A.E. Development experience and development prospect of electromechanical technological complexes of movement and positioning of technic shelf development equipment. Journal of Mining Institute. 2016. Vol. 221, p. 701-705. DOI: 10.18454/PMI.2016.5.701

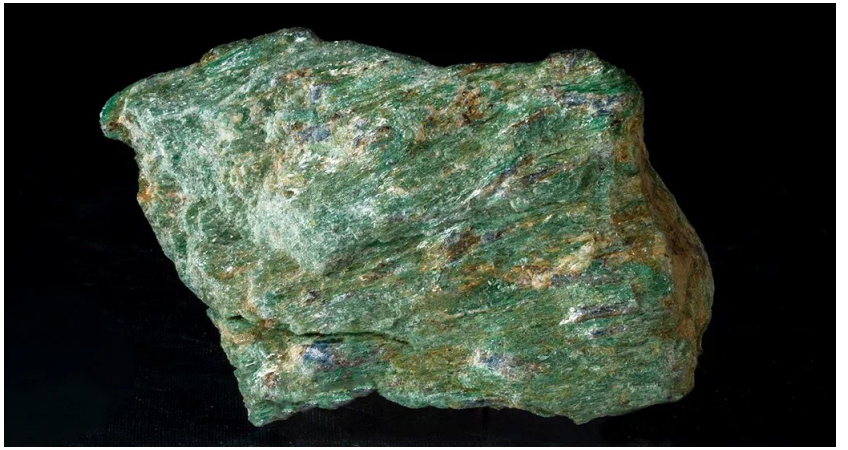
Abstract. From the example of active semisubmersible drilling rigs it is shown characteristics of electromechanical complexes of drill rigs and anchor position control systems on the base of controlled electric drive with directcurrent motors. It is presented suggestions which allow increasing electric power and service reliability criteria through the use of semiconductor converters supplied from power semiconductor converter with active front end in technological drilling systems, propulsion and position control systems of electromechanical systems on the base of noncontact asynchronous motors. It is outlined information about experience of using such kind of electromechanical complexes at the objects of mining industry working in difficult operating conditions. It is presented information about developing of electromechanical complexes of displacement systems, position control systems, technological and technical shelf development equipment and their characteristics. Also it is outlined structures and examples of designing modern high efficiency systems with contactless actuating motors.

Kozyaruk A.E. Energy efficient electromechanical systems of mining and transport machines. Journal of Mining Institute. 2016. Vol. 218, p. 261-269. https://pmi.spmi.ru/pmi/article/view/5106

Abstract. The problems of selecting the type and the structure of mining and transport machines electromechanical control system, providing energy efficiency and performance. The conclusion about the most admissibility of variable frequency drives with induction motors and power semiconductor converters was made. The methods and technical means of improving the energy efficiency of asynchronous electric motors due to the choice of increased power characteristics motors, design of special motor control algorithms and applying of semiconductor converters with active rectifiers, providing high power factor and improving of the electricity supply quality were reviewed. To improve the operational characteristics prompted use of diagnostic systems and residual life assessment of electrical equipment. Implementation of designs tied to the excavator-transport sector. The schemes of the excavator power drive, mining truck and implemented complex picture at coal mine are shown.

Shonin O.B., Pronko V.S. Energy-efficient control of asynchronous motor drive with current refinement of the loss minimum on the basis of fuzzy logic. Journal of Mining Institute. 2016. Vol. 218, p. 270-280. https://pmi.spmi.ru/pmi/article/view/5107

Abstract. Currently, asynchronous electric drive on the basis of semiconductor frequency converters is widespread because of the relative simplicity and reliability of the design, the use of digital control systems, providing the accuracy and flexibility of process control, which allows for a significant increase in product quality, reduction in energy consumption and improvement of the enterprise profitability. In spite of these advantages, the problem of ensuring high energy efficiency of the drive in wide range of its operational modes is still not solved in full scale. The paper is devoted to the reduction of losses in the asynchronous drive on the basis of en-ergy-saving control algorithms that aim to ensure the desired mode of the driven mechanism while minimizing losses in copper and steel of the motor. On the basis of the motor model, taking into account magnetic losses, dependences of losses in the copper and steel, as well as the total loss from the absolute slip have been derived for different operating points of the drive. The optimal values of the absolute slip for different speeds of the rotor have been obtained for use in the con-trollers ensuring operation of the drive at maximum efficiency, highest power factor and minimum of the stator current. For minimizing the losses in the drive when changing the motor parameters it has been offered the combined method based on the method of loss model and iterative method of searching the minimum of power consumption. The effectiveness of the proposed control system using fuzzy logic is confirmed by comparing the graphs of losses and efficiency, obtained at using a traditional control law and the optimal control law.



MGS 573/125. Kyanite within fuchsite shale, Karelia. Item belongs to the Mining Museum.

Lyashenko A.L., Pershin I.M. Development of the stepper motor control system in steam generating units. Journal of Mining Institute. 2015. Vol. 213, p. 62-70. https://pmi.spmi.ru/pmi/article/view/5216

Abstract. The article deals with the design and operation of a steam generating unit through the example of the reactor core RBMK-1000 (High Power Channel-type Reactor). It contains the description of the equipment being a part of the multiple forced circulation circuits (MFCC), which form the reactor. Careful consideration is given to the process of controlling the coolant flow in the reactor fuel channels via shut-off control valve (SOCV) and the necessity of its (the process) automation. The problem of SOCV automatic control system synthesis is formulated and solved. The possibility of using a device with extended frequency response (EFR) for a frequency response analysis of distributed parameter systems (DPS) is considered. The problem of developing a method for calculating the settings of the distributed PID-controller is formulated and solved. Software for the simulation of thermal field in the reactor core is developed.

Limanskii A.V., Vasileva M.A. Use of renewable energy sources in the coal industry. Journal of Mining Institute. 2014. Vol. 210, p. 86-92. https://pmi.spmi.ru/pmi/article/view/5269

Abstract. There are three fundamental basic documents in energy conservation and energy efficiency today: the Energy Strategy in the period up to 2030; the Federal Law «On energy-saving and energy efficiency and in amending particular legislative acts of the Russian Federation»; and the State Energy Conservation and Energy Efficiency Program in the period up to 2020. In recent years, the upward trend in the use of renewable energy sources (RES) is becoming all the more evident. Until recently, the development of energy has seen a clear pattern: the areas of energy which have developed most are those which have a quite fast direct economic effect. The social and environmental impacts associated with these areas were considered only as incidental, and their role in decision-making was negligible. With this approach, we considered RES only as a future energy source, when traditional energy sources have been exhausted, or when obtaining them becomes extremely expensive and timeconsuming. The primary driver behind the intensive development of RES has been public pressure based on environmental concerns, rather than economic calculations about the future. The economic potential of the world's renewable energy is currently estimated at 20 billion tons of oil equivalent per year, which is twice the annual output of all fossil fuels. This fact shows us the path of energy development in the near future. In this paper, on the basis of the laws of the Russian Federation, renewable energy in the coal industry is considered. We describe the experience and prospects of the use of mine water and burning rock dumps.

Zhukovskii Y.L., Sizyakova E.V. The introduction of the system of energy saving and energy efficiency at the enterprises of metallurgy. Journal of Mining Institute. 2013. Vol. 202, p. 155-160. https://pmi.spmi.ru/pmi/article/view/5678

Abstract. In the article the basic principles of energy conservation and efficiency of the enterprises of metallurgy. The analysis of the energy saving potential in the metallurgical complex. We describe the stages of implementation of energy management, energy analysis of the structure of the enterprise.

Abramovich B.N., Yakovleva E.V. Photovoltaic power plant of direct conversion for the mineral raw complexes. Journal of Mining Institute. 2012. Vol. 196, p. 210-213. https://pmi.spmi.ru/pmi/article/view/6053

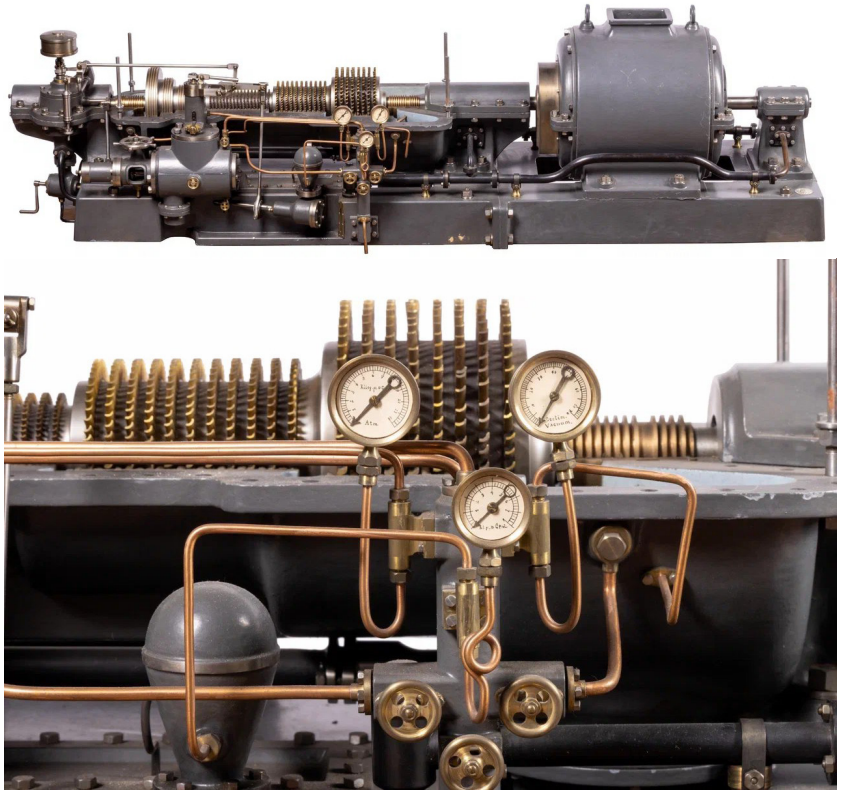
Abstract. Designing of photovoltaic power plant of direct conversion power of 1 kW simplifies the process of performance and direction at the mineral raw complexes. This work examine existing at present day PV cells, it is selected the more suitable for the conditions of mines, open pits and oil-producing enterprise. It is presented the structure of photovoltaic power plant.

Ivanchenko D.I., Shonin O.B. Identification of turn to turn faults in power transformers by means of the amplitude-phase analysis of negative sequence currents. Journal of Mining Institute. 2012. Vol. 196, p. 240-243. https://pmi.spmi.ru/pmi/article/view/6060

Abstract. The paper is dedicated to analyzing identification of turn to turn faults by digital differential protection relay of power transformers. Reliable algorithms of finding turn to turn faults from external faults and transformer inrush are described.

Shklyarskii Y.E., Dobush V.S. Evaluation of phase relationships harmonics frequency drives. Journal of Mining Institute. 2012. Vol. 196, p. 285-288. https://pmi.spmi.ru/pmi/article/view/6070

Abstract. In article the new approach to modelling of processes arising in the presence of the frequency electric drives is offered, offering to consider corners of shift of phases on various harmonics. Research of power characteristics of a frequency drive was spent on the basis of the spent experiment.



A model of a Brown, Bovery-Parsons system steam turbine, 1906, Frankfurt. Item belongs to the Mining Museum.

Abramovich B.N., Belskii A.A. Selecting parameters of wind and diesel power plant for power supply of mining intallations. Journal of Mining Institute. 2012. Vol. 195, p. 227-230. https://pmi.spmi.ru/pmi/article/view/6142

Abstract. The paper is dedicated to analyzing the use of wind and diesel power plants for the power supply of mining facilities located remotely from centralized power supply networks. Regions which are promising in terms of using their wind potential are determined. An example of the network for using a wind and diesel power plant to supply submersible motors of centrifugal pumps in an oil well cluster is presented.

Ivanchenko D.I., Shonin O.B. Application of Kalman filter for digital differential protection relay of power transformers. Journal of Mining Institute. 2012. Vol. 195, p. 255-258. https://pmi.spmi.ru/pmi/article/view/6148

Abstract. The paper is dedicated to analyzing the use of Kalman filtering theory for Application in digital differential protection relay of power transformers. The state variables for the fault identification and protection operation criteria are described. Comparison of operation times of differential protections, based on Kalman filtering theory and Fourier algorithm is presented.

Kudryavtseva A.V., Shonin O.B. Optimization of pulse width modulation for multilevel converters of variable-frequency electric drive. Journal of Mining Institute. 2012. Vol. 195, p. 263-267. https://pmi.spmi.ru/pmi/article/view/6150

Abstract. The paper is dedicated to optimization of a pulse width modulation (PWM) in multilevel inverters with floating capacitors. Comparison of PWM techniques which satisfy the condition of a capacitor voltage balance is presented from the electromagnetic compatibility point of view for the case of a fan-loaded induction motor.

Proskuryakov R.M., Kopteva A.V., Voityuk I.N. Automatic adjustment of metrology performance meter random signal transducer analyzer liquid flows. Journal of Mining Institute. 2012. Vol. 195, p. 277-280. https://pmi.spmi.ru/pmi/article/view/6153

Abstract. New way of statistical pulsation measurements by radioisotope technique is described, being alternative to the existing stream control methods and allowing to improve accuracy of measurements. The basic formula fundamental for the method of calibration characteristics correction is shown.

Shklyarskii Y.E., Gonsales Palau I. Reactive power compensation optimization and its optimization in the electrical network complex. Journal of Mining Institute. 2011. Vol. 194, p. 349-352. https://pmi.spmi.ru/pmi/article/view/6211

Abstract. The optimization of reactive power compensation in the presence of harmonics in the electrical network complex is a complicated computational problem. The authors propose a calculation method that significantly reduce the computation procedure and still get the desired result as the choice of device parameters for reactive power compensation and harmonics filters.

Shklyarskii Y.E., Skamin A.N. Reduction methods of high harmonics influence on the electric equipment operation. Journal of Mining Institute. 2011. Vol. 189, p. 121-124. https://pmi.spmi.ru/pmi/article/view/6503

Abstract. This work contains brief analysis of high harmonics reduction methods. It is offered to make a choice between reduction methods of high harmonics influence on condenser batteries depending on factors of harmonics occurrence. Definition algorithm for the most effective method of high harmonics reduction on condenser batteries operation is created.

Skamin A.N. Efficiency increasing of condenser batteries operation in mining enterprise`s electric circuits. Journal of Mining Institute. 2011. Vol. 189, p. 107-110. https://pmi.spmi.ru/pmi/article/view/6499

Abstract. This work contains the method of effective reactive power compensation at the expense of high harmonics reduction. The decrease of condenser batteries overloading from the high harmonics is based on variation of condenser power depending on current and voltage spectral structure, electric network parameters and load power.

Model of a solenoid electric drill. Union Rock Drill, USA, 1870s.
One of the first electric drills in the world. Scale 1:6.
Presented by Engineer L. Nikolsky. Item belongs to the Mining Museum.

Turysheva A.V. Electrical supply of power installations of oil extracting from independent power stations. Journal of Mining Institute. 2010. Vol. 186, p. 156-160. https://pmi.spmi.ru/pmi/article/view/6733

Abstract. In article the imitating model of the closed system of an independent electrical supply with the energy carrier in the form of passing oil gas, with which help probably is presented: to establish parities of capacities of microturbine installation and погружного the electric motor for system work in a nominal mode; to eliminate the higher harmonious components of a current and pressure for maintenance with the electric power of the remote areas of the oil extracting satisfying with GOST 13109-97.

Imenkhoev I. Application of double-current asynchronous motors with vector regulation (DCAM) used as windmill electric generating plants. Journal of Mining Institute. 2009. Vol. 181, p. 96-103. https://pmi.spmi.ru/pmi/article/view/7039

Abstract. The paper offers a comparative analysis of synchronous motors with frequency converter (SMFC) and double-current asynchronous motors (DCAM) used as variable frequency generators at windmill electric generating plants. Issues of vector control of DCAM's are discussed. Rotor current and decoupling regulating circuits are described as well as circuits to control active and reactive powers.

Kozyaruk A.E., Korzhev A.A., Krivenko A.V. Method of Watt-metrography in the system of monitoring and estimation of operation life for electric equipment. Journal of Mining Institute. 2008. Vol. 177, p. 62-64. https://pmi.spmi.ru/pmi/article/view/7246

Abstract. The method of monitoring and estimation of a residual resource of the electric equipment, based on the analysis of spectrograms of consumed electric capacity is offered. The function chart of the information-diagnostic complex realizing the given method is submitted.

Scientific edition

POWER ENGINEERS' DAY

Digest

JOURNAL OF MINING INSTITUTE

№ 5 • 2023

Editor *S.V. Sinyavina*

Digesters *Y.E. Shklyarskii, P.V. Kotova*

DTP specialist *S.A. Lysenko*

Photos are submissed by the Mining Museum
(photographer *P.V. Dolganov*)

Publishing House
of Empress Catherine II
Saint Petersburg Mining University
https://pmi.spmi.ru

The Mining Museum
https://museum.spmi.ru

Anyone wishing to issue a scientific digest is welcome
to Publishing House of Empress Catherine II Saint Petersburg Mining University
(email: pmi@spmi.ru)