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Table of contents

Scientific committee composition.....	3
Table of contents.....	10
Greetings from the Scientific committee co-chairmen:	
Sorin Mihai Radu, Rector of the University of Petrosani, Romania	13
Viktor Moshynskyi, Rector of National University of Water and Environmental Engineering, Ukraine	14
Section "Sustainable use of natural resources"	
A. (Stanimirescu) Soica, S.M. Radu Water quality of "Valea arsului" tailing dump lake	15
K.B. Rysbekov, M.B. Nurpeisova A.A. Bek Use of enrichment waste for obtaining building materials	16
M.D. Stochitoiu, Ilie Utu Developing solutions in transmission energy system for electroenergetical system decarbonise in romania as part of trilemma energy	19
M. Petlovanyi, K. Sai Research into peculiarities of sealing the underground gas generator during gasification of adjacent coal seams	21
B. Beqaj Reuse of gray water and rain water in a residential complex	24
Toktosunova B.B., Kushnazarova S.Z., Kochogulov M.B. Study of thechemical composition of ore-bearing minerals of the black shale pharmacy of the sarydzhas area of the "Kurgak" deposit	26
Seidu J., Ewusi A., Kuma S. Y. Appraisal of data partitioning and its effect on the performance of artificial neural network models	28
Kiljanek M., Sobczyk W. raw materials and peats as conventional energy sources	30
Gavryushenko O.O., Poznyak V.V., Kharytonov M.M. Biological land reclamation profiles construction and testing in the mining regions of Ukraine	32
N. Salahudeen, U. Ladan low temperature synthesized cone stover activated carbon for adsorption of aqueous crystal violet sorbate	35
E. Juzaszek, W. Sobczyk Landscape transformation under the influence of mining activities	38
Chobotko I.I., Tynyna S.V. Device for extinguishing waste heaps capable of combustion	39
B. Beqaj Qualitative aspects of surface water in Albania	41
Abdullayeva L.A., Ahmadova G.N., Velieva N.V. The use of modified clay minerals in the purification of organic and inorganic pollutants	43
Onoprienko D. M. The application efficiency of agrochemicals with irrigated water	45
M. Poros, W. Sobczyk GLocal geopark holy cross mountain-geological and mining heritage appreciated by unesco	48
Overco M.V., Virich S.O., Babenko M. O. Usage of heat pumps for regulating air temperature in residential areas	50
Shykhov S. K., Schullerus G. Winter M. Rational model of the motor in the forecasting control system of dynamic efficiency of the asynchronous drive	52
Kudrynetskyi R.B., Krupych S.O., Skibchik V.I. Peculiarities of cultivation agricultural crops by no-till technology	54
Bayramova S.S., Mamedova S.H., Agaeva Z.R. Rational use of natural resources in the process of cleaning the ventilation air	56
Cheilytko A.O., Ilin S.V., Yerizanu V.V. Environmental problems of energy and ways to solve them using renewable energy sources	57
Sobczyk E.J., Sobczyk W. Is biomass energy sustainable? Analysis of selected indicators of sustainability	60
Chushkina I.B., Bordalyova A.V., Kostenko E.V. Technology of water use on the example of Zaporizhzhya iron ore plant ..	62
Berezutskyi V.V., Berezutska N.L. Reducing environmental risks of aquatic technical fluids	64
Zhekeyev M.K., Zhekeyeva N.B. Some environmental challenges of the south Kazakhstan and managing them	66
Stepanenko S. P., Dnes I., Popadiuk I. S. Investigation of channel parameters for removal of dust and light garbage impurities from the pneumatic separator	69
Diatel O.O., Diachenko N.O. Assessment of environmental damages and possible consequences of cross-border groundwater pumping by Khotyslavsky quarry	71
Rukhlova N.YU., Lutsenko I.M., Rukhlov A.V. An effective way to maintain the liquidated mines	73
Manidina Y.A. Determination of kinetic characteristics of the sulfur oxide(IV) absorption process by a solution of iron(II, III) compounds	75
Chornyy S.G., Isayeva V.V. The quality of irrigation water of south bug and kamianska irrigation systems	78
Krupych S.O., Krupych O.M., Levko S. I. Requirements for the size of quarters of industrial walnut plantations and calculation of the working cycle time of the machine-tractor unit	80
Gamajunova V. V., Khonenko L. G., Kuvshinova A.O. Measures to preserve soil fertility and effective use of moisture in the zone of the southern steppe of Ukraine	83
Belokon K.V. Intermetallic catalysts development to reduce emissions of motor vehicles through catalytic disposal of pollutants	86
Antonik I.P., Antonik V.I. Level of modern man-made impact on the state of the inhulets river	89
Volk P.P., Dereviachina N.I. Justification of ecologically safe approaches to recultivation of territories of closed coal mines of western Donbas	91
Section "Mining and processing of useful minerals"	
Korniyenko V.Ya., Malanchuk Z.R., Semeniuk V.V. Analysis of known technologies of amber mining in rivne-volyn region	95
Rudko H.I., Lytvyniuk S.F., Karly V.E. Deposits of critical mineral raw materials of ukraine.condition and prospects	97
Lazar M., Faur F. G., Apostu I. M. Establishing the geometry of sterile rocks dumps in the jiu valley region to ensure long-term stability	99

<i>Krukovskiy O.P., Krukovska V.V., Kostytsia A.O.</i> Formation of unloaded zones in hard prone-to-outburst rocks nearby the stope	102
<i>Demin V.F., Kamarov R.K., Zhumabekova A.Ye.</i> Methods of mining seams of the karaganda coal basin	105
<i>Chukharev S.M., Pysmennyi S.V., Zaiets V.V.</i> Enhancement of integrity of over 1000 m deep mine workings AT Kryvyi Rih iron ore basin	107
<i>Shwager N.Y., Komisarenko T.A.</i> Protection of mine workers in emergencies	108
<i>K. M. Tomiczek.</i> Selected annotations on the impact of bedrock vibration accelerations induced by underground mining on the buildings	111
<i>Ishchenko O.K.</i> Efficiency and seismic safety of construction of underground structures in a mass of strong rocks of complex structure	113
<i>Umarova I. K., Aminzhanova S. I., Soledinova E. E.</i> Development of the technological scheme of enrichment iron-containing ore of the tebinbulak deposi	115
<i>Vu Trung Tien</i> Research and application of semi-mechanized mining technology for a few mines of dong bac corporation in quang ninh coalfield, Vietnam	118
<i>Dmytrenko V.I., Struk R.Yu.</i> Influence of drilling mud on capacity-filtration characteristics of carbonate rocks	122
<i>Nehrii S., Nehrii T., Shepelenko R.</i> Increasing the miners safety in the underground coal mining	124
<i>C. Farsi, Z. E.A. Rahmouni, Zaoui M.</i> Evaluation of materials from the excavation of the ouenza hematite deposit (north-east algeria) by gravimetric enrichment	126
<i>Daouda Keita, Lamine Cisse, Mamady, Keita</i> Industries at the heart of the city of conakry? What are the consequences on the environment?	127
<i>Vasyliiev D.L., Malich N.G., Katan V.A.</i> Modeling of rock destruction of asymmetric loading with the aim of finding ways to reduce energy costs	129
<i>Khavalbolot K., Bolormaa Ch.</i> The causal loop of the system dynamic modelling of occupational safety systems	131
<i>Victor Mutambo, Chela Makumba and Kalunga Ngoma</i> Increasing mining productivity and efficiency in the face of dewatering challenges and increased mining depth at Konkola copper mine, Zambia	133
<i>Kondratets V.A., Matsui A.N.</i> General scientific and special methods of cognition in the methodology of implementation of energy efficient invariant control by ball grinding-classification of ores	134
<i>Stupnik M.I., Kalinichenko O.V., Pochtarev A.V.</i> Improvenemt of ore drawing technology and mined iron ore grade in underground mining	137
<i>V.F. Demin, R.K. Kamarov, A.Ye. Zhumabekova</i> Efficient working conditions of stoping faces	139
<i>N. Salahudeen, U. Idris</i> Effect of beneficiation on the physicochemical characteristics of dugani clay	141
<i>Aminzhanova S.I., Mishareva M.E.</i> Investigation of the features of the material composition iron-containing ores of the temirkan deposit	143
<i>Cheberiachko I.M., Cheberiachko Yu.I., Trofymova O.P.</i> A method of producing red oxide	146
<i>Vasyliiev L.M., Vasyliiev D.L., Osinnia N.V.</i> The record of horizontal normal stresses in methods for calculating the limiting state of rocks	148
<i>Umarova I.K., Aminzhanova S.I., Saydiraimova M.I.</i> Development of a technological scheme for the enrichment of tungsten-containing ores of the koytash deposit	150
<i>Viktoriia Dmytrenko, Yuliia Diachenko</i> Lubricant additives improvement of drilling fluids	152
<i>Pogrebnyak V.G., Pogrebnyak A. V., Perkun I.V.</i> The nature of hydrodynamic drag reduction of oil flow in pipelines by polymer additions	154
<i>Javkhlant G., Khavalbolot K.</i> Organization and optimization of logistics management of mongolian coal transportation ..	157
<i>Umarova I.K., Mishareva M.E., Mengilboev Zh.A.</i> Development of the technological scheme of enrichment gold-bearing ores of the auminzov deposit	159
<i>Kharchenko M.O., Manhura S.I., Manhura A.M.</i> Investigation of the mechanical properties of pipes for long-term cooling systems	161
<i>Rudniev Ye.S.</i> To the question of selecting indicators for establishing the dangerous properties of coal seams	164
<i>Enkhjargal G., Khavalbolot K.</i> Improving economic efficiency by managing open pit equipment operations based on bigdata analyses and machine learning	167
<i>Konoval V. M., Gretskey D.V.</i> The news explosive technologies of the destruction of strong rocks on the complex structure	169
<i>Slobodyanyuk V.K., Maksimov I.I., Katyba A.S.</i> Technological peculiarities of iron ore production management when developing the open pit mines on a phased basis	171
<i>Osenniy V.Ya., Dreus A.Yu., Osinnia N.V.</i> On the efficiency of the combined method of formation of blasting wells at the pervomaysky deposit of the Krivbass	174
<i>Khudyk M.V.</i> Determination of the level of production noise of mine compressor stations and means of its reduction	176
<i>Oleinichenko A.A., Filatieva E.M., Filatiev M.V.</i> Engineering method for forecasting earth surface movement during coal seam mining	179
<i>Babychev I.K., Frolov O.O.</i> Simulation of joint dumping of overburden rocks and iron ore enrichment waste	182
<i>Pedchenko N.M., Pedchenko M.M., Pedchenko L.O.</i> Development of gas hydrate deposits and storage of gas in the form of gas hydrates	185
Section "Machine building and automobile transport"	
<i>Sakhno V.P., Marchuk M.M., Marchuk R.M.</i> Mobility of the metrobus. ways of improvement	188
<i>Tytov O.O., Sukhariev V.V., Usatyi T.S.</i> Determination of technological parameters of the crusher with wave profile of rolls	190

<i>Wloch J., Sobczyk W.</i> Ways of disposing of metal waste from the automotive industry	192
<i>Akanova G.K., Golchak I.P., Kolga A.D.</i> Improvement of control systems for hydraulic drives of technological machines	194
<i>B.I. Marc, A. (Stanimirescu) Soica.</i> Monitoring the noise level produced by rotor excavators	197
<i>Stadnyk O.S., Morozuk S.V.</i> Analysis of methods of sorting non-ferrous metals and alloys in vehicle utilization technology	198
<i>Volyk B.A., Lepet Y.I.</i> Results of field studies of quality of soil cultivation with a bionic lancet paw	201
<i>Pikula M.V., Panai T. S., Kushpel V.K.</i> Improving the quality of the surface layer of details by vibration processing	202
<i>Palcik J., Sobczyk W.</i> Implementation of sustainable development goals in urban transport in Kraków (Poland)	205
<i>Antsyferov O.V.</i> Energy dependences in vibro-impact operation mode of a vertical vibration mill	207
<i>Levko S.I., Krupych O.M., Semen Ya.V.</i> Forming head press of vegetable materials with combined working surface	209
<i>Wójtowicz M., Sobczyk W.</i> Environmental threats caused by human economic activity and transport	211
<i>Borodai V.A., Nesterova O.Yu.</i> Energy efficient asynchronous drive for pump and ventilation plants	213
<i>Sokol S.P., Volik B.A.</i> Efficiency of using v - and u -similar deep rippers in the conditions of soil melioration and recultivation	215
<i>Fedorov S.I., Boroday V.A.</i> Express analysis of basic parameters of accumulator batteries	217
<i>Kukhar V.Yu., Ph.D., Norenko D.D.</i> The justification of the design of a laboratory facility for experimental measurements of the resistance force of a brush cleaner moving along a strainer mesh	218
<i>Banzak O.V., Banzak G.V., Yefimenko N.A.</i> Development of statistical simulation model of maintenance processes	221
<i>Sakhno V.P., Marchuk N.M., Marchuk R.M.</i> To determine the stability of the metrobus in unstable driving modes	223
<i>Wloch M., Sobczyk W.</i> Management of rubber waste from the automotive industry	226
Section "Economics of natural resources use"	
<i>Khomiuk N., Pavlikha N., Voichuk M.</i> Ecological tools for diversification of sustainable development of rural areas	228
<i>Oforu-Mensah Emmanuel Ababio.</i> Precolonial and modern artisanal mining in Ghana	231
<i>Zakorchevna N.D., Demydiuk Y.S.</i> Assessment of ecosystem services in the lower Dniester basin	231
<i>Koshliakov O.Ye., Dyniak O.V., Koshliakova I.Ye.</i> Peculiarities of determining technical and economic indicators in substantiation of expediency of operation of groundwater deposits in Ukraine	234

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INCREASING THE MINERS SAFETY IN THE UNDERGROUND COAL MINING

With the deterioration of mining and geological conditions of coal seams and increasing the longwalls load, various emergencies are increasingly occurring. Moreover, the analysis of the circumstances and causes of accidents indicate that increasingly their main cause is the human factor. However, this is not always the worker's fault. Sometimes it is difficult for miner to assess the situation in the workplace due to the presence of many distracting and masking factors, as well as his psychophysiological condition. Heavy and stressful working conditions, personal fatigue "provoke" the miner to simplify operations by disregarding the requirements of safety rules. Therefore, it is important to establish the interconnection between the level of miners injuries in coal mining and their physiological capabilities during of making the production operations.

Really, at implementation of productive process operations the mortgage of safe mining is accordance of power-hungriness of works to physical possibilities of miners. These possibilities can be estimated by the energy expenditure of the miners organisms. According to the amount of energy expenditure to perform certain operations over a period of time, we can set the intensity of energy expenditure of the body and assess the difficulty of work for a particular worker. That is, the total energy expenditure of the worker (E_T , kcal) when performing the operation or their combination, constituting a certain production cycle with a duration of t is determined by the expression (Nehrii et al. 2017)

$$E_T = \sum_{i=1}^n (N_i t_i), \quad (1)$$

where t_i - the duration of the i -th operation (sub-operation), min., and the weighted average energy expenditure for the production cycle (N_T , kcal / min.) taking into account the forced breaks, will be (Nehrii et al. 2017)

$$N_T = k_w \sum_{i=1}^n (N_i t_i) / \sum_{i=1}^n t_i, \quad (2)$$

where k_w - the coefficient of working time density.

The energy expenditure of the human body in different studies was determined in different ways: by determining the reduction of energy resources of the organism; by measuring heat production; by the magnitude of the oxygen demand; by determining the amount of work spent on the implementation of production operations; by heart rate. The most universal is the method of determining energy expenditure by heart rate, because it is faster, simpler and allows to quickly determine the condition of the worker.

According to the results of studies presented in (Zolina et al., 1983) and (Research Report, 1994), a linear dependence of energy expenditure of miners on heart rate, which has the form (Nehrii et al. 2017)

$$N = 10,4(HR - 71,6) \quad W \quad (3)$$

$$(R^2=0,9; t>t_{cr}(22,08>2,06); F>F_{cr}(225>4,24))$$

To verify this dependence and determine the difficulty of the miners in performing certain operations, observations were made on the miners with the fixation of their physiological and ergonomic characteristics. 643 heart rate measurements were performed during various operations by different miners. Then from expression (3) the current energy expenditure was determined, and from expression (2) - the average value of energy expenditure of the miner's body during the performance of a particular operation. It was found that the heart rate of miners varies from 76 to 168 beats/min. (on average from 81 to 145 beats/min.), and, depending on the type of work performed, the energy expenditure of their organisms varies from 46 to 1003 watts (on average from 91 to 760 watts).

Comparison of the energy expenditure of miners with work schedules showed that the underground workers of the main professions during the shift experience increased physical activity. The body's total energy expenditure often reaches or exceeds acceptable values long before the end of the shift. They show earlier signs of fatigue. The total energy expenditure during the works was determined from expression (1) and compared with the allowable (290W) and optimal (174W) values of energy expenditure of the organism, which are regulated in the normative document (State sanitary norms and rules, 2014).

To assess the difficulty of work, an indicator was adopted (Nehrii et al. 2017)

$$k_e = \frac{N_r}{290}, \quad (4)$$

where 290 is the conditional limit of the difficulty of continuous work without rest for able-bodied men, W.

In cases where $k_e \geq 1$, working conditions are harmful (State sanitary norms and rules, 2014), otherwise - the worker performs his duties in a safe environment. Comfortable working conditions will be in the case when energy consumption will not exceed 174 W ($k_e < 0,6$).

The study of accidents data at the mines of the Pokrovsky and South Donbass coal districts, consideration of work schedules related to an accident, allowed to establish the patterns of miners injuries during the main production processes.

Determining the energy expenditure of the miners' bodies affected by the production cycle operations that preceded the occurrence of the adverse event, led to the conclusion that before the injury, the performers worked in hazardous conditions due to the difficulty of work.

The comparison of accidents and the coefficient of severity of work, calculated from expression (4), indicated that most injuries were received at $k_e > 1$ (mostly k_e was in the range of 1.04-2.41). All

operations were regulated by the work organization schedule and were performed in strict compliance with it. That is, the implementation of regulated work was accompanied by injuries to workers. In this case, one of the ways to reduce the level of injuries may be by reduce the loading on the person by changing the improvement of the work schedule and optimize of the operations process. To do this, we can increase the duration of breaks for compensatory rest or increase the number of workers on labor-intensive operations. Then a break for compensatory rest is required for the duration of work t_w (min.) And can be determined from the expression (Nehrii et al. 2017)

$$t_r = \left(\frac{N}{4,2} - 1 \right) t_w. \quad (5)$$

Thus, it was found that accidents can be associated with employee fatigue, when the physical capabilities of miners do not correspond to the energy intensity of production operations that make up the work schedule. Therefore, it is necessary to further study the physiology of miners to ensure safe working conditions.

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EVALUATION OF MATERIALS FROM THE EXCAVATION OF THE OUEENZA HEMATITE DEPOSIT (NORTH-EAST ALGERIA) BY GRAVIMETRIC ENRICHMENT

Abstract

Quarries and mines that exploit hematite ore Fe_2O_3 usually have a large quantity of waste rock with low iron content, stored in the slag heaps of quarries or mines without enrichment. This work consists in finding solutions to this product to make it more or less usable in industries. As an example of use, the Fe_2O_3 content in the clinker after grinding and homogenisation varies between 1 and 8%. Africa. After chemical and mineralogical analysis of the whole product, the large percentage of existing chemical elements is the hematite ore Fe_2O_3 which has a low iron concentration. To improve its iron content, it must be treated by chemical and hydro mechanical