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"INNOVATIVE DEVELOPMENT OF RESOURCE-SAVING TECHNOLOGIES AND SUSTAINABLE USE OF NATURAL RESOURCES"

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Dear Colleagues,

I address you, on the occasion of the International scientific and technical conference ***"Innovative development of resource-saving technologies and sustainable use of natural resources"***, a collegial greeting and warm congratulations for all the accomplishments in your activity.

I am honored, together with my colleagues, that the University of Petrosani, starting this year, is co-organizer of your well known and appreciated conference. Friendly appreciation and solidarity feelings binds me with the National University of Water and Environmental Engineering.

Valuable graduates are high educated by your University, in the field of bachelor's and master's studies, recognized in the academic and scientific circles in Ukraine and Europe, and having an orientation of scientific research towards the top problems of the theory and practice of economic and social life. The fact that the University always expands its horizon of studies related to the dynamics of modern public life, provides the country with a reservoir of human resources with high qualifications and various competences.

This wide opening to the contemporary world makes the National University of Water and Environmental Engineering a powerful center of scientific and cultural irradiation, well integrated in the circuit of international cooperation.

In this moment of scientific balance, I wish you the best of luck and I am convinced that the collaborative relations between our universities will be fruitful.

Sincerely yours, Professor Ph.D.Eng. Sorin Mihai RADU Rector of the University of Petrosani, Romania

Dear Colleagues!

It is a great honour for me to greet all the participants of the International scientific and technical conference "Innovative development of resource-saving technologies and sustainable use of natural resources and open it with Prof. Sorin Mihai RADU, Rector of the University of Petrosani.

The international status of the conference is confirmed by the members of the organization committee representing 18 countries of Europe, Asia, Australia, Africa and Latin America.

Special gratitude should be expressed to Prof. Bulat A.F., Academician of the National Academy of Sciences of Ukraine; Prof. Voloshin O.I., Corresponding Member of the National Academy of Sciences of Ukraine; Prof. Panayotov V.T., Corresponding Member of the National Academy of Sciences of Bulgaria; Prof. Yussupov Kh,A., Corresponding Member of the National Academy of Sciences of the Republic of Kazakhstan; directors of research institutes and leading researchers.

The four sections of the conference include over 90 abstracts from 35 research institutions of 16 countries.

It should be noted that university students and their supervisors are also taking part in our conference.

The conference was arranged due to scientific and technical cooperation of the National University of Water and Environmental Engineering (Ukraine) and the University of Petrosani.

It is pleasant that this scientific event is taking place when we celebrate the 105th anniversary of our University. The universities are sure to expand their international research cooperation in future.

I wish fruitful work and good health, which is essential now, to all the participants of our conference.

Sincerely yours,
Viktor MOSHYNSKYI,
Doctor of Agricultural Sciences, Professor,
Rector of National University
of Water and Environmental Engineering, Ukraine

S E C T I O N

"SUSTAINABLE USE OF NATURAL RESOURCES AND WATER ENGINEERING"

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TECHNOLOGICAL FEATURES OF PEAT EXTRACTION IN UKRAINE

Ukraine is the southernmost country in Europe, where peat resources are still of industrial importance. According to the State Committee for Geology, 2168 peat deposits with geological reserves of about 2 billion tons have been discovered and explored in Ukraine with varying degrees of detail. The total area is about 1 million hectares, within industrial limits - about 600,000 hectares; balance stocks of peat exceed 838 million tons. The average annual peat production in Ukraine is much less than the real possibilities.

Ukraine's peat deposits are represented mainly by lowland type (96% of all resources). There are also small (1.8%), transitional (1.6%) and mixed (0.6%) types of peat deposits. By the nature of peat accumulation and features of peat deposits on the territory of Ukraine, the following peat regions are distinguished: Polissya, Malopoliska, Lisostepova, Stepova and Carpathian. The most favorable conditions for peat accumulation occurred in the post-glacial period in Polissia, where numerous and diverse peat bogs were formed. The peat reserves and resources of this region (Volyn, Rivne, Chernihiv administrative regions) make up almost half of the total peat fund of Ukraine [2].

The lowland type of deposits is with soil nutrition, so the content of mineral salts in the peat. Ash content is different: from 15-25 to, up to 30-40%.

High-ash lowland fields after hydro melioration are more appropriate to use in agriculture as fodder or arable land. In its

composition lowland peat contains lime and peat vivanite, which promotes high fertility of agricultural crops. Lowland peat with high ash content, carbonate and phosphorus content and naturally low acidity is also a valuable fertilizer or component for the production of plant growth stimulants, soil mixtures for the cultivation of flowers, vegetables, mushrooms, the basis for composting and the like.

Lowland peat deposit include deposits formed wholly or largely from lowland peat.

Most types of peat found in the territory of Ukraine are suitable for the production of organic fertilizers, mainly peat-based compost, animal bedding, plant growth stimulants, soil mixtures, peat cups for seedlings, etc.

According to geological-geomorphological features, 11 peat-marsh regions are distinguished within the peat-marsh regions, areas, each of which is characterized by a certain degree of wetlands and peat land. The most swampy (10.1%) and peat (7.3%) districts of Western Polissia in the peat-swamp region of Polissia [1].

The state concern Ukrtorf is engaged in the extraction and processing of peat in the country, in the structure of which there are the following state enterprises: Volyntorf, Zhytomyrtorf, Kyivtorf (operates in the territory of three oblasts - Kyiv, Poltava and Cherkasy - one peat plant), Podillatorf (Khmelnytskyi, Vinnytsia and Ternopil regions), Rivnetorf (one plant for the production of Smigatorf peat briquettes), Sumy and Irvantsivsky. [3]

The Ukrtorf concern produces up to 600,000 tons of peat annually, the vast majority of which (62%) is converted to fuel briquettes - a fairly efficient solid fuel with a lower combustion heat of about 15 MJ / kg, humidity up to 20% and ash content up to 23 % [4].

At present, layered-by-surface or milling method of extraction is dominant in the Ukraine. In this method, the final product is a milling crumb.

Milling peat is used as a raw material for the production of the following products: fuel; fertilizer; litter; pots and packing material; activated carbon; yeast; mining wax.

Two types of milling peat ere produce at Ukrainian enterprises: fuel and agricultural. From the fuel milling peat produced semi-briquettes, which are used as municipal fuel.

In the milling method of peat extraction, the product is obtained in the form of a loose mixture of small particles, different in size, but not more than 20-25 mm.

The milling method got its name from the initial milling operation. Milling - the process of processing peat deposits with mills. The cutter is a tool with cutting elements (knives). Rotating around its own axis and sinking into the stock at a progressive stoke, they remove a small thickness of the layer, turning it into crumb [4].

Drying of milled crumb is carried out on the same area, where milling was performed in natural open-air conditions due to the use of solar energy and heat of air masses. This method depends on weather is seasonal. In order to accelerate the drying and obtain a more homogeneous moisture content of the finished product is used to stir the drying layer.

Dried to the required humidity, the milling peat is collected from the spread of pre-prepared rolls in stacks of the correct triangular or trapezoidal section.

Peat comes into the stack directly from the harvesting machine or from the piles at the foot of the stack, created by bunker harvesters. From the heaps to the pile, the peat moves the stacking machine and evens it on the surface with an even layer.

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UDC 532.5

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DEVELOPMENT ANALYSIS OF THE FLOW HYDRODYNAMIC STRUCTURE THEORY IN PIPES

During the development of heat, hydropower and hydraulic engineering and water engineering, there is a growing need to increase the reliability and efficiency of structures, namely pipelines. Transportation of liquids by pipelines is widely used in engineering practice. The purpose of hydraulic calculations of pressure pipelines is the calculation of their hydraulic parameters. Accordingly, the hydraulic calculation of pipes mainly solves three problems: the pressure loss in the pipe, the flow of fluid during its transportation, and finding the diameter of the pipe.

Pipes are part of facilities with a high class of consequences (responsibility) and must provide the reliability of operation in different operating conditions. Therefore, there is a need to improve the approach to the hydraulic calculation of pressure pipes with different purposes, namely the development of the theory of the kinematic structure of the flow in them [1, 2].

One of the first scientists of the 19th century to develop the theoretical foundations of the flow structure was S. Navier, who introduced additional terms into L. Euler's differential equation to take into account tangential stresses that occur in the presence of a velocity gradient.

J. Stokes obtained the solution of this equation in 1845 for small pipe diameters and flow velocities. But he noted that for large pipe diameters and high fluid flow, there is a discrepancy between the theoretical calculation and the experimental values. J. Stokes explained this phenomenon by the presence of vortices that change the structure of the flow.

J.V. Boussinesq investigated this phenomenon in 1877 and suggested that at high fluid consumption in the new flow regime there

is not the usual molecular viscosity, but much higher in value, effective viscosity.

For the first time in 1895 O. Reynolds developed an approach for the statistical description of turbulent currents. He divided the hydrodynamic characteristics into averaged velocities and pulsation velocities. He compiled the equations of turbulent flow, which later became known as the Reynolds equation. But one of the main disadvantages of these equations is that they are not closed and do not allow to solve specific problems without additional conditions.

A large number of works have been performed by various authors, but this problem remains unresolved.

Therefore, in the 20th century, the questions of turbulent flow were studied by such scientists as M.A. Velikanov (studied the problems of turbulence), J. Taylor (developed the theory of vortex transfer); V.M. Makaveev (developed the theory of turbulent mixing), A.N. Kolmogorov, A.M. Obukhov (developed the theory of the local structure of turbulent pulsations), T. Karman (theory of complete similarity of local characteristics of turbulent flow, including all components of pulsations), L.G. Loitsyansky, A.A. Driedman (developed a statistical theory of turbulence) and others.

The following scientists also studied the question of the hydrodynamic structure of the flow: G. Reichardt (developed an inductive theory), D. Rotta, R. Deisler, and others.

The theory of the wall layer of turbulent flow was first described by V. Tolmin in 1931. The following scientists were also engaged in these researches: L. Prandtl, V.F. Durenda, H.L. Dryden, G. Schlichting, and others.

I. Nikuradze, F. Shevelyov, I. Nikitin investigated the regimes of turbulent flow, the pipe friction number in pipes, and hydrodynamic structure [3-5].

Experimental studies of flow regimes in pipes with uniform granular roughness and hydraulically smooth pipes and the distribution of averaged flow velocities were performed by I. Nikuradze. Also, F.A. Shevelev in laboratory conditions on hydraulic and aerodynamic installations investigated regimes of flow and distribution of velocities in steel and cast-iron pipes.

G.V. Zheleznyakov, S. Kullupailo, and A.D. Altshul proposed power laws of distribution of averaged velocities, which adequately

approximate the experimental values. They accord to the boundary conditions on the axis of the pipe but do not take into account the peculiarities of the phenomenon near the inner surface of the pipe.

L. Prantl's logarithmic law of distribution of averaged velocities is often used in hydraulic calculations. This law poorly describes the boundary conditions on the axis of the pipe and near the inner surface of the pipe.

I.K. Nikitin proposed a universal two-layer model of turbulent flow. This model includes a wall layer with a linear velocity distribution and a logarithmic profile of turbulent flow. Using the method of photo-video shooting, he obtained empirical dependences to determine the pulsation velocities that describe the structure of the flow.

One of the disadvantages of the universal two-layer model of turbulent flow is the incorrect boundary conditions on the axis of the pipe. It is also incorrect to assume a linear distribution of averaged velocities in the wall layer (laminar flow).

Based on the generalized results of the study of the hydrodynamic structure of the flow in the pipes of many scientists, we have developed a theory of turbulence. We have taken into account all the main disadvantages of semi-empirical theories. The relationship between flow regimes and their hydrodynamic structure was also revealed. And this made it possible to improve approaches to the hydraulic calculation of pipes.

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UDC 556.3

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A GEOSTATISTICAL APPROACH TO GROUNDWATER MODELLING FOR THIAROYE COASTAL AQUIFER

The Thiaroye aquifer is an unconfined and coastal aquifer. Situated in the peri-urban part of Dakar, Senegal, this region is located in an old dune network formed by hills and depressions. It concerns several areas like Guediawaye, Thiaroye, Pikine Yeumbel, Boune, Keur Massar, Malika, Tivavouane Peul. The water table is naturally close to the surface and without human intervention, the water table forms lakes in these depressions. Almost 40% of the population has settled in these areas with potential risk of flooding, coastal erosion or sea level rise. This is the reason why Thiaroye groundwater resource evaluation and management still rise two main issues:

- what will be the effect of human intervention like pumping on the area water levels?

are there likely to be any undesirable side effects of development, such as seawater intrusion or any contamination that could serve to limit yields.

For addressing these issues through this paper, we investigate a combination of geostatistical and mathematical methods for explaining the Thiaroye coastal aquifer groundwater dynamics (movement) and contamination by both seawater and Nitrates. The purposes of this investigation were to provide an overview of current groundwater hydraulic heads and quality spatial distributions in the study area.

Modelling of groundwater dynamics

For the calibration of the hydraulic heads, we use a least square criteria

$$R_h = \frac{1}{n_{obs}} \sum_{i=1}^{n_{obs}} \left(h_{measured_{(i)}} - h_{\mathrm{modelled}_{(i)}} \right)^2 \qquad (1)$$

Where h (m) refers to piezometric heads and is given by formula (2)

$$h = \alpha_0 + \mathrm{P}(t) + \varphi(x,y) \qquad (2)$$

The values of h_{measured} in formula (1) for three selected piezometers installed at Pikine, Boune and Tivavouane Peulh from may 2005 to april 2017 are used for the calibration. It consists of finding the best polynomial functions P and Q minimizing the residual R_h.

Using Eviews, one therefore obtains the following equation

$$h = -0.88343 - 0.23579 \cdot t + 0.01466 \cdot t^2 - 0.00028 \cdot t^2 + 1.338 \cdot 10^{-6} \cdot t^4 + 4.131 \cdot 10^{-8} \cdot X^2 - 3.588 \cdot 10^{-7} \cdot Y^2 \quad (3)$$

The flow net shows that groundwater flows from Pikine to Boune and from Tivavouane Peulh to Boune. The net recharge ΔR_N is given by

$$S_y \frac{\partial h}{\partial t} - \nabla(T \nabla h) = \Delta R_N \quad (4)$$

From (3) and (4), one can infer the following equation (5)

$$\Delta R_N = [-0.23579 + 0.02932 \cdot t - 0.00084 \cdot t^2 + + 5{,}352 \cdot 10^{-6} \cdot t^3] S_y - 6{,}3498 \cdot 10^{-7} \cdot T \quad (5)$$

Where $T\left(\frac{m^2}{s}\right)$ represents the transmissivity of the aquifer and S_y the storativity or specific yield of the aquifer;

The calculations within the area covered by the three piezometers and from 2005 to 2017 show net recharges ranging between -0.01 to +0.07 m/month.

Modelling of groundwater contamination

We will use the least square method. Fields measurements were performed in 2014 in the Thiaroye area for 13 boreholes located in Thiaroye area and identified by their geospatial coordinates (X,Y) and consisted mainly of measuring the depth to water table (H) in meters, Electric conductivity (EC), the concentration of Total dissolved Solids (TDS), the concentration of Nitrates (NO_2) and the concentration of Sodium (Na). Using OLE estimation with Eviews, one obtains the following formulas of CE and [Na]

$$CE = 12311.78969 + 0.26889X - 0.05158Y + 15400328H + 1.0075TDS \quad (6)$$

The coefficient of determination R^2=0.94 and Fisher statistical tests shows that the model is globally significative at an error threshold of 0.01 % max: there is globally a linear relation between EC and the other variables.

$$[Na] = -369288{,}5181 + 0.16994X + 0.19745Y + \\ + 139.33363H - 1730.4957 \cdot [\mathrm{NO_3}]^{-1} \quad (7)$$

The coefficient of determination R^2=0.82 and Fisher statistical tests shows that the model is globally significative at an error threshold of 0.5%: there is globally a linear relation between [Na] and the other variables of the model.

Conclusion:

This study shows monthly weak recharge rates within the area covered by the three piezometers, certainly due to efforts aiming to prevent the area from flooding by controlling the water table level with pumping systems. Concerning groundwater quality, we notice a high dependence of Electrical conductivity to geospatial coordinates, depth to water table and salinity as well as an inverse correlation between sodium and nitrates concentrations. If one moves deeper in the aquifer, seawater is predominant whereas at shallow depths, nitrates are more present.

Abreviations:

OLS – Ordianary Least Square
PDE – Partial Differential Equation
EC – Electric Conductivity
TDS – Total dissolved Solids concentration
[Na] – sodium concentation
[NO_3] – nitrate concentration

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UDC 532

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SOME ASPECTS OF POWER SYSTEMS DECARBONIZING ACORDING TO THE U.E AMBITIONS

The energy transition looks like a marathon rather than a sprint nowadays. As the price of photovoltaic cells and wind turbines have a favorable diminishing the economy decarbonizing has gotten to be approachable.

Energy transition is in a strong tie with wider set of decarbonizing due to the main challenge of world for climate change. The electricity are representing more than 20% of final demand. Sequestration retrofitting and utilization of carbon capture are representing a rough way and requires a major injection of capital and a long period of time to retrofitting with unproductive downtime for power plants. There are necessary to think for re-purposing or re-using the existing power plants than building new infrastructures. International cooperation and concerted action are necessary to reinforce useful energy access and simultaneously develop, diversify and decarbonize whole economies.

The 2030 climate and energy framework establishes points of view for reducing through cutting greenhouse gas emissions and rising the share of clean energy and energy efficiency. Under the energy union, UE is working to integrate Europe's energy markets for ensuring security in power energy, improving the energy efficiency and decreasing carbonize of economy. International cooperation and concerted action are necessary to reinforce useful energy access and simultaneously develop, diversify and decarbonize whole economies.

The ultimate target is essential to reach the objectives in the climate field. The three main directions are:

Priority statute grant for energy efficiency and develop the energetic sector based on renewable sources because the energy production and operating represent about 75% from CO_2 emissions;

the pressure on the fossil fuel industry will be increased due to regulatory of limiting the Carbon emissions.

UE supplier with secure energy security at accessible and competitive prices; in according with Renewable Energy Agency the cost of renewable sources energy will be cheaper than fossil fuel worldwide.

An integrated, interconnected and digitalized UE energy market.

Final energy consumption reached about 18 % in EU from renewable sources, up from 17% in 2017 and about double 2004 (8,5 %). Sweden has the highest consumed energy from renewable sources (54,8 %), followed by Finland (41,2%), Latvia 40,3 %, Denmark (36,1 %) and Ostrich (33,4 %). Romania has 0,1% away from own national framework objectives.

It seems that Romania till 203, will increase about 44% of energy production supplied by sector included in market scheme of emissions certifications taxes (ETS) and 2% of energy supplied from another sources without (ETS), with greenhouse emissions in compare with 2005 years.

Romania will reach 27,9 % of final consumption from renewable energy and improve the energy efficiency with 37,5% (Integrated National Plan in the field of Energy and Climate Change).

The gross final energy consumption of all energy sources, covers total energy delivered for energy purposes to final consumers as well as the transmission and distribution losses for electricity and heat. National energy security has traditionally been characterized by the robustness of energy systems and strategic oil stocks. The shift to digital, decarbonized, and decentralized energy systems raises new energy security challenges - including extreme weather, grid visibility, reliability and resilience. In the next few years, the decisions which taken in Europe will influence in the strongly way the model of the world responds to the challenges of climate.

In order to ensure a fair and just transition to E.U ambitions, some aspects must highlighted:

The coal regions must be founded in specific boost for facing the toughest challenges;

Energy efficiency is a vital principle for the clean energy transition;

Smart sector integration with stronger integration of the electricity, heating and cooling, transport, gas, industry is efficiency through incorporate renewables into all parts of the energy sector.

The world needs to capture as much as 6 billion metric tons of carbon dioxide by 2050, according to modeling done by the International Energy Agency, the energy giant's shareholders are pressuring the company to take steps to ensure climate change doesn't convert their investments into stranded assets. And to scale up, the cost of carbon capture needs to come down.

For example in 2019, the electrical energy production from wind and solar farms has increased with 64TWh at 600 TWh and for the first time has overtaken the electrical energy production produced in coal power plants with 100 TWh. The wind farms supplied with 14% more energy in 2019 than 2018, while solar farms recorded a growth of their production with 7%. On the other hand, the electrical energy production has decreasing with more than 6% due to dryness weather. Viewing the new annual capacities about 16,8 GW was installed in wind farms and more than 16,5 GW in solar farms.

Energy transition is in a strong tie with wider set of decarbonizing due to the main challenge of world for climate change

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WASTE MANAGEMENT IN RECLAIMED MINELANDS TO PRODUCE THE BIOFUEL FEEDSTOCK

The lack of its own mineral resources (oil, gas, coal) in Ukraine, makes it necessary to import them from other countries. In consideration of the fluctuations in energy carrier prices with an increasing trend, the search for alternative energy sources is an important issue in stabilizing the economic situation in Ukrainian regions. Because of rapid global climate changes, it is very important also to limit the use of conventional energy sources and focus towards bio-renewable sources. Today in Ukraine, out of 32 million hectares of arable lands, 8 million hectares are unproductive. There are huge areas of wastelands in industrial southeastern and central regions with destroyed soil and large volumes of mining wastes and empty rocks brought to the surface as a result of intensive mining and processing activities. Even after many years of reclamation, these technogenic lands differ significantly from zonal soils in the level of fertility, physical, chemical, agrochemical and other important ecological indicators. They are of little use for the cultivation of crops for food production. On the other hand, the growing of energy crops in such territories may prove promising and economically viable as energy crops generally require less fertility and can grow well in marginal lands (Blanco-Canqui, 2016). Domestically produced energy is one part of an overall Ukrainian strategy to replace imported fossil fuels. Energy crops currently represent an additional part of the natural resource potential (Bielski, 2015). Rapid depletion of natural resources and environmental degradation all over the world bring up the issue of creating environmentally friendly renewable energy sources in Ukraine.

Dnipropetrovsk Region is in the southeastern part of Ukraine. The Region occupies an area of 31923 sq.km. The area of abandoned mine-lands and industrial landfills is about 200 thousand ha, situated in several districts with deposits of manganese, iron, non – ferrous metal, uranium ores and black coal. Six models of mine land biological reclamation have been developed and tested in several mining regions by the department of soil science and ecology of DSAEU (Tarika and Zabaluev, 2004). Abandoned minelands are often associated with low fertility, acidity, or heavy metal toxicities. That is why growing perennial grasses on reclaimed minelands require sometimes nutrient inputs or soil amendments for toxic substrata amelioration. It makes sense to investigate the use of "waste nutrients" that are locally or regionally available to promote high yields of bio-feedstock crops (Xiaohan Yang et al., 2011).

Reclaiming mined lands that have been left desolate is critically important in Ukraine. These lands should be returned to nature. The need is especially critical in the mining regions (counties) of Dnipropetrovsk province. The rocks of the Nikopol manganese basin in the southeast part of Ukraine are, when exposed to the surface, a problem for environment management for the future. The potential of marginal lands for growing second generation crops as biofuel has received increased attention in recent years. Recently, more and more attention is to Miscanthus, the leading crop as a supplying cellulose-rich feedstock for the chemical industry and for energy production. Miscanthus giganteus is a perennial grass with C4 photosynthesis type, triploid spontaneous hybrid between Miscanthus sacchariflorus (Maxim.) Hack. and Miscanthus sinensis Anderss. This bunch of grass has a large root system that captures nutrients, and numerous stems provide wide cover. Since the hybrid is sterile, there is no threat of its invasion into the natural ecosystems.

A low requirement of sweet sorghum to soil conditions makes it possible to use this crop for cultivation in marginal lands. The sorghum is grown mainly in the steppe southern and central regions of Ukraine. A significant part of the steppes is concentrated in the zone where 400-450 mm of annual precipitation falls, and the sum of effective temperatures is optimal for sorghum cultivation. Sweet sorghum can be grown as monoculture for 3-5 years without loss of yield, providing proper protection against weeds and compensation

for nutrient removal. The biomass of woody plants can provide alternative energy raw materials and simultaneously reduce the emissions of toxic gases. This is a fast-growing poplar clone, which makes it possible to create high-productive plantations. The energy poplar is predominantly grown by two technologies: short rotation system and medium rotation system. The poplar tree productivity on fertile zonal soils can reach 20 t/ha. The lifetime of energy poplar plantation is 15-20 years (Klasnja et al., 2012). We have obtained poplar tree reaction unpretentiousness data to the soil fertility and the possibility of its cultivation in reclaimed minelands, although the biomass productivity in these cases is much less, from 6 to 11.5 t/ha.

The developing cost- and energy-effective solutions for municipal sewage sludge utilization can significantly stipulate the suburban and agricultural areas sustainable development. According to the state standard of Ukraine it is allowed to introduce municipal sewage sludge (MSS) for growing crops on arable lands a dose of not more than 10 tons/ha for three years. A large dose is possible in the case of mine land reclamation. Hygienic properties and high content of heavy metals in MSS are the main problems that hinder the application of wastewater sludge for technical crops or biofuels production. Plant biomass fuel quality was investigated in model field experiments settled in Pokrov land reclamation experimental station of DSAEU situated in the south of Dnipropetrovsk province within Nikopol manganese deposit.

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INTEGRATED HYDROGEOLOGICAL INVESTIGATIONS FOR DETECTION OF DECCAN TRAP COVERED AQUIFER IN ZILPA AREA, KATOL TALUKA NAGPUR DISTRICT INDIA

Integrated Hydrogeological investigations in Deccan Trap covered and draught prone Zilpa Area in Katol taluka Nagpur District was carried out to located deccan trap covered deeper aquifer. The Landsat ETM, and SRTM data used for mapping the hydro-geomorphological features of Katol Taluka. Zilpa Area forms a topographically high plateau area and situated in water divide area. Bouguer Gravity anomaly map shows -40 mGal gravity low located in the south of Katol and has NW-SE trend. The gravity low indicates presence of subsurface low material, hence also named as Katol basin. The Volcanic flow mapping resulted in identifying five basaltic flows in the area forming Deccan Trap of Cretaceous to Eocene age (60-30 Ma). These flows are separated by three interppeans beds and one red bole occurring in between Flow IV and Flow V. Regional Geological model suggests the presence of Upper Gondwana Kamthi Sandstone of Permian to Lower Triassic Age (350-250 Ma) at a depth range of 300-380 m below the deccan trap. Soil Infiltration test (n=16) shows that the infiltration rates varies from 0.33-2.22 cm/hr. for Black cotton soil and 0.5 to 2.07 cm/hr for Sandy loam to Clayey Loam.

Twenty-two Vertical Electrical Soundings were carried out using Geomative GD10 high sensitivity Resistivity meter. The top soils show 5 to 48 Ohm m with thickness ranging from 1m to 1.4m, weathered basaltic formation shows resistivities varying from 40-60 Ohm m, Fractured Basalt which forms Aquifer I shows (above 30 m depths) zone and Aquifer II in the depth range of 100-140 m shows 29-<40 Ohm m resistivity, massive basalts show 45-180 Ohm m and

Kamthi sandstone of upper Gondwana age shows 19-38 Ohm m resistivity at a depth range of 220-270 m. Therefore, the boreholes were drilled up to 300 m depths. Borehole logging shows variable deccan trap thickness in the area from 216-270 m. All the thirteen boreholes show 10,000 to >10,000 gallons per hour flow rate and the piezometric surface varies between 96 m bgl to 130 m m bgl. Papadopoulos-Cooper method of single-well pump tests was performed for deccan trap covered Upper Gondwana Kamthi sandstone shows transmissivity of 300 m^3/day and storage coefficient $9.98 \cdot 10^{-3}$. Trap covered Gondwana Kamthi sandstone has huge ground water potential of 63.96 million cubic meter (MCM).

Meteorological data of 119 years from year 1901 to 2015 was taken for long-term rainfall analysis and hydrogeological water budgeting. Katol taluka has total geographical area of 73463 hectare (ha) out of which 18170 ha is hilly area where run off takes place. The recharge area available is 3832 ha in command area and 51461 ha in non-command area. The ground water recharge is mainly through the fractures, joints and faults or through large reservoirs. Rainfall recharge during non-monsoon season computed by Rainfall Infiltration (RIF) method. Estimation shows recharge during monsoon season is 12432.77 while non-monsoon season 2204.13. the net natural discharge is 1034.72-hectare meter (ham), and net ground water availability is 19659.61 ham. Annual gross draft for all uses estimated is 16782.34 ham with irrigation sector being the major consumer having a draft of 15735.28 ham. Annual draft for domestic and industrial uses is 1047.06 ham. The allocation for domestic and industrial requirements supply for next 25 years is about 1933.08 ham. The present stage of ground water development of Katol taluka is 87.27%, with no significant fall in ground water levels trend and hence categorized as safe. Even though categorized as safe a sharp rise in water draft is noticed from 138.26 MCM in 2008 to 166.96 MCM in 2013, hence recommended micro irrigation practices like drip and sprinkler irrigation systems. Rainfall harvesting and artificial recharge of aquifers also recommended for long-term availability of sufficient water. A check dam is constructed with three recharge wells of 6 inches diameter reaching up to confined aquifer which will recharge ~300 cubic meter water per day during the rainy season.

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BIOECOLOGICAL EVALUATION OF DIFFERENT MODELS OF TECHNOSOILS

The Nikopol manganese ore basin is located within the southern part of the Ukrainian crystal plate, near the cities of Pokrov, Nikopol and Marganets. Technological processes associated with the extraction of manganese ore are accompanied by mixing of individual genetic horizons and the formation of internal and external heterogeneous dumps of quarries. Dump-pit formations are the most characteristic representatives of man-made landscapes. Rocks exposed to the surface of the day are subjected to physical and biological weathering processes. They are gradually involved in the life cycle and soil formation.

The process of humus accumulation changes depending on the time stage of soil formation and vegetation cover development. All this causes differences in the morphological structure of the profile and physical and chemical properties of soils, including in the structure, fractional group composition, energy parameters of humus, and affects the ecological state of the soil as a whole. The process of reclamation of disturbed land consists of two stages - geotechnical and biological (Dryzhenko, 1985; Uzbek, 2000).

The bioecological criterion characterizes the type of land reclamation and development in terms of neutralizing the harmful effects of the mining industry on the environment and creating conditions for self-restoration of landscapes.

The use of legumes and grasses as improver crops, especially for the functioning of various structures of technosoils, contributes to an increase in the content of not only organic matter, but also essential nutrients. The arrival of a significant amount of plant residues and specific root secretions significantly activates the transformation of

physical, physico-chemical and biological properties of disturbed lands as a result of open-pit mining (Kharytonov et al., 2020).

It was noted that at the first stages, a necessary condition is the mandatory creation of single-species populations from perennial legumes. Studies have found that in various structures of technosoils, an increase in the humus content was fixed in the layers of 0-10 and 10-20 cm. It was possible due to a significant influx of root and crop residues of perennial legumes and grasses, their mineralization and humification.

There is a certain genetic and parametric relationship between the texture of the soil, its density of addition, total porosity, structural and aggregate state, dynamics of nutrients, humus content, water-physical characteristics and features of cellulose decomposition of various structures of phytomeliorated rocks. Improvement of physical and water-physical properties of technosoil models to some extent comes to the fore, since it determines a wide range of necessary conditions for the sustainable functioning of phytocenoses.

Thus, the main characteristic of these properties is the formation of a water-resistant structure. It was determined that the composition and properties of edaphic structures of technosoil at different stages of biological development and use are transformed.

It was found that the level of fertility of phytomeliorated rocks significantly increased the content of mobile nutrients. Prototypes of soil genetic horizons are formed in the direction of soil genesis equal to zonal type formation.

The gradation of the biogenicity level of edaphotopes by enzymatic activity in the thickness of 0-40 cm was made up. It was established that abiogenic rocks are those that were selected directly from the quarry. Edaphotopes formed on the day surface are characterized as weakly biogenic after a long stay in the fallow state (without vegetative cover).

However, in the bulk layer of the black soil and gray-green clay, the recovery of the biochemical potential was more intense. That's why they can be classified as mid-biogenic. Almost all the study edaphotope under phytomelioration impact, except red-brown clay, described as biogenic. So, the study of the enzyme potential formation of in the thickness of edaphotopes indicates their gradual

approach to the level of zonal chernozem due to the introduction of phytocenoses saturated with legumes into production.

The enzymatic activity of substrates is the starting biotic component at the first stages of the technogenic ecosystems formation. Favorable conditions for the functioning of plants are gradually created after inoculation of edaphotopes by spores of microorganisms introduced from the outside. Over time, microorganisms and plant root systems form a single, unbroken and very complex biogeocenotic system that constantly functions in the edaphotope thickness. The level of enzymatic activity stabilizes, becomes independent of seasonal fluctuations in the number of microorganisms and is an enzyme pool, which reflects the quality indicators of edaphotopes. The enzyme pool of edaphotopes is an important regulator of the biochemical homeostasis of reclaimed land.

It performs biogeocenotic functions and ensures the continuity of metabolic processes even in extreme conditions of man-made ecosystems.

The gradation level of biogenetic topsoil phytomelioration of rocks was folded. The obtained results of our work substantiate the possibility of applying and implementing parameters of edaphic characteristics of technozem models by enterprises of the mining complex. The control system provides for the reproduction and accumulation of organic matter, nutrients, changes in the basic physical properties, redox potential and pH level, optimization of the air regime, and growth of microbiological activity of technozem models.

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ELECTROCATALYTIC INTENSIFICATION OF BURNING PROCESSES FOR HARD AND GASEOUS FUEL

The development of civilization makes more new challenges to science, even in such traditional sphere as fuel combustion. Gas, oil and coal are the raw material for energy, metallurgy, chemical industry and other industries. Therefore are ongoing searches for methods of rational use of fuel. One of these methods is electrocatalytic fuel combustion, which is in the handling the fuel on the catalyst, which is in the area of electrical discharge.

The fundamental scientific problem, which was put, is: to learn and develop the apparatus and technology of electro-catalysis as the method for declining the energy of activating on a catalyst due to bringing of him in the area of quiet electric discharge. In the processes of electro-catalysis of overcoming of energy of activating is carried out for the account of following acts: synthesis and extinguishing of oxygencontained radicals; reception of energoactive and reactionable atoms and molecules due to the stream of lone electrons; wave influence of discharge on the system in an area to the catalyst; ultraviolet irradiation; thermal influencing of quiet discharge.

Optimization of process of burning of hard fuel. The experiments on optimization of fuel burning were conducted on setting which consists: from a combustion chamber with the arc device; thermostat; source of energy and compressor. The arc device is the complete set of the reticulated electrodes with an inflicted on them catalyst. Electrodes are placed in the ceramic tube of combustion chamber. A combustion chamber is placed in an electro-thermostat. Air which before contiguity with a coal passed through electrodes was given from below in a combustion chamber. In a combustion chamber loaded a 1 kg of fuel which ignited by an electro-thermostat.

At by the use as a fuel the electrocatalysis of process burning of coal was the considerable economy of fuel 10-15%. The degree of coal burning down during conducting of both experiments is definite. For this purpose was definite ashity of coal and degree of burning

down of coal at burning without arc and with arc. The degree of coal burning down at single experience makes approximately 72 % (that approximately corresponds to the caldrons having of heating with a whole grate); the degree of coal burning down at the using arc arrives at 89 %. The degree of increase of burning down made on the average 17,45 %.

Similar results were obtained by burning wood and pellets.

By using the electrocatalysis for incineration of wood, namely pine, oak and birch, maximum temperature difference between the simple incineration and incineration with processing is achieved:

- for birch at a voltage of 3,5-5 kV increase of heating value at 15-20%;
- for oak at a voltage of 5,8-6,2 kV increase of heating value at 16-25%;
- for pine at a voltage of 3,1-3,5 kV increase of heating value at 14-21%.

In this case, we greatly reduce emissions into the atmosphere. Thus, from coal combustion is achieved emission reductions NO_x up to 80%, CO up to 52%. When wood combustion is achieved emission reductions NO_x up to 49%, CO up to 33%.

Consumable power at the electro-catalysis made on the average 2-3% from the got power due to the economy of fuel.

Optimization of process of burning of gaseous fuel.

The experiments on optimization of burning process of gaseous fuel were conducted on stand and pilot options For prevention the declining of catalyst activity, a catalyst was shown out of area of burning.

The experiments were conducted, both with a clean gaseous fuel, and with addition in the gaseous fuel of different additives. As a fuel the methane and propane-butane mixture were used. A propane - butane mixture has the soft terms of electrocontacting comparatively.

The most economy of fuel is achieved at the dosage in the gas stream of additives at tension 6-11 kV and arrived at approximately 12 %. Consumable power at the electro-catalysis made on the average 3-5% from the got power due to the economy of fuel. But consumable power here considerably higher.

On the economy of fuel time of gas stream staying in the area of reaction does not mean.

At by the use as a fuel natural gas the electro-initiation of process of synthesis of radicals was carried out at tension of 10 kV and higher. There was the considerable economy of fuel (without addition of additives ~15 %, with addition of additives ~20 %).

Conclusion. The conclusion is that using of electrocatalysis with burning fuels leads to a significant increase in the amount of heat: the coal to 10-15%, wood to 14-25%, gas 15-20%.

This delivers a significant reduction in environmental impact. So with coal combustion NO_x emissions reduction is achieved by 80%, CO by 52%. Using wood -reduces NO_x by 49%, CO by 33%. The degree of burnout of coal increases by 17,5%. The consumption of energy to undertake the process does not exceed 5% of the excess heat.

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CHARACTER OF CHANGES IN UNDERGROUND WATER CONDITIONS ON THE AREA ADJACENT TO TAILING PONDS OF MINING AND CONCENTRATION WORKS

As is known, 1 kt of crude ore mined by the open pit method produces 200 t of marketable iron ore products, while the rest 800 t are mining and concentration wastes. Concentration waste materials (tailings) include liquid phase materials (slurry) of aqueous suspension remains of fragmented rock mass from which an iron ore component is extracted by the magnetic-flotation method. Slurry is fed to specific alluviation maps (beaches) of tailing ponds that can be either of plane or multilayered types.

In Kryvyi Rih iron ore region, there are eight tailing ponds of five operating mining and concentration works. They are mostly

concentrated in the southern part of Kryvyi Rih where four tailing ponds are located on the territory of 3-5 thou. ha. Two of them belong to the mining and concentration works (GZK) of the PJSC *ArcelorMittal Kryvyi Rih* (PJSC *AMKR*) (*Myroliubivka* and *Obiednane*, Map IV) and the rest - to the PJSC *Pivdenny GZK* (*Voikove* and *Obiednane*, Map I). The basic technical parameters of these facilities are the following

Tailing pond	Year of	Height, m construction	Area,	Capacity,ham m^3
Myroliubivka	1957	145	479	107
Obiednane Map IV	1971	180	320	235
Voikove	1955	75	250	157
Obiednane Map I	1971	135	230	185

Being gigantic hydro-structures on the surface, tailing ponds are factors greatly affecting hydro-geological structures. The research conducted deals with assessment of remote consequences for underground waters of the Cenozoic horizon of long-term functioning tailing ponds of mining and concentration works of the southern GZK group.

Before building tailing ponds, the aquifer in the Quaternary System sediments was widespread only in alluvial deposits on the left bank of the Inhulets and sporadically - in loess soil loams on watershed sections. After constructing the GZK tailing ponds, in 1961, the flooding expanded along the plane [1] heading to the Inhulets river and adjacent ravines, absolute levels of underground waters varying from 95 to 30 m. During the following decade, there were some changes in level modes caused by introduction of Maps I and VI of Obiednane tailing pond that made water levels raise abruptly. In 1975-1980, the subterranean back water zone of the horizon reached 1.5 km.

In 1984, the total area of water-table uprising on the territory adjacent to the tailing ponds of the PJSC *Pivdenny GZK* and the PJSC *AMKR* made up about 50 nkm^2 with the 3 m-level of underground waters that still remains the same.

Five years after constructing the tailing ponds, salination of the Quaternary horizon averaged 6.5 g/dm^3. In 1975, it increased up to 8.8g/dm^3, while in 1990, it reached 11.5 g/dm^3. Right now, there are

formed stable leakages of water with 7 g/dm^3 salination along the left-hand bank of the Inhulets river 1.7 km off Voikove tailing pond [2]. Anomalous content of manganese (up to 0.209 mg/dm^3), oil products (up to 4.65 mg/dm^3) iron ore, aluminum and bromine is detected in the underground waters [3].

The aquifer of Neogene sediments with 10.5-40 m deep underground waters is characterized by plane expansion and before construction of the tailing ponds, its salination was up to 1.93 g/dm^3. It was widely used to meet household needs in drinkable water through wells and springs.

Construction of Voikove and Myroliubivske tailing ponds in 1960-1963 increased the level of Neogene horizon waters by 30m. After putting into operation Obiednane of Map I and I tailing ponds in Hrushevata Ravine, the water supply area shifted to the watershed *Hrushevata Ravine-Shyroka Ravine* and contaminated underground waters headed north-west towards the left-hand bank of the Inhulets. Technogenic factors and filtration losses from tailing ponds eventually activated the geological processes in flooding areas. This resulted in a landslide formed on the left bank of the Inhulets (Novoselivka) in 1989 and covered 22 farmsteads. In 1996-1998, there were new landslides resulted in erosion and bank destruction as well as marshy lands and quick sands. Hydrogeological surface damages are being observed and there are fresh cracks, subsidences, landslides, solution sinkholes, etc. [3].

In the 5-year time after constructing the tailing ponds, water salination was 5.6 g/dm^3 and reached 11-14 gr/dm^3 site wide from the tailing ponds to the bank of the Inhulets. There were found admixtures of manganese (up to 18.11 mg/dm^3), oil products (up to 140.9 mg/dm^3) and zinc (up to 90.56 mg/dm^3). As a result, all drinkable water wells were destroyed.

The data provided indicate that construction and exploitation of facilities accumulating liquid wastes of iron ore concentration are extremely dangerous technological solutions causing irrevocable destruction of the hydrosphere on great territories located far from such sites.

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WATER QUALITY OF URDARI AND SOUTH PESTEANA PIT LAKES

Pit lakes result from the natural and/or artificial flooding of the remaining gaps of the former open-pit mining perimeters. Urdari and South Pesteana pit lakes were formed by natural flooding of the former lignite open-pits located in the mining perimeters identically named.

The flooding process took place exclusively by natural processes. The remaining gap of South Pesteana open-pit, located in the meadow area of Jiu River, received, in addition to the influx from precipitation, an important supply of water from aquifers, while the flooding of the remaining gap of Urdari open-pit, located in a hilly area, was done mainly by water supply from precipitation.

The 2 pit lakes, Urdari and South Pesteana, have naturalistic value. However, pit lakes can have multiple and important uses. They can take on one of the following functions: lakes for recreation and leisure, lakes for fish farming, irrigation or industrial water supply basins, retention basin for protection against floods. Among the aspects that allow choosing the type of use of a pit lake is water quality.

Taking into account that the water quality was not monitored so far for the 2 pit lakes, for the present study water samples were taken in order to determine their quality. The analyses of pH, chlorides, and suspensions were performed in the laboratory of Zănoaga Water Treatment Plant, while the other analyses were performed in the chemistry laboratory of the University of Petroșani. Standard methods of sampling, transport and analyses have been applied [1].

Table 1 shows the values of the main surface water quality indicators, compared to the existing standards [2].

Table 1

Results of water quality analyses

Nr. crt.	Quality indicator	UM	Determined values				IInd quality class [2]
			South Pesteana	Depășiri [ori]	Urdari	Depășiri [ori]	
1	pH	pH units	8,2	-	8	-	6,5-8,5
2	CBO_5	mg/l	7,70	0,54	5,10	0,02	5
3	CCO_{Cr}	mg/l	17,30	-	14,10	-	25
4	Chlorides	mg/l	12,05	-	12,05	-	100
5	Sulphates	mg/l	40,81	-	22,84	-	150
6	Calcium	mg/l	55,20	-	112,40	-	150
7	Magnezium	mg/l	16,30	-	34,80	0,392	25
8	Phenols	mg/l	0,1400	140	0,0800	80	0,001
9	Iron	mg/l	0,140	0,4	0,108	0,08	0,1
10	Suspensions	mg/l	6,19	-	3,78	-	-

Under the conditions of flooding the remaining gaps of the former lignite open-pits, the water comes in contact with coal remains in the dump or with the lignite layers from the in-situ slopes. The elementary chemical composition of lignite includes carbon, oxygen,

hydrogen, nitrogen, and sulfur. Sulfur in contact with water can lower the pH of the water leading to its acidification. Although this possibility exists, the analyses performed on the water samples taken from South Pesteana and Urdari pit lakes does not confirm this hypothesis.

The relative high concentrations of Calcium and Magnesium that are found in Urdari and South Pesteana lakes can be explained by the contact of the water with the possible remains of marine fauna, sometimes highlighted in the sediments of Oltenia mining basin.

Higher CBO_5 values indicate the presence of biodegradable organic substances that reduce the concentration of dissolved oxygen in the water.

The highest exceeding was recorded in the case of phenols. Phenols can have a neurotoxic effect on fish but at much higher concentrations then those highlighted by the analyses.

Generally, suspensions in the waters of these lakes are not pollutants, but can temporarily influence the quality of the emissary (Jiu river). Sterile (fine sands, clays, dust) and/or useful (lignite) rock particles may be in suspension. A simple natural settling of suspensions considerably improves the water quality. With regard to suspensions in water, the results indicate a very low amount that has no negative influence on the overall quality of the water.

According to the analyses results, it is found that, from a qualitative point of view, the water in the lakes presents falls into the second quality class, which corresponds to a good quality according to Directive 2000/60/EC [3]. The specific limits of this class correspond to surface waters which have been affected by some human activity, but nevertheless can ensure all uses properly. The aquatic ecosystems are not affected.

By applying simple treatment methods the water from the two lakes under study, can be prepared for drinking purposes.

The mining activity in the area is coming to an end. Considering the agricultural specificity of the area in which the 2 objectives are located (Gorj county, Romania), the major water requirements of agricultural crops and the dry periods registered in the region, the possibility of using the water from pit lakes for irrigating crops was considered [4]. In addition, the pit lakes can be tourist attractions (for swimming, fishing or even practice different sports).

The good quality of the water from the lakes formed in the former lignite open-pits Urdari and South Pesteana and the multiple possibilities of their use contribute to the local economy on medium and long term, in the context of mine closure. The ecological benefits consist of reducing the impact on environmental components and improving their quality, the harmonious reintegration into the landscape of the former mining perimeters, the restoration of the ecosystems adjacent to the remaining gaps, and the emergence of aquatic ecosystems.

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BIOLOGICAL TESTING OF ROCKS AND THICKNESS OF THE BULK SOIL LAYER FERTILITY

Kerch iron ore deposits industrial development was occurred in the middle of nineteen century (Lebedinsky, 1988). There were three iron ore and one limestone open-pit mines, dressing plants etc. 60% of deposits are overlaid with brown (oxidized) and roe (oxidized redeposited) ores with oolitic and rarely disseminated ores. The

ferrum and manganese are the main components of iron ore, while phosphorus, arsenic, calcium and magnesium oxides and others are adulterants (Kharytonov et al, 2013). Land disturbed by open pit developments (with overburden rocks brought to the surface of the day) without artificial application of pre-removed soil mass on them is a very long and complex restoration process (Tarika and Zabaluev, 2004). There is a need for targeted reclamation, including work to preserve the upper fertile soil layer. Despite this, the reclamation technology is used that does not provide for selective excavation of overburden rocks and separate dumping them into industrial dumps.

As a final result the mechanical mixing of overburden rocks is carried for the formation of complex technical mixtures for leveling and serving as the underlying basis for the bulk layer of soil mass (Kudrik et al., 2010). The use of peas as a biological indicator was due to the fact that this medium-demanding plant removes restrictions due to different nitrogen content in genetic horizons cased the effect of nature nitrogen fixation and can record changes in environmental conditions that plants of other trophy groups are not able to respond to. The results of the pot experiment allow us to get data on peas productivity depending on kind of soil horizon (Table 1).

Table 1

Peas growth indexes on different soil horizons in the pot experiment

Soil horizons	Productivity, g/vessel	%
H	6,78	100
HP	3,37	49,7
Phk	2,35	34,7
H+HP	5,53	81,6
H+HP+Phk	4,87	71,8

The effective fertility of the soil mass of a mixture of three soil genetic horizons (H+HP+Phk) was 71.8 % of the fertility of the humus horizon.

The soil mass, consisting of a mixture of humus and first transition horizons of southern black soil (H+HP) occupies an intermediate position in terms of fertility between the humus and first transition horizons.

The impact of the type of soil horizon on the pea yield was studied in the conditions of roughed terrain (Table 2)

Table. 2

The yield productivity of peas grown in rough terrain

Slope exposition	Soil horizons	Yield, t/ha
Plain	H+HP+Phk	12.1
Northern	H+HP	13.9
Southern	Phk	11.0

High peas yield level in case of H+HP soil profile was due to better soil moister conditions in slope with northern exposition. The ratio of N:P:K in the plain site (H+HP+Phk) was 1:0.25:0.5. The lack of upper and lower transition horizons leads to a change in the ratio of N: P: K to 1: 0.17: 0.36 (H+HP) and 1: 0.23: 0.4 (Phk) respectively.

The yield of the peas green mass in he trials with application to loess-like loam and gray-green clay of 50 cm of black soil exceeded the yield on rocks by 5.93 t/ha or 70.4% and by 6.47 t / ha or 62.1 % (Table.3).

Table.3

Peas yield in trials of reclaimed lands with rocks and black soil, t/ha

Trials	Yield
Loamy like loess (LLL.)	8,40
LLL +50 cm of black soil (BS)	14,35
Gray-green clay (GGC)	10,42
GGC+ 50 cm BS	16,89

Gray-green clay proved to be the best underlying base for the bulk soil layer. It was 2.54 t / ha or 17.7% of increase in the peas yield in comparison with loess-like loam. It was established that optimal ratio of clay minerals provides rather high capacity of grey-green clay absorption. It make possible to consider this mining rock as a potential water proof layer to construct artificial soil-ecological profile.

The ecohydrogeological background of reclaimed lands forming and exploration was worked out. It foresees an environment restoration of disturbed lands to manage flow down, atmospheric precipitations taking aside. The process of the reclaimed profile biogenetic horizons formation and promotion with total depth 1.0-1.2 m and involvement of more suitable rocks for artificial water proof layer were tested.

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ENERGY EFFICIENT CONTROL REGULATOR DEVELOPMENT FOR THE ASYNCHRONOUS MOTOR WITH LONG-TERM OPERATING MODES USING THE MICROCONTROLLER

It is known that the industrial complex of Ukraine meets its own energy needs by about half of what is needed [1]. At the same time, the other half of the needs are provided with imports, depending on the type of minerals it is from 20% to 85% of demand. If a contingency appears, this can lead to failure of the normal operating mode of the power supply. On the other hand, industry and social infrastructure using equipment with low energy efficiency. As a result, the impact of these problems on the energy intensity makes the economy of Ukraine uncompetitive in terms of long-term investment.

Use of electric drives consumes up to 70% of the electricity from the entire power supply of the enterprise. At the same time, a significant part of it is spent on the operation of pump and ventilation systems, which, being powerful systems with a long-term operation

mode, are defined as mechanisms with high energy consumption. Therefore, the developers of electric drives use a variety of ways to decrease energy wastes in electromechanics:

- using an unregulated drive with an average load factor higher than 0.6 relative units [2];
- use of drives with increased volume of active materials [3];
- reduction of wastes on the network section by stationary centralized or local filter-compensating devices;
- regulation of the electric drive through power converters [4], where the use of voltage regulators has an advantage over frequency converters [5], because of significantly lower cost;
- use of conversion pulse-width modulation systems [6].

Thus, it is advisable to use the voltage regulators with a simplified control circuit and the principle of pulse-width modulation for electromechanical systems with long-term operation modes, which simultaneously takes into account the local compensation of reactive power and solves the problem of switches commutation.

Therefore, the main task is to develop an automatic control system that will provide the required level of power, depending on the production task at the inputs of the asynchronous motor (AM). As a result of the analysis above, it follows that the realization is possible by a step control system of the electric drive.

The simplest in terms of the required level of energy efficiency is a two-step system, which will ensure energy-efficient use of AM depending on its load. Based on experience and research in the field of using electromechanical systems with the long-term operation mode, the switching trigger of the relay regulator should be set at 60% of the rated load of the AM [7].

Existing methods are based on the creation of a circuit of the pulse-phase control system using a large number of discrete elements, which makes the manufacture of the control unit complicated and provides a low level of maintainability. This increases the cost of maintenance, repair, and replacement of the control unit.

To address the question that is defined it is proposed to partially or fully replace the existing circuit with a discrete element implementation on a microcontroller circuit with further development of the algorithm to perform the necessary functions.

In the analysis of existing microcontrollers, were identified those that meet all the needs, namely the minimal required number of I / O ports, minimum speed, expansion, etc.

PIC - Despite the unpretentiousness of the usage conditions and low cost have a small number of ports;

AVR - has a widespread architecture (Arduino) and a lot of different modifications with a wide range of functionality;

ARM Cortex - one of the most advanced representatives of RISC with a wide range of functionality and advanced programming architecture, has improved heat transfer, but relatively expensive and difficult in use.

Thus, based on the price to functionality ratio and the general experience of project implementation using microcontrollers, it is advisable to use AVR as the minimum necessary option for the implementation of the control scheme.

Conclusions

The current issue of drive efficiency is a relevant and important field for research. One of its directions is the control of energy supply,. In combination with the usage of energy-efficient motors, reactive power compensation by filter-compensating devices, and the use of converters with a high power factor, this can lead to significant energy savings.

At the same time, the two-step converter control system ensures the simplicity of the mains voltage conversion system and low capital costs, and a sufficient power factor is provided by a system with pulse-width modulation of the mains voltage.

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MATHEMATICAL MODELING OF REVERSE OSMOSIS FOR DESALINATION OF SEAWATER

Abstract

Global continuous growth of population and increasing shrinkage of water bodies have increasingly result into scarcity of fresh water. The need for sourcing alternative means for fresh water for human and animal consumption becomes a great problem of our contemporary time. Desalination of seawater through reverse osmosis process is a viable solution to the fresh water scarcity challenge (Loeb and Sourirajan, 1962; Ligaraya et al., 2020; Monjezi et al., 2020; Kim et al., 2020). Figure 1 shows a pictural illustration of osmotic process.

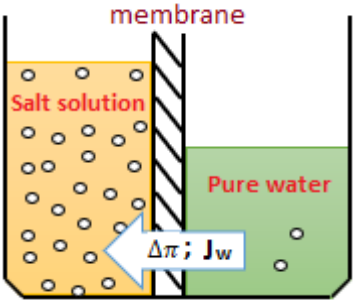

Fig. 1. Pictural illustration of osmotic process

In order to achieve reverse osmosis, the pressure of the concentrated solution can be raised to counter the osmotic pressure. As the pressure of the concentrated solution is raised, the osmotic diffusion is slowed down until and the activity gradient across the

two ends of the membrane is lowered. At the point the activity gradient is zero, the osmotic diffusion is stopped.

A further increase in the pressure of the concentrated solution will result into diffusion of solvent from the concentrated region to the dilute region (Amjad, 1993; McCabe et al., 1993; Cath and Childress, 2006; Zhao et al., 2012; Shaffer et al., 2015; Lilanea et al., 2020).

Model equations for prediction of process parameters of reverse osmosis for desalination of seawater were developed via mathematical derivation from basic equations for reverse osmosis process.

Working on the assumption of laminar flow of water across reverse osmosis membrane, and adopting the Hagen-Poiseuille model of flow model for the flow of water across the membrane, Equation (1) was developed as a model equation relating the interfacial solute concentration (C_{si}) with the process pressure difference (ΔP).

$$C_{si} = C_s e^{\left(\frac{\Delta P(fgd^3)}{64\mu L^2 k_c}\right)} \quad (1)$$

Using the pressure difference as the primary independent variable, the corresponding interfacial solute concentration $(C_{\downarrow}si)$, the solute concentration polarity (Γ), water flux $[(J]_w)$ and osmotic pressure ($\Delta\pi$) of the process could be determine using Equations (1), (2), (3) and (4), respectively.

$$\Gamma = \left(e^{\left(\frac{\Delta P(fgd^3)}{64\mu L^2 k_c}\right)} - 1 \right) \quad (2)$$

$$J_w = \frac{C_s k_s}{dC_s}(e^{\left(\frac{\Delta P(fgd^3)}{64\mu L^2 k_c}\right)} - 1) \quad (3)$$

$$\Delta\pi = RTC_s(e^{\left(\frac{\Delta P(fgd^3)}{64\mu L^2 k_c}\right)} - 1) \quad (4)$$

Therefore, employing the model equations developed, operations of reverse osmosis for desalination of fresh water can be simulated and real time behaviour of the operational parameter can be monitored and predicted for an improved and optimized process operations.

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PREVENTION OF BIOFOULING OF INDUSTRIAL REVERSE WATER SUPPLY SYSTEMS BY PLASMA WATER TREATMENT

Reagent-free methods of biofouling prevention in reverse water supply systems are of the utmost interest. It is a specific class of process techniques, which should include the physical methods based on preliminary treatment of reverse cycle water with ultrasonic vibrations, UV radiation, electrolysis, vacuum treatment, etc. At the same time, new modern methods based on advances in high-energy chemistry find practical application in the technology of water treatment. Among these are radiolysis and methods based on electric discharges of various types (spark, quiet, barrier discharges); each of them makes a certain energy contribution to biofouling prevention in the process pipelines of recirculated water supply systems. The processes of pre-treatment of aqueous media with low-temperature non-equilibrium contact plasma are of particular interest. Scientific works in this domain have been conducted for the last few years in the plasma process laboratory of USUCT. Previous studies showed that the use of NCP (non-equilibrium contact plasma) for treatment of water from various reservoirs could solve a number of problems of water treatment for industrial purposes, since the basis of such processes is the accumulation of reactive particles, radicals, peroxide and superoxide compounds in the aqueous medium, combined with the action of UV radiation and classical electrolysis.

First of all, studies of water samples of the Dnipro River as a main source of water intake of industrial enterprises located on its banks, were conducted. The experiments were carried out in duplicate. Comparison samples and those exposed to NCP were held for 12 months. 1 l glass bottles filled with water taken from the natural sources (as a reference) and bottles with the same water after

its plasma treatment were placed so that part of them stayed in the natural light in normal daily mode, while the other part was in the darkness at the constant temperature, close to 18°C. Samples of the Dnipro water were treated at the following parameters of contact plasma: current *I*=80-100 mA, voltage *U*=550-600 V in accordance with the recommendations given in [ ]. In the course of plasma treatment of samples, the changes of pH factor and concentration of peroxide compounds in the aqueous media were recorded.

Apart from zooglea bacteria, fouling in the reverse cycle is represented also by nematodes and oligochaetes, rotifers, infusorias, and a large number of the protozoans and algae (diatom, green and blue-green algae). Thread-like iron bacteria are often growing in water supply pipes, and such growth significantly reduces the pipes' capacity or causes their complete blockage. *Leptothrix orchaceae* are more common in pipes. Unicellular iron bacteria in the form of individual cells and mucous zooglea, various species of *Siderocapsa* and *Sideromonas*, can be found there as well. Gallionellas (*Gallionella ferruginea Ehrb*) are often found in water pipelines filled with water from underground sources. Furthermore, in case of severe contamination of water with organic compounds the fouling caused by various species of aquatic fungi may develop. The activity of bacteria in pipelines is often accompanied by the decrease in pH, which accelerates the corrosion processes. Inorganic compounds involved in the fouling are carbonates, phosphorus compounds and sulfur present in water. To a large extent, probability and intensity of the biofouling development is determined by the environmental conditions, i.e. physical and chemical properties of water. Thus, the underlying factors and sources of biofouling of the inner surfaces of pipelines deprived of penetrating light, as well as the surfaces of cooling towers in the conditions of the natural light, were identified. The behavior of biofouling is typical for the other sources of water intake without any additional treatment and after plasma treatment. The insignificant differences are observed in case of studying samples taken from slow-moving/small rivers, where the level of contamination with various species of bacteria and microorganisms is slightly higher than, for example, in the Dnipro River. These differences do not change the general picture of the degree of biofouling in the recirculated water supply systems, which is a

criterion for the viability of using NCP for the conditioning of industrial water at food factories and in other branches of industry, first of all, from the natural reservoir such as the Dnipro River. The studies found that as a result of contact action of non-equilibrium plasma on water samples taken from different sources, irreversible processes occurred in the liquid medium, which affected the properties and composition of water.

The mechanism of chemical transformations in such system is described in detail in [1,2]. Results of studies indicate that plasmochemical treatment of water inhibits the process of active development of algae within the closed and open process facilities.

Therefore, in the process of use of non-equilibrium contact plasma for treatment of the aquatic environments, it is possible to solve a number of important systemic problems of the provision of industrial production with high-quality return water, increase in the level of operation of process equipment, and reduction of water consumption for heat-exchange processes and pollution of external water basins after removal of return water from the process cycle.

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CHANGE OF HYDRODYNAMIC STATE WITHIN THE KILIYA DISTRICT OF ODESSA REGION

In recent years, due to global cataclysms on the planet, much attention has been paid to the study of the harmful effects of water. The concept itself refers to important environmental, socio-economic problems that require constant attention and solutions, includes three

main areas: flooding, inundation, pollution of surface and groundwater sources. The following work on the example of one of the districts of Odessa region is devoted to the study of one of the manifestations of the harmful effects of water, namely flooding. Kiliya district is located in the south-western part of Odessa region and borders: in the northeast with Tatarbunary, in the north with Artsyz and in the west with Izmail districts. Orographically, this area belongs to the Black Sea lowlands. The largest mark in the northern part is 60-65m, and in the south -1-2m. The steppe landscape prevails. The depth of the erosion cut in the northern part is 20-25 m, in the central part - 15 m and in the southern part 1-2 m. There are two main types of relief - erosion-accumulation-denudation (watershed space) and erosion-accumulation (valleys). The main forms of relief are watershed plateaus, watershed slopes, floodplain terraces, floodplains of rivers and lakes and the bottom of beams, coastal cliffs, depressions such as hearths. [1]

The river network is relatively well developed. The main rivers are the Danube, the Nerushai, the Dracula, the Kyrgyz-Kytai, and the Aliaga. In addition, there are five unnamed rivers, which have a fragmentary distribution within the settlements.

The grid of irrigation canals is of great importance in the hydrography of the district, and the natural hydrological regime of temporary watercourses largely depends on the influence of reservoirs (Dracula, Kozia) and irrigation.

Lake Kytai is the easternmost body of water from the group of freshwater lakes in the Odessa region. Located 8 km from Kiliya and extended in the meridional direction. It consists of two lakes - northern and southern Kytai, which are separated near the villages of Krasny Yar and Priozernye by an earth dam. The shores and bed of the lake are composed of forest-like loams, the height of the shores is up to 10 m. [3] The lake, the Danube and reservoirs are the source of irrigation of the lands of Tatarbunary, Chervonoyarsk, Shevchenkivska, Priozernyanska, Vasyliivska irrigation systems and five rice.

Studies of the state of flooding were carried out in 17 settlements of the district on the basis of long-term materials of SE "BLACK SEA CRH" (Odessa hydrogeological and reclamation expedition) taking into account the developments [2, 4]. In four settlements the

closed and open drainage is put. Nineteen more closed, open and combined drainage systems have been installed on the irrigation areas adjacent to the settlements. In addition, there are three rice irrigation systems nearby with an extensive system of water supply and discharge open channels.

During the study period, flooded areas were observed in 6 settlements, but in recent years their number has decreased to two. Flooded areas covered an area of 614 to 527 hectares, which is 14.8 and 12.7%, respectively, of the total area of settlements in the area. The number of yards that fall into this area was 1398-1560. Potential flooding was observed mainly in eight settlements (nine in 2017 and 2018) on an area of 112-472 hectares (2.7-11.4%). Flooded areas were observed in the villages of Priozerne, Furmanivka, Primorske, Lisky, Desantne, and Trudove. Potentially flooded areas in addition to the above villages are found in the villages of Dmytrivka, Myrne and Shevchenkove. The total area of the critical depth of the groundwater level, depending on the year, ranges from 639 to 1086 ha, which is 15.4-26.2% of the total area of settlements of Kiliya district. This area includes an average of about 2080 buildings. In total, nine settlements in the district have areas with critical groundwater levels that negatively affect the condition of households.

The main reasons for the presence of flooded and potentially flooded areas within the Kiliya district are:

- naturally high levels of groundwater in the valley of the Danube and in the beams within the settlement that significantly respond to the amount and intensity of precipitation;
- intensive watering (flooding) on rice irrigated lands adjacent to settlements and homesteads;
- absence or clutter of the drainage and discharge network in some villages, absence of storm drains.

At the same time, in recent years there has been a decline in groundwater levels, which are affected by the above reasons, which leads to a decrease in critical areas. This is influenced by the redistribution of weather and climatic conditions - rising air temperatures and changes in rainfall intensity from prolonged rains to heavy rains. In addition, the actual irrigated areas are significantly reduced, where crops other than rice are practically not irrigated.

Economical technologies and methods of irrigation, namely drip irrigation, are beginning to be used on homestead plots.

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WATER -SUPPLY DEMAND IN THE SOUTH GOBI MINING AND HEAVY INDUSTRY REGION OF MONGOLIA

Mongolia’s Southern Gobi region is endowed with copper, gold, coal and includes the country’s largest coal reserve found at Tavan Tolgoi, and the world’s largest known copper and gold deposit at Oyu Tolgoi. The growth of mining at these reserves over the last decade and at Shivee Ovoo, where Mongolia’s second largest coal reserve is located, has triggered population migration and initiated the construction of largescale heavy industry. The Southern Gobi is set to experience additional exploitation of known deposits, expansion of mineral exploration and related heavy industry promoting continued economic growth. This and wider commercial and agricultural development around the mines will all contribute to increased water demand.

In order to assist the Ministry of Mining and Heavy Industry develop this plan, the 2030 WRG commissioned a rapid update to the

2016 hydro-economic assessment. The update specifically aimed to: understand the current and future growth in water demand to 2050 in the Tavan Tolgoi and Oyu Tolgoi regions with a focus on the mining and heavy industry sector; comparison to the current water supply providing an understanding of any future supply-demand gap; identification of potential water demand reduction and supply augmentation interventions; prioritization of these interventions to close the supply-demand gap; and the development of recommendations and concrete actions.

Mining is expected to accelerate and become a major industrial backbone in the Gobi region of Mongolia. The Tavan Tolgoi is the largest coal site of Mongolia which has high-grade coal deposit in the Gobi and Oyu Tolgoi mine is the largest project in Mongolian history.

The study includes coal mines, coal concentrators, power plants and copper-gold mines in Tavan Tolgoi and Oyu Tolgoi mining and heavy industrial zones. From a review of relevant policies, programs and planning documents and through discussion with operating companies 19 major projects were identified. These include open pit coal mining (Tavan Tolgoi, Ukhaa khudag, Baruun Naran etc), coal washing plants, open pit and underground copper mining (Oyu Tolgoi and Kharmagtai), copper concentrate processing plant and copper smelter.

The copper smelter plant will have the capacity to process 1 million tons of concentrate per year and copper ore extracted from the Oyu Tolgoi underground mine. With the commissioning of the Oyu Tolgoi underground mine in 2029, it will be possible to produce 2 million tons of copper concentrate per year, but only 50% of this is planned to be smelted in this plant.

The assessment of the future water demand for mining and heavy industry purposes is made across the time horizon of 2030-2050 in the Tavan Tolgoi and Oyu Tolgoi regions. Across this time-period, future water demand is estimated for 3 scenarios of low, medium and high growth to provide a more differentiated analysis. High growth relates to the maximum mine production capacity as highlighted and subsequently approved in the respective feasibility reports. Whilst the mining and related heavy industry sectors provides the focus of

this work, water demand for domestic, livestock, irrigated agriculture, social service sector and industry is estimated.

The most holistic cost-effective solutions are to combine wet and dry coal processing at the coal washing plants. This approach is already planned for the Bor Teeg coal washing plant by Erdenes Tavan Tolgoi JSC and indicates the feasibility of the approach in the Southern Gobi. It is recognized that the exact choice and configuration of coal beneficiation depends upon the impurities of the extracted coal and the final end market. It is recommended further analysis is undertaken to understand the applicability of this option for the planned coal washing plants that Erdenes Tavan Tolgoi JSC and Tavan Tolgoi JSC plan to develop.

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ON THE FEASIBILITY OF THE DEVELOPMENT OF SMALL HYDROPOWER IN UKRAINE

The share of hydropower in the overall balance of renewable energy in Ukraine from 2010 till the first quarter of 2020 decreased almost twice, from 98.4% to 44.9% [1]. As a result, the potential for more efficient regulation of the load schedule in the national combined energy system (CES) by means of highly manoeuvrable hydropower facilities decreased too.

In time, the share of small hydro in total hydropower in Ukraine varied from 1.24% in 2010 to 1.88% in 2020. But, its share is expected to decrease significantly after the commissioning of new facilities at the Dniester pumped-storage hydropower plant. As well as, the small hydropower does not have sufficient regulatory ability compared to large hydropower. Moreover, taking into account the topography, and hydrological characteristics of Ukrainian small rivers the work of small hydropower plants according to the "green tariff" in the CES of Ukraine should be also considered in the context of renewable energy that needs regulation. The only thing that can be calming in this situation is that the share of small hydropower in the balance of hydropower in the country will stay negligible [2].

There is also a tendency for a significant reduction of the share of small hydropower in the structure of non-traditional renewable energy. So, from 2010 till the first quarter of 2020 it fell from 43.0% to 1.5% [2]. According to data for the first quarter of 2020, the power of solar plants in households (618 MW) in the country has exceeded five times the installed capacity of small hydropower (116 MW) [1]. Nowadays, household solar, bioenergy (biomass and biogas) in Ukraine can be considered as a more acceptable "green" alternative to small hydropower. Additionally, small hydropower in our country cannot be considered as quite environmentally friendly, even in comparison with the large hydropower [2].

It is known that hydropower can adversely affect the environment [3]. However, taking into account numerous socio-ecological and socio-economic effects is sometimes a quite complicated challenge of analyzing and comparing alternatives because of difficulties to get rid of the influence of various subjective conclusions under solving similar tasks. Still, the decision-making problem when one considers environmental factors can be significantly simplified if just feasible alternatives will be compared [2].

In practice, not only cost indicators and their ratio to expected results determine the feasibility of projects. Projects may be effective but not useful. Often, the effectiveness of projects can be also stimulated by various kinds of special preferences, for example, in the form of a "green tariff" for produced electricity, etc.

This report presents the results of feasibility analysis of perspective plans for the construction of new hydropower plants

(HPPs) including the development of small hydropower in Ukraine according to the current national Hydropower development program [4]. We considered the next eight alternatives ordered and numbered according to increasing installed capacity, namely:

- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades; this option was accepted as a “zero” alternative;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, and also the further development of small hydropower in the country;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, and also the construction of the Kakhovka HPP-2;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, the construction of the Kakhovka HPP-2, and the further development of small hydropower;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, and the construction of the Upper Dnistrovskyi cascade of HPPs;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, the construction of the Upper Dnistrovskyi cascade of HPPs, and the further development of small hydropower in the country;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, the construction of the Kakhovka HPP-2, and the construction of the Upper Dnistrovskyi cascade;
- the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, the construction of the Kakhovka HPP-2, and the Upper Dnistrovskyi cascade of HPPs, and the further development of small hydropower.

In the research, the method (see [5]) of decision-making on the basis of a pairwise comparison of alternatives taking into account the risk of unused possibilities was used.

Components of aggregate risks of eight abovementioned alternatives were estimated in dimensionless units for main water-energy and operability characteristics, and costs of commissioning of new hydro generating capacities. It turned out the best alternative is 3) the second stage of reconstruction of the HPPs of the Dniprovsky and Dnistrovsky cascades, and the construction of the Kakhovka HPP-2.

All considered alternatives providing for the further development of small hydropower in the country were revealed worse than alternatives where its further enlargement is neglected. It may indicate that the decision regarding to support small hydropower in the country is ungrounded.

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ENVIRONMENTAL IMPACTS OF MINING - ATMOSPHERIC CONTAMINATIONS

The paper presents one of many impacts of mining industry on environment. Mining is one of the most influential fields for our specie in terms of the provisioning of resources for the human race, there is a constant and fluctuating demand of minerals to preserve and improve our development and way of living, but as opposed it, is also one of the most harmful practices to our environment from different angles if not supervised and regulated.

Atmospheric contamination is denominated as the presence of substances, matter or any kind of energy which involves risk, harm or severe inconvenience to people and any type of asset.

There are 3 main elements to consider: pollutants emission, pollutants dispersion or atmospheric dissemination, pollutants immission. We distinguish atmospheric pollutants like: SO_2, NO_x, carbon oxides, volatile organic compounds VOCs, chlorofluorcarbons compounds CFCs, suspended particles, heavy metals, NH_3, H_2S.

Atmospheric pollution has implications at a local, national and global level. The principal impacts are the urban environment pollution, acid rains at a local degree and the ozone layer destruction and greenhouse phenomenon at a global degree. Atmospheric particles in the air are produced due to blasting, drilling, excavation, land movement, transport, resources transference, wind erosion of land while surface extraction or any operation of underground mining carried out in the surface. Blasting itself and combustion due to diesel devices both emit nitrates than can be hosted in underground mines as much as in surface mines. During processing, transport, milling, vehicles, wind erosion of dry areas from waste ponds, roads and material piles will rise atmospheric matter into the

air. Atmospheric pollutants such as particulate matter, heavy metals, carbon oxides, SO_2 and nitrates may be produced during extractive activities and processes.

The main atmospheric pollutant sources are:

-particulate matter carried by the wind as a result of excavation, blasting, material transport, wind erosion (more frequent in open pits), fugitive dust from tailings deposits, dumps, waste piles, roads. Exhaust emissions from mobile sources (vehicles, trucks, heavy machinery) also contribute increase particulate matter levels.

-gaseous emissions from the fuels burning in stationary sources such as vehicles, blasting and mineral processing.

When a source releases pollutants into the atmosphere, the contaminated substances are transported in the air, diluted and subject to physical and chemical changes in the atmosphere and eventually reach the receptor. These pollutants can cause serious effects on people's health and on the environment.

The mobile sources of pollutants in the air include all type of heavy vehicles used in excavation operations, vehicles to transport workers to the mine or trucks transporting necessary materials for processing. The degree of pollutant emissions from these sources depends on the fuel used and working conditions of the of equipment. While emissions from individual sources may be relatively small, the amount of emissions as a whole is a matter of concern. Mobile sources generate large amounts of particulate matter, carbon monoxide and volatile organic compounds that contribute significantly to the formation of ground-level ozone.

The main gaseous emissions from stationary sources come from burning fuels in power generation facilities and drying, roasting and smelting processes. Many precious metal implement smelting processes before transporting the material to refineries. Generally, gold and silver created in smelter furnaces are capable of creating elevated amounts of mercury, arsenic, sulphur dioxide and other metals.

Fugitive emissions are those emissions that cannot be expelled through a chimney, ventilation duct and other functionally equivalent openings". The most usual sources of fugitive emissions in extractive operations are: storage and handling of materials, mining processes, dust leaks, blasting, construction activities, access roads to mining

areas, leaching piles and ponds; deposits of sterile material and debris. Impacts due to fugitive emissions can vary a lot in each case, that is why they are difficult to predict. Due to their potential they should be considered as a significant source of hazardous pollutants.

Extractive activity is essential to supply the world´s demand for materials, the actual real concern for sustainable development must serve for governments, companies, and social and intellectual groups as a motivation to ensure the environmental impacts overview and assessment coming from mining projects, so that we can maintain a constant and sustainable supply of the world´s material needs, crucial for the global development.

Mining activity has clear impacts on different elements of the environment, and they must all be properly assessed from different angles, implying an environmental reclamation plan which must be included since the first planning stage of an extractive project and must involve the participation from the whole society.

S E C T I O N

“MINING AND PROCESSING OF USEFUL MINERALS”

UDC 661.842

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ECOLOGICALLY SAFE OPERATION OF PHOSPHOGYPSE LANDFILLS AT PJSC "RIVNEAZOT"

After analyzing the object of the study, which included topographic survey, determination of chemical, mechanical composition of soil and groundwater, water-physical properties of soil of the adjacent territory, three steps were proposed to ensure ecological and safe functioning of phosphogypsum dumps PJSC "RivneAzot" [1,2].

In the first stage, a scheme to intercept contaminated water from the territory of phosphogypsum dumps is proposed to prevent the spread of contamination. The area around the dumps requires the installation of a collector-drainage network that will intercept and divert contaminated groundwater to treatment facilities of PJSC "RivneAzot", which are located 5 km from the territory of the study object. In the second stage, it is recommended to cover the phosphogypsum dumps with a protective film, followed by powdering the fertile soil layer with the landing of vegetation, which will prevent wind erosion and contamination of the surrounding areas [3].

Protective polymer films, as a material for anti-filtration devices are virtually impermeable, have high resistance to the aggressive effects of common chemical reagents, high deformability, low

material intensity and high manufacturability. Advantages of polymer films include the fact that the formation of water retaining elements depends on local conditions of construction.

Film anti-filtration devices must be reliable in operation throughout the life of the structure. The reliability of operation is determined primarily by the properties of the polymer film element.

These properties must be such as to distinguish between the types of impacts (mechanical stresses, water, temperature fluctuations, etc.), which are possible during both operational and construction periods, would not cause changes in the material or its damage, which is unacceptable in terms of reliability anti-filtration device.

In our case, not only punctures, cuts, but also changes that would lead to a violation of the integrity of the films and, consequently, a loss of water tightness in the term shorter than the service life of the structure, are inadmissible in film anti-filtration elements.

In the absence of mechanical damage in the film due to its small porosity, the movement of water through the film is possible only in the form of diffusion of water molecules and soluble substances in it. Diffusion water losses, however, are quite small and in our case acceptable. Soil-coated screens have a lifetime of up to 100 years. The vegetation recommended for planting in a meter layer of soil is small shrubs with sowing grasses.

The third stage is designed for a longer term - is the processing of phosphogypsum on building materials with the simultaneous decontamination of phosphogypsum from harmful elements and the removal of rare earth metals that occur in the composition of phosphogypsum - up to 1%.

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IMPROVING THE EFFICIENCY OF THE WORK OF THE VIBRO DEVICE FOR AMBER EXTRACTION BY THE VIBRO-HYDRAULIC METHOD

In Ukraine, considerable deposits of amber have been explored. Rivne region accounts for about six percent of the world's stock of amber. At present, the main stocks of amber-succinate of Ukraine are found in the right-bank part of Polissya - the Pripyat Amber Basin (the northern part of the Volyn, Rivne, Zhytomyr and Kyiv oblasts). There were 44 amber deposits and a couple of fields: Klesivske, Vlina, and others. The total reserves are estimated at 100 thousand tons, which predominate in sandy and sandy-clay soils at depths up to 15 meters and are sufficient for research and introduction of new technologies and equipment [1].

Extraction of amber from sand deposits is mainly carried out in two methods: mechanical and hydraulic. The mechanical method involves the mechanical development of an array of soil in an open quarry or underground, and includes: the disclosure of the productive soil layer, excavation work, rock breeding, rocketing, rock washing, land reclamation. The hydraulic method is carried out by blurring the productive soil layer with high pressure jets, and by removing amber to the surface of the deposit by hydraulic flows. The method is accompanied by the removal of mineral soil to the surface of the deposit, does not ensure the complete removal of amber from the deposits, energy-intensive, leads to changes in the structure of soils, the formation of cavities. Therefore, these problems need to be disrupted by the fact that mechanisms and machines used for known methods of amber extraction (mechanical and hydraulic) damage the environment, destroying the natural landscape, and also does not completely remove the valuable component from the massifs [2;3].

Amber has applications in various industries. It is easy to cut, polished and polished, with a wide range of colors. The main

direction of the use of amber is the jewelry industry, products of its chemical processing in the medical and chemical industries are widely used. In the jewelry industry, amber fractions of large and medium size are used to make jewelry. In medicine, amber acid is used. In order to get it, amber is crushed into powder. For this purpose, even the smallest grains of this stone will suit, which usually remains in the soil after the development of amber deposits by mechanical or hydraulic methods, are suitable [4; 5].

In the National university of water and environmental engineering its staff proposed a hydromechanical method of lifting amber to the surface of the field, the novelty of which is confirmed by the patent of Ukraine №32201 and modernization over time №34122 [6; 7].

The disadvantage of this design of the vibrating device is that the creation of a solid suspension layer occurs along the entire height, while consuming significant energy to destroy the relationships within the soil mass. Placing vibrators on the surface of the vibrating device, transmitting oscillations to hollow rods, does not allow to fully use the energy of vibration waves with increasing depth of immersion, which leads to energy loss and reduces the efficiency of the device with significant economic costs.

The device is based on the task aimed at transmitting vibrational energy through the depth inside the soil mass, which is then spent on the very tips of the vibroprinting, and not on the surface of the rods. The task is achieved by the fact that in the vibrating line, which includes the compressor and spaced apart in space and fixed on vertical hollow rods of biconical vibrating emitters, cylinders with moving pistons are placed in the hollow rods at the tips, to which high-pressure tubes lead through which air is supplied under pressure, which drives the entire rod with biconical vibrating emitters and the transmission of vibration waves to the exciting array occurs.

Such a construction of a vibration device for amber mining allows to increase the efficiency of the device itself and the efficiency of using the energy of vibrational waves with increasing depth. Biconical horizontally The vibrating emitters are spaced in such a way that the projections of three adjacent centers on the horizontal plane form an equilateral triangle. This arrangement makes it possible to exclude additional energy consumption for the ineffective use of the vibrating line for amber mining.

The use of this vibrating edge for amber mining allows efficient energy consumption, creates an oscillator that acts as a compressor, completely eliminates amber from the deposit, excludes rock removal to the deposit surface, and reduces the energy consumption of the process and the environmental impact on the environment.

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AN OVERVIEW OF ENERGY TRANSITION CONSIDERATIONS ASSOCIATED WITH COAL BURST OCCURRENCES

Coal burst is a form of violent and dynamic failure of coal or rock, with a high-velocity ejection of materials from underground openings. It has been identified as high safety and production risk in underground coal mines, which threatens the sustainable use of natural resources. It involves a sudden release of strain energy stored within the coal or rock mass due to the disturbance of an unstable state of equilibrium [1]. The quantification of the energy transition involved in this dynamic failure process plays a significant role in understanding the coal burst mechanisms.

International experience on coal burst has been widely reported in the majority of the mining countries. Over the years, a significant amount of research has been carried out to understand, forecast and control coal and rock bursts. These studies indicate that dynamic failures occur under the effects of complex environments of geology, stress and mining conditions, and there is no one set of defining characteristics that is responsible. The relative roles of these different contributing factors can change from one site to another [2]. The energy sources that cause coal burst are highly complex. These sources are the rock mass as elastic strain energy, the potential energy within the adsorbed gas phase, seismic energy related to rock fracture or faulting together with energy-related to mine geometry. Recent research in Australia into understanding coal burst by the authors highlighted the following four main research topics [3]:

1. Coal burst mechanisms (both direct and indirect)

a. Energy sources

b. Energy storage (geological units and material properties)

c. Energy release and damage mechanisms

2. Triggers (or causative factors)

a. What causes or initiates failure?

b. How is the energy release manifested?

3. Prediction

a. Monitoring

b. Identification of "coal burst risk domains" at a mine site

4. Controls

a. Preventative measures for elimination of risk (i.e., mine design criteria)

b. Mitigation of risk (i.e., support design)

To understand and manage coal burst, it is important to apply analytical and computational methods to determine the energy magnitude required to cause a coal burst. Quantification of the energy elements and the energy release process are two critical aspects of understanding coal burst mechanisms. Its essential to conduct a preliminary assessment of the energy components involved in coal burst and discusses the strain energy, gas expansion energy, seismic energy and internal plastic work done, and the associated kinetic energy, using analytical and/or numerical modelling methods. Further studies using computational methods should be conducted to explicitly represent the coal mass, the cleating features, seismic energy convention/magnitude in and around excavations, and gas desorption to quantify the energy components and the energy levels in greater detail and accuracy. Seismic energy has been identified as another source of energy that contributes to coal burst. In addition, the contribution of gas expansion energy to coal burst needs to be quantified considering desorption and free gas expansion. This abstract provides a basis for further research to quantify the effects of energy involved in coal burst to help establish effective coal burst control strategies.

To understand the energy requirements for ground support in coal burst control, dynamic numerical modelling and laboratory testing need to be conducted to quantify the energy build-up and transfer within the support rock and coal mass. Importantly, a systematic

approach is required to understand the roles and interactions between different support elements as well as the host rock and coal mass.

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THE USE OF OXIDIZING AGENTS AS A WAY TO INCREASE THE EFFICIENCY OF MINING HYDROGENOUS URANIUM DEPOSITS

The global demand for electricity continues to grow; more than 20 countries are interested in creating nuclear power. Of the 30 countries already operating nuclear power plants, more than 10 are building new power units or actively completing construction of previously suspended facilities, and 16 countries have plans or proposals for the construction of new reactors[1].

JSC "NAC "Kazatomprom» it is the world's largest producer of uranium with natural uranium production, in proportion to the Company's ownership interests, accounting for about 24% of total global primary uranium production in 2019. Kazatomprom, together

with its subsidiaries, affiliates and joint ventures, is developing 24 deposits united into 13 uranium mining enterprises. All uranium mining enterprises are located in the territory of the Republic of Kazakhstan and use the technology of underground well leaching (UWL), paying special attention to best practices[2].

Each field has a number of problems and tasks that need to be addressed. These problems and tasks can be either individual-for a specific field, or shared by several fields at once.

One of these problems is the selection of optimal technological parameters for conducting UWL under the most favorable conditions at hydrogenated fields.

The condition of uranium in UWL largely depends on both the mineral composition of the deposit and its type and age. For example, oxidized minerals are better dissolved, nasturan, uraninite and tar are worse. At the same time, U^{4+} minerals (uraninite, nasturan, coffinite) are effectively dissolved only in the presence of oxidants, which contribute to an increasein the redox potential in the formation[3].The resulting redox reactions in the formation largely determine the efficiency of the uranium leaching technology, the completeness of metal recovery into solution, the specific costs of chemical reagents, energy consumption, and overall technical, economic, and environmental performance of production.

Tetravalent uranium, however, has a low solubility, both in acidic and alkaline environments. In order to achieve an economically acceptable leaching of uranium from the ore, an important role is played by its oxidation to a hexavalent state, which has a higher solubility. For this purpose, trivalent iron compounds are usually used.

It is known that in the pH range from 1.0 to 3.0, which is the most typical for the UWL process, the most effective individual oxidizer is Fe^{3+}, and the complex ones are only those that again include Fe.

At the same time, the rate of dissolution of uranium minerals in a sulfuric acidic environment in the presence of Fe depends very significantly on the value of the redox potential (RP), and in the RP range from 400 to 500 mV, there is a sharp jump in the leaching rate..

The RP value, in turn, is directly related to the Fe^{3+}/Fe^{2+} ratio in the leaching solution. In the case of sulfuric acid UWL of uranium,

iron is always leached from the reservoir in a significant amount (0.5-3 g/l and higher), so that regardless of the nature of the oxidant used, the speed of the UWL process is determined by the Fe^{3+}/Fe^{2+} ratio in productive solutions (PS)[4].

Thus, we come to the conclusion that the intensification of the UWL process is inevitable. By their essence, all known methods of intensification of the UWL process can be classified as follows: hydrodynamic; physical; physico-chemical; chemical (the use of oxidizers).It is impossible to clearly separate physical and chemical methods of process intensification, since there is a close relationship between them: physical methods always entail the appearance of intermediate chemical processes that also initiate reactions[5]. Studies of the intensification of the leaching process using artificial oxidizers are carried out constantly.

Currently, air oxygen, hydrogen peroxide and purified trivalent iron in the form of $Fe_2(SO_4)_3$. On an industrial scale, oxygen is used in Uzbekistan's oilfields, and hydrogen peroxide is used in the Semizbai field (Northern Kazakhstan).

Analysis of various methods of leaching intensification shows that all of them accelerate the process and increase the degree of recovery of the useful component by several times. However, they are not universal and can only be applied depending on the conditions of specific deposits and require more careful study.

One of the promising directions for research is the use of sodium nitrite ($NaNO_2$) as an oxidizer. Laboratory studies have shown that the introduction of sodium nitrite into leaching solutions contributes to the rapid oxidation of iron (II) according to the following scheme

$$HNO_2+Fe^{2+}\rightarrow NO+Fe^{3+}$$

Positive laboratory experiments indicate the need to conduct pilot-industrial tests directly at the fields where it is planned to use this oxidizer.

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BACKFILL TECHNOLOGIES AND GREEN MINING IN UNDERGROUND METAL MINE IN MONGOLIA

Currently, there are more than 900 mining and concentrating plants, of which about 6 percent are mines of various capacities, underground mining of fluorspar, tungsten, lead and zinc in Mongolia and 5.8% of the total territory of Mongolia is covered by mining licenses.

The mining sector plays an important role in the social economic development of our country, but on the other hand, it has a significant negative impact on the environment. For example, open pit mining may have a lower operating cost than an underground mine of the same capacity, but the destruction of the area's natural environment without recovery can dramatically increase the cost of rehabilitation, which is limited by economic feasibility.

Therefore, it is our duty as researchers to study, develop and introduce new technologies that will have a low impact on the

environment, meet world standards and be waste-free. One of them is to improve the technology of underground ore mining with a full-fledged mining system aimed at developing green mining and then introduce it to the underground mines of our country.

One example of the rapid development of underground mining in the world is the continuous improvement of the non-waste filling system in accordance with the mining and technical conditions of the deposit and the type of mineral. For example, in the People's Republic of China, the relevant rules and standards stipulate that underground mining of ore deposits must be carried out without waste through a full-fledged mining system.

The fact that this technology has not been introduced in underground mines in our country shows that we focus on mine profitability and less on the environment and mine safety. For example, during the operation of an underground mine, the technical conditions of the mine are deteriorating due to the increase of voids in the ground and the pressure of the rock core, which leads to the loss of mining operations and safety risks. In addition, the ore block is left as a pillar to ensure the safety of the mine, which makes it impossible to fully extract the minerals. One of them is Ulaan mine of lead and zinc mixed metal located in Dashbalbar soum of Dornod province.

From all of the above, it is clear that in addition to non-waste underground mining, there is a need to introduce a “filled mining system”, one of the most advanced international technologies for occupational safety, environmentally friendly and green mining. This will incur some costs, but on the one hand, it will be possible to fully extract the proven reserves of the deposit, reduce the amount of waste to be supplied to the tailings dam, and reduce the amount of degraded land. On the other hand, it will be possible to operate profitably by reducing the cost of waste management and mine rehabilitation by a certain percentage.

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MONITORING THE QUALITY OF THE ENVIRONMENT IN THE MINING UNITS AS A RESULT OF THE MODERNIZATION OF THE EQUIPMENT

The paper analyzes the Jiu Valley basin and the Oltenia basin.

Both surface and underground mining produce negative effects on the environment. Some of these effects are represented by dust pollution, which is a pollution, directly proportional to the number of technological processes that are used for the movement and extraction of rocks.

Currently, environmental pollution in mining areas is decreasing because they have invested in developing mining machines and technologies.

For surface mining we chose an excavator with rotor from the SRs 2000 range, on wrestling steps with heights of 25-30 m and excavation capacities between 2800 and 4500 m^3/h.

Underground machines have a much smaller size and capacity compared to outdoor equipment. The one most used underground cyclic mine excavator are: - Overtake loader - Load-Haul-Dump (LHD) unit.

A loading-unloading machine, or simply LHD, as the name suggests, can combine the work of a loader and a dump truck. In this way, one operator works instead of two in the first case.

Without difficulty in narrower areas

If until 2010 the pollution of the environment was very high from this year, the first steps of modernization started and with them began a decrease of dust and dust emissions in the environment.

The main objective of this study is to observe how the improvement of mining technologies and equipment leads to an improvement of the environment.

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UNSTRENGTHENING OF GAS-BEARING COAL SEAMS

It has long been known that the hardness of coal increases with the removal of gas from it. We accept the condition that the gas pressure σ_g acts in all directions and changes by linear law according to the formula

$$\sigma_g = g \cdot l, \qquad (1)$$

where g - gradient of the increase in gas pressure deep into the massif per unit distance from the working face, Pa/m; l - distance from the face to the considered point along the plane of the seam, m.

The current value of the bearing rock pressure along of plane bedding of the seam we describe by the formula [1]

$$\sigma_{y_i} = \sigma_{y_\xi}\left(1+ f_c\left(1-t_l \cdot l\right)\cdot l/h\right), \qquad (2)$$

where $\sigma_{y\xi}$ - vertical normal stress at the top of the squeezing crack; f_c - coefficient of contact friction; $l = \frac{1}{l_m}$ - coefficient attenuation of contact friction along the seam; l_m- length bearing of zone; l - distance from the face to the considered point.

The specific force of the rock pressure on working a face of seam is determined by the formula

$$p = \frac{\sigma_{y_\xi}}{l}\int_0^l\left(1+\frac{f_c(1-t_l \cdot l)l}{h}\right)dl = \sigma_{y_\xi}\left(1+\frac{f_c \cdot l}{2h}-\frac{f_c \cdot t_l \cdot l^2}{3h}\right). \qquad (3)$$

Part of working face region by the length of the abscissa x_ξ comes out from under of the load. The bearing capacity σ_c during the development of a squeezing crack according to TMEKN ξ on the part which didn't leave from under loading and equal (l-x_ξ), is determined by the formula.

$$\sigma_c = p\frac{\left(l-x_\xi\right)}{l} = \sigma_{y_\xi}\left(1+\frac{f_c \cdot (l-x_\xi)}{2h}-\frac{f_c \cdot t_l \cdot (l-x_\xi)^2}{3h}\right)\frac{\left(l-x_\xi\right)}{l}. \qquad (4)$$

Now let's determine the stress $\sigma_{y\xi}$ taking into account the gas pressure. For this, we introduce into the system for calculating the normal stress $\sigma_{y\xi}$ at the crack tip [2, 3] the gas pressure σ_g of the coal seam according to formula (1).

According to the theory of local fracture [3], the reactive vertical stress $\sigma_{y\xi}$ at the crack tip is the front support of the roof-seam system.

As the crack develops, the value of this stress constantly increases. Therefore, in the absence of gas, external attraction of energy is required for the development of a crack. A different picture arises in the presence of tensile stress from gas pressure at the crack tip, which reduces the reactive vertical stress.

It has been experimentally confirmed that the internal of gas pressure sharply reduces the strength of coal and, of course, sharply reduces the bearing capacity of working a face region of coal seam [4-7].

This occurs due to a decrease in the effective tangential stress at the crack tip under the action of the tensile normal stress of gas. On the basis of the set of theoretical studies carried out, an important conclusion can be formulated*: the bearing capacity of the working a*

face zone of a gas-bearing coal seam is determined by the values of the coal's resistance to shear, the gas pressure in it, and the part of the working a face of the seam that did not come out from under the load during the formation of a squeezing crack.

This conclusion makes it possible to explain the phenomenon of increasing the strength of coal after its degassing [4].

This occurs due to a decrease in the effective tangential stress at the crack tip under the action of the tensile normal stress of gas.

Conclusions.

1. The bearing capacity of the working face region of a gas-bearing coal seam is determined by the values of the coal's resistance to shear, the gas pressure in it, and the part that did not come out of the load during the formation of the crack of squeezing.

2. The observed experimental facts of coal strengthening after its degassing are explained by a decrease in the internal pressure of gas.

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RESEARCH ON HYDROMETALLURGICAL PROCESSING OF POWER PLANT ASHES

The paper presents the research undertaken in order to recover some macro and micro elements from the ashes resulting from the combustion of energetic hard coal from the Jiu Valley coal basin. Due to the very low contents of these elements, their recovery by classical processing methods is very difficult, therefore, the experimental attempts to recover them was focused on hydrometallurgical processing. The solubilization tests were performed with different leaching agents, at different leaching concentrations and times, the response function being the extraction by weight in the case of macroelements and the extraction of metal in the case of microelements.

Inorganic substances from coal, by burning, turn into ash which contains a number of elements present in large quantities known as major elements or macroelements. They are found in quantities of more than 1% of the mass of ash having a weight that decreases in the order: Si, Al, Fe, Ca, Mg, S, Na, K, Ti, P.

In addition to macroelements whose distribution determines the oxide composition of the ash, in coal there are present in small quantities (between 1 ppm and 1%) a number of other elements, known as trace elements, rare elements, minor elements or microelements.

Laboratory research was carried out in order to extract some chemical elements from the ash by acid and alkaline leaching.

Alkaline leaching was performed in order to extract aluminum and similar chemical elements in terms of their chemical properties. The leaching rate, expressed by the amount of substance passing into the solution per unit of time, depends on a number of parameters such as: temperature, leaching reagent concentration, stirring speed, solid particle size, leaching time.

The leaching reagent used was sodium hydroxide, at different concentrations; the leaching time was 24 hours, with intermittent stirring at 100 °C - initially to start the chemical reaction after which the leaching took place at ambient temperature.

Along with aluminum, the solutions resulting from ash leaching also contain sodium silicate which can be precipitated.

It was found from the obtained data that the highest extractions by weight were obtained in the case of using NaOH solutions - 10% concentration. These values of the extractions are small if we take into account the fact that the share of aluminates and silicates in the ashes of Paroseni is over 70%, therefore the alkaline leaching proved to be inefficient for these ashes.

Acid leaching was performed in order to verify the possibilities of hydrometallurgical recovery of ashes. In order to choose the optimal leaching reagent and the corresponding concentration, several sets of tests were performed, with different reagents, at different concentrations. This type of leaching was performed at a low temperature, by intermittent stirring, at a leaching time of 2 hours.

From the research data there can be observed that the highest extraction by weight (15.38%) was obtained by using as a leaching agent the nitric acid - concentration 15%.

The aim of this paper was to highlight these secondary resources of raw materials - existing in the ash ponds from thermal power plants that use energetic hard coal from the Jiu Valley Basin - likely to be used efficiently after processing by conventional and/or unconventional technologies.

The chemical analyzes highlighted the existence in the ashes of Paroşeni of some microelements such as: Cu, Pb, Zn, Co, Mo, Cr, V, Ti, Mn, Cd, Au, Ag, Pt, U. Although the contents of the chemical elements present in the ashes taken from the Paroşeni tailings ponds are lower than the minimally exploitable ones worldwide, having the advantage that these ashes do not require operating costs but

exclusively preparation, it can be argued that the recovery of these chemical elements from ash can be cost-effective by applying technologies adapted to their specific characteristics.

Attempts for acid and alkaline solubilization of power plant ash aimed to obtain acceptable weight extractions, the best being acid leaching with nitric acid concentration 15%.

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GRAVITY CONCENTRATION OF ORE FROM ATYGAY DEPOSIT

The Atygay gold deposit (West Khazret site) belongs to the hydrothermal genetic type of the gold-sulfide quartz (mid-depth) ore formation. By the number of sulfides this deposit is classified as a low-sulfide group.

The results of rational (phase) analysis for gold show that the main amount of gold (96.3%) is in the ore in a loose form and in a form of aggregates with ore components, i.e. in cyanized forms. Gold covered with films of iron hydroxides and carbonates, and associated with sulfides (0.62%), thinly interspersed in rock-forming minerals (2.47%). The results of mineralogical studies show that native gold (visible) was found in the form of loose grains of a lamellar shape in heavy fractions of gravioconcentrate and in average initial ore sample. The size of the gold pieces, judging by their cross-section in the flatness of the briquette, in diameter is 0.06-0.22 mm. Bright yellow gold (R-85%), high-grade composition (%): Au-96.54; Ag-2.78; Fe-0.68.

In the polished section the fine gold was found in the form of inclusions in pyrite grains. Grain sizes are 0.005; 0.007; 0.015 mm. The grain shape is oval, isometric, and irregular [1,2]. Based on the results obtained the gravity enrichment is applied to the processing of the studied ore [3].

Gravity enrichment is carried out on 3-inch laboratory centrifugal concentrator Nelson KC-МД3 [4] on the sample of crushed ore of size class +1,2÷-0,071: weight of the sample per test 3-10 kg; centrifugal acceleration is 60G; consumption of fluidizing water is 3,5

l/min; the solid performance is 0.5-0.6 kg/min.; overpressure of fluidizing water is 10-14 kPa; solid content in the pulp, provided to gravity enrichment is 25-30%.

According to the screen characteristics of crushed ore, it was found that the gold content by size classes varies in a fairly wide range, which indicates its uneven location in the ore. The results of wet screen analysis of crushed ore samples confirmed the uneven distribution of gold in the ore.

For the purpose of assessment of the gravitational ore enrichment, the GRG tests were conducted by using the Knelson company method (Canada) [5] (Table 1).

Table 1

GRG test results for the studied sample

Product	Product yield		Concentration of Au, gr/t	Extraction of Au, %
	gr	%		
1 stage Atygay initial -1,6 mm				
concentrate	115,9	1,16	25,57	17,53
tailings	9884,1	98,84	1,41	82,47
ore	10000,0	100,00	1,69	100,00
2 stage Atygay 80% of class -0,3 мм				
concentrate	113,8	1,15	17,60	14,48
tailings	9770,3	98,85	1,21	85,52
supplye	9884,1	100,00	1,40	100,00
3 stage Atygay 80% of class -0,071 мм				
concentrate	119,6	1,22	17,15	17,10
tailings	9650,8	98,78	1,03	82,90
supply	9770,3	100,00	1,23	100,00

The highest rates of gold extraction were obtained at the first stage with a size of P80 -1.6 mm and the third stage with a size of P80 -0.071mm. This confirms that the ore contains relatively large gold pieces and small loose ones.

The results of GRG tests showed that the ore of the Atygay deposit is effectively enriched at centrifugal concentrators.

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RESEARCH OF DETERMINING FACTORS OF INCREASE EFFICIENCY OF ROAD TRANSPORT

Improving the use of quarry vehicles is associated with various ways to solve problems, among which there is a reduction in downtime for loading and travel time in General, as well as an increase in the load capacity of dump trucks.

Reduced loading downtime is provided by an optimal ratio between the bucket capacity of the excavator and the transport vessel. Loading dump proportional to the number of immersed buckets and ego growth over the optimal values increases the downtime of dump truck for loading, travel time and, as a consequence, the performance of the dump truck.

If this ratio is less than 4-5 (a large bucket of an excavator and a small dump truck body), then it is difficult to accurately unload the rock and the performance of the excavator.

Loading dump proportional to the number of immersed buckets and ego growth over the optimal values increases the downtime of dump truck for loading, travel time and, as a consequence, the performance of the dump truck.

The definition of this ratio is particularly acute if the total loading time of all dump trucks serviced by one excavator exceeds the race time and after that a queue is formed at the loading vehicle.

However, for quarries that use road transport to deliver minerals over long (not rational) distances, the inflated loading time of a single dump truck does not significantly affect the trip time.

The queue at the excavator is not formed and the concept of "rational ratio of bucket capacity and body" changes. In this situation, at the forefront of the payment performance of dump with increasing distance of transport that can be achieved , in particular, the increase in carrying capacity of dump trucks, including the use of trucks with trailers.

Simulation performance the example dump trucks MAZ-5551 and MAZ 5551 trailer shows that the drop in replacement performance of dump with increasing distance of transportation 5 km to 15.0 km., provides compensation 80% increase in load capacity dump truck with 10 t to 20 t and 100% as the distance increases from 5 to 11 kilometers.

UDC 622

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ANALYSIS OF APPLICATION THE MEANS FOR REPLACING THE EXPLOSIVES AT ROCK MASS DESTRUCTION

Abstract

Blasting operation, with help of chemical explosives, is associated with series of negative effects that are reflected to seismic effects of blasting, air blast waves, fly rock, etc. Particularly care should be taken in the destruction of rock mass in coal mines with methane regime and explosive coal dust. Also, special attention should be devoted to works in urban areas, e.g. in tunnel construction, when rock mass destruction is performed near buildings or facilities that are special important for

conservation, such as cultural – historical monuments. In these working conditions, the non – flame blasting can be applied for rock mass destruction, that is realized by using the means for replacing the explosives.
Key words: Cardox system, blasting, oscillation velocity

The means for replacing the explosives

The means for replacing the explosives represent undangerous systems which implies that they do not produce noise and dust, do not create fly rocks in wide area, seismic shocks etc. In procedure of application of these means, their potential energy is transferred to useful work without the occurrence of flames. If a carrier of potential energy is liquid carbon – dioxide, then we are talking about Cardox procedure. Reaction process in Cardox cartridge is referred on volume increasing of liquid carbon dioxide when it converts into gaseous state. Application of Cardox system is very simple. Cardox cartridges of the corresponding diameter are placed into boreholes where classical machine for mine detonation is used for cartridge initiation. The carrier of potential energy can be a compressed air. During releasing the compressed air from the steel cartridge under high pressure, the load on the borehole walls is performed and causes the rock material destruction between cartridge and free surface. The carrier of potential energy, instead liquid carbon – dioxide, can be a solid chemical mixture.

The solid chemical mixtures are developed high amounts of carbon dioxide during heating similar as Cardox procedure. The advantage with respect to Cardox procedure is in that the special facility for filling the cartridges is not needed, already the created cartridges for gases production, immediately before blasting, are placed into cartridge [1].

Although when application the means for replacing the explosives is not representing a classical blasting, these procedures often use the term blasting.

Analysis of application the means for replacing the explosives

To test the application of the means for replacing the explosives from one side and mine operations that are performed by using explosives from the other side, tested blastings are executed at marble.

In the first case, Cardox system is applied. [2]. In the second case, marble exploitation is performed by using the following explosives:

Detonex, Amonex-1 i ANFO („Trayal“ - Kruševac, Serbia). In both cases, measuring the rock mass oscillation velocity and corresponding frequency are carried out. As criteria for estimating the seismic effect are used: Criterion of the IFZ of the Russian Academy of Sciences and Criterion according to DIN 4150 - Germany.

In case of application the Cardox system, one tested blasting is performed whereby five values of the rock mass oscillation velocity are registered at five monitoring points.

Registered values of the rock mass oscillation velocity near the blasting point were in domain of allowed values [3].

In case of using the explosives, total of seven tested blastings are performed whereby twenty-three values of oscillation velocity are registered at four monitoring points. Registered values of the rock mass oscillation velocity near the blasting point were also in domain of allowed values [4].

If we observe techno - economic effects of the application of Cardox system and explosives, it can be said that they are more favorable when using the explosives. In case of need for increased production volume of Cardox application, the number of Cardox pipes can be increased. The production increasing can also be achieved by parallel operation at several benches.

Conclusion

In this paper, the application of the means for replacing explosives from one side and application of explosives from the other side were analyzed.

Based on performed measuring, it was stated that both of ways can be applied for rock mass destruction, but techno – economic effects are better at application of explosives.

If there was need for application of the means for replacing explosives due to their more favorable properties, in terms of environmental protection, techno - economic indicators can be regulated with usage of the increased numbers of Cardox pipes and with parallel operation at several benches.

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BASIC PHYSICAL AND CHEMICAL MECHANISMS OF ULTRASONIC FIELD INFLUENCE ON POROUS MEDIUM

According to the existing knowledge about the mechanisms of ultrasonic impact on the filtration process two groups observed physical processes can be highlighted. The first group includes the phenomena, the existence of which requires constant wave impact on the fluid saturated environment, as well as after the termination process indignation the effect of influence disappears after a relatively short period of time (relaxation time) and the porous medium and the filtered liquid back into standard starting position. Such phenomena are caused by influence of wave radiation on rheological properties of heterogeneous environments, changes in the structure of the fluid flow in the pore space, influence on the processes of interfacial interaction in multiphase filtration and others.

The second group includes the physical phenomena and mechanisms of the processes have the aftereffect, i.e. their effect on

filtration lasts for quite a long time after the cessation of physical impact. To them can be referred processes of cleaning the pore space of impurities, irreversible processes of cracks formation in the rock, increasing its permeability, accelerating the process of capillary impregnation and others. Use of such phenomena allows sharing time treatment processes formation and operation.

The appearance and spread in layer of acoustic oscillations accompanied by a large number of secondary effects that have different physical nature, different dependence on intensity and frequency of oscillation. These effects should be considered separately [1].

The mechanical effects. In the presence of acoustic oscillations a destruction semiconsolidated environments may take place. The most obvious use of this effect is the destruction of the clay crust when it is irradiated with powerful ultrasound. With a powerful acoustic effect, where the increasing permeability of rocks can increase, the effectiveness of the injection can be achieved. Increase of permeability is achieved both by reducing pore blockage of clay particles, etc., and by the formation of micro cracks. As mudding zone thickness is 1–2 cm, its reduction has to facilitate injection of fluids into the reservoir. [2]

The increase of thermal conductivity. The thermal conductivity of small samples (1,5 –3,5 wave length) in the acoustic field is increased approximately to 25% in filling pores with water, oil or air. The absolute increase in thermal conductivity was to 0,4 kkal/h*t*deg. Increase the effective thermal conductivity of the environment results in a more gentle spatial temperature distribution, resulting in increased range heating layer. This effect, called thermoacoustic, was proposed to use to increase the range and rate of heat formation treatment in the fields with high-paraffin crude oil and bitumen. It can be used for the same purpose at any thermal effects.

Phase transitions. When placing the liquid in the acoustic field it is degassing. For normal conditions the quasi-equilibrium concentration is 20-30% less than equilibrium of its value does not depend on frequency or the power of influence. Last values determine the speed setting of quasi equilibrium state, which is achieved by time of 10 minutes to 2 hours. The velocity is

proportional to the square of the amplitude of sound pressure and frequency.

Changing filtration processes. Since the frequencies of about 10 kHz fluid friction against hard skeleton does not coincide with the phase velocity of flow, the Poiseuille law in capillaries is broken. A similar effect in combination with the action Sound pressure should lead to a change in flow filtration processes in the sound field.

Cavitation. Acoustic cavitation is an effective means of sound wave energy concentration of low-density in a high energy density associated with closing pulsations of bubbles cavitation. Cavitation mechanism is as follows.

Sound passes through any liquid in the form of waves that consists of alternating cycles of compression and tension [3]. The source of ultrasonic waves (piezoceramic and magnetostrictive transmitter) can be represented as a piston immersed in liquid and runs by short and quick jerks.

This pressure wave can be described as shock wave spreading in the environment as a result of certain molecular interactions. If the piston operates at a frequency of 20,000 aftershocks in a second, the ultrasound is generated in the environment.

In the cycle of compression cavitation bubbles can almost instantly carried away with a large amount of energy.

Today is known for a wide list of different physical processes and phenomena in various geological and technical conditions are the basis of acoustic arrangements intensification of inflow of hydrocarbons from the productive strata.

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OCCUPATIONAL SAFETY ISSUES IN THE MINING INDUSTRIES OF MONGOLIA

Over the last decade, the number of employees in Mongolia has been growing in employment due to the growing number of enterprises in light and heavy industry. Specially, the number of people directly or indirectly employed in extractive and processing industries of mining with foreign and domestic investment is over 30000.

On the one hand, it has a positive impact on Mongolia's economic and social development, on the other hand, it seriously important problem for providing the safety and health of employees.

Generally, the number of employees affected by the industrial accident in Mongolia during the 1990s and 2000s is relatively small, but in recent years it is likely to increase seriously. It is related to the number of employees and heavy and light industries in 1990-2000 and current time. For example, in recent years, the number of industrial accidents has increased sharply in relation to the number of staff in the mining and processing plant in Mongolia. Therefore, mining industry accidents are a major threat to Mongolia, and the development of a sophisticated, scientist approach, advanced approaches and strategies for safety, and implementations and ruling to operations is too important.

The study was performed based on registration and information database of the Mongolian General Inspection Agency has investigated industrial accidents occurring in enterprises in the public and private sector. The industry accidents study was processed occurred on from 2004 to 2015 years because amendments of

industry accidents' registration rules and formats was different in 2009 and 2015.

Over the past decade, industrial accidents number were over 300 in per year and have risen to over 400 in 2011-2013 years included in the mining field.

In the mining industries of Mongolia 721 accidents were occurred and 890 employees were affected by the accidents from 2004 to 2015 years and of that 248 (28%) workers were killed, 106 (12%) workers were injured.

At the same time, mining sectors are commonly used by reactive or proactive methods to minimize accidents. Proactivating techniques are to prevent accidents by eliminating hazards. The general principle of a proactive approach is to reduce or minimize the hazard by evaluating, assessing and monitoring risk levels.

It is important to develop a methodology for improving safety condition in the mining sector of Mongolia by assessing hazard risk by unclear logic and establishing a risk modeling model

Turning and changing phenomenon from hazards of workplace to accidents in the mining industry may be random, so the result of the risk assessment can be random. It is therefore important to develop a methodology for minimizing coal mine open pit production by assessing hazard risk by fuzzy logic and developing a risk assessing model.

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THE DEVELOPMENT OF WORKS ON COMPLEX RECYCLING OF RAW MATERIALS OF BASALT OPEN-PIT MINESFOR THE REMOVAL OF ALUMINUM CONCENTRATE

Ukraine has the large reserves of basalt deposits, the development of which is carried out in a quarry way. The purpose of the performed researches was to study the composition of the basalt mined rock itself, including basalt and the accompanying zeolite-smectite tuff. The primary object of research was the basalt open-pit mine of Rafalovka in the Rovne region. N.S. Polyakov Institute of Geotechnical Mechanics NASU, together with the National University of Water Management and Natural Resource Utilization, have been studying the mineralogical composition of processed products of basalt raw materials for a number of years. There were up to 25% of magnetically sensitive iron and 2–2.5% of native copper in basalt due to the establishments of preliminary studies [1,2]. The accompanying tuff included 30-35% of magnetically sensitive iron and 1.2-1.5% of native copper [3,4]. Meanwhile, tuff is a dump mass and is seldom used, and basalt after pre-processing is used in the form of crushed stone for concrete products or large-dimensioned constructions. At the same time, the high concentration of useful products aroused the industrial interest, which required the further research on mineralogical composition of the mentioned open-pit mines, as well as on the other ones.

The additional studies of mined rock of basalt deposits in the Rovne region has showed the composition of aluminum oxide within 10-15%. The analysis and generalization of the research results has

demonstrated that while separating the components of raw material by the unit weight with the help of the difference in the deposition rates of particles, it is possible to separate aluminum oxide from the enclosing rock. It should be noted that by the case of a laboratory experiment with the use of a dense medium separation, in some cases, it is possible to increase the concentration of aluminum oxide up to 25-30%. In addition, the researches were focused on improving the used equipment and the method of obtaining aluminum concentrate, and considering the necessity of the complex recycling of basalt raw materials for the extraction of iron, copper, aluminum concentrate and silicate part from the enclosing rock, it becomes necessary to create a separate processing station and rational use of mined rock.

Considering that such processing includes a dump mass of tuff, as a technogenic material, such a technical solution allows to increase the register of finished products, as well as improve the ecological situation in the region, through its zero-waste mining and complex recycling.

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DEGASSING OF COAL MINES

Intensification of mining operations and improvement of technical and economicper formance of minesarel argely constrained by thein creasing gascontent of mineworking sresulting from constant deepening of mining operations and putting deposits and formations with difficult mining and geological conditions intooperation. Limiting the productivity of mechanized complexes by the gasfactor doesnotallow the necessary intensification and concentration of mining operations.

Degassing as a set of measures to extract methane from coal veins and mined-out space of existing coal mines, along with ventilation means, has become one of the main, and sometimes the only effective way to combat gas emission in mining areas.

Depending on the mining and geological conditions of mining, the gas characteristics of coal veins and gas emission sources determining the danger of the formation of increased methane concentrations at workplaces, degassing in coal mines was developing in three directions:

- degassing of the worked-out space;
- preliminary degassing of mined coal veins;
- enclosing degassing during preparatory mine workings.

Based on the results of numerous scientific research carried out to find the most effective methods and schemes for degassing, as well as the accumulated experience of isolated removal of methane from underground mine workings in the 50-80s of the XX century the notable progress has been made. However, subsequently, the volume of degassing work carried out at mines has sharply decreased and is currently at an unacceptably low level. This trend is typical for all coal-mining regions. Along with the increase in gas abundance in

coal veins, the volume of degassing work has also been constantly increasing, thereby creating conditions for the effective use of various degassing methods as the only, at that time, means of combating gas release.

The reduction in the degassing works volume began in the early 1990s. On the one hand, this is a consequence of the coal industry restructuring, on the other, a sharp deterioration of the financial and economic situation of coal enterprises of that period. The mines were unable to acquire the necessary equipment and apparatus. Moreoverit should be added that most of the machine-building plants producing drilling rigs, vacuum pumping units, measuring and control instruments have ended up outside Ukraine and their products have become difficult to obtain.

To eliminate the unfavorable situation in mines regarding the fight against methane, they began to look for alternative methods to reduce gas abundance, which, due to the conditions of the formation of gas hazard in mining areas, were focused mainly on preventing the release of methane from the and mined-out space and satellite layers. The method of combating gas emission from the worked-out area, based on the use of special gas suction units, has become widespread in mines.

Initially, the method used (as an secondary one), due to its efficiency and the effect, took the leading position.

However, the accidents that have occurred in recent years in gas suction systems using fans have shown extremely low safety of this method. When applied in the way it is intended, i.e. with an almost unlimited concentration of methane in the aspirated gas-air mixture, a high technical culture and strict adherence to production discipline are required. This is not feasible at this stage.

If, however, the volume fraction of methane in the removed gas mixture is maintained at no more than 2%, which is proposed as the main safety improvement measure, then the application of this method actually becomes useless. In this case, the required gas regime in coal mines will be provided by increasing the amount of supplied air, i.e. methane will be removed by ventilation.

Thus, degassing remains one of the main ways to reduce the gas content of coal mines, which have development prospects not only in

terms of ensuring the safety of mining operations, but also in terms of producing methane for industrial use.

In this regard, comprehensive measures should be taken to increase the volume of methane extraction from coal seams by various degassing methods.

In addition to the above technical and economic factors, a significant role in reducing the volume of degassing work in the coal industry was played by the fact that the latest editions of regulatory documents do not contain the clear criterion for the need to apply degassing.

So, according to the current Safety Rules in coal mines, degassing should be carried out in gas mines, where it is impossible to ensure the methane content in the air within the established standards by means of ventilation. In this interpretation, manufacturers are actually given a permission to use various combinations of ventilation methods, schemes and means to achieve the required results.

This does not exclude the possibility of the futility of the efforts being made.

The control authorities do not seem to be able to require thatthe degassing is used at the initial stage in one way or another.

It should be emphasized that the efficiency of degassing systems depends on a very large number of natural and technological factors and in some cases it is possible to create a situation when the established criteria for the need to perform degassing will not correspond to the real state of affairs.

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CAPABILITIES OF USING DIRECT X-RAY FLUORECSENCE METHOD FOR TESTING ANODE COPPER SAMPLES

The objective of introducing rapid analysis of copper anode samples has been outstanding at copper smelters of Kazakhmys Smelting LLC for a long time. Currently comprehensive chemical test is only performed on average daily samples (comprised of four shift composites).

Online flow of information on chemical composition of copper anodes for each shift has not been available. Rapid testing would be the right method of filling this gap (notably, using x-ray fluorescence (XRF) method).

Until late however, XRF method has failed in achieving inspiring results in testing copper anodes. Reasons for such failure included low quantities of by-product minerals (including gold) along with an especially heavy copper matrix.

We completed studies, which showed that rapid testing of copper anode samples using the XRF method have good implementation prospects. The studies involved application of EDXRF local analysis spectrometer RLP-21T (LA) (from Aspap Geo LLC, Almaty). There were 4 series of measurements performed in total.

Measurement series 1-3 were performed on two samples (№1 and №2) of copper anodes from Balkhash Copper Smelter (BCS), which were collected during shift № 4 on 27 July 2019 (fig. 1A).

These samples were collected from melt № 627 (the chemical composition determined as average value for melts № 624 through № 627).

The data collection area from the surface of a sample is shown in fig. 1B. Study results discussion.

Series 1. XRF exposure 200 sec. During processing of test results, the option of removing elements from the table Percentages of Elements table using the criteria of $C<\Delta C= 2\sigma$ (σ is absolute root mean square error of XRF method) was switched on.

Series 2. XRF exposure 200 sec. During processing of test results, the option of removing elements from the table Percentages of Elements table using the criteria of $C<\Delta C=2\sigma$ was switched off. During processing of spectra, Ni was included deliberately (since automated determination did not identify NiKa line with very powerful CuKa peak values in the background).

Series 3. The measurement was performed in conditions similar to Series 2 with the additions of Au, Te and Sn in the list of processed values (to align the elements identified during chemical tests and those identified during XRF tests). Only copper anode sample № 1 was the subject of the study.

The table Percentages of Elements obtained after XRF-testing of the "thick" sample is shown in fig. 1. XRF testing determined the presence of indium, which is not on the list of elements determined during chemical analysis.

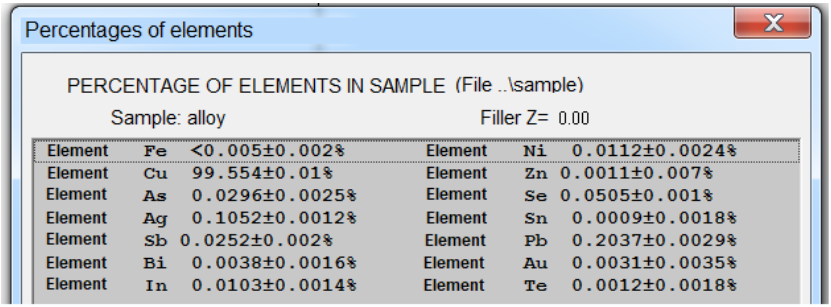

Fig. 1. Series 3. Results of XRF test of Sample № 1

Table 1 data demonstrate convergence between chemical analysis and XRF testing of copper anode.

Table 1

Series 3. Results of XRF test of copper anode Sample № 1
(*– data for July 2019 average monthly sample)

Elements	CCL		XRF	
	C, %	± Δ_C, %	C, %	± Δ_C, %
Copper	99.43	0.14	99.5540	0.0100
Silver	0.1039	0.0042	0.1052	0.0012
Lead	0.17	0.04	0.2037	0.0029
Arsenic	0.019*	0.004	0.0296	0.0025
Antimony	0.019*	0.004	0.0252	0.0020
Selenium	0.057*	0.020	0.0505	0.0010
Iron	0.0032*		<0.005	0.0020
Bismuth	0.0029*		0.0038	0.0016
Nickel	0.010*		0.0112	0.0024
Tin	<0.0010*		0.0009	0.0018
Zinc	Not		0.0011	0.0007
Indium	Not		0.0103	0.0014
Gold	0.00244*		0.0031	0.0035
Tellurium	0.0039*		0.0012	0.0018

XRF test did not identify percentages of S (0.0054%), Si (0.0010%), P (0.0019%), Cr (0.0013%) and Mn (<0.0001%). S, Si, and P are light elements. A special design of measurement chamber would be required to determine these elements with XRF.

For chromium, additional spectra processing option needs to be switched on. Manganese is present as a trace element, therefore its determination with XRF is not necessary. XRF errors for Au, Sn and Te are higher than those in baseline chemical analysis. it is required that exposure is increased with optimized excitation conditions for L lines of gold.

Series 4. The goal was to reduce error for gold. XRF exposure was 600 sec. Tested samples: 4 samples (cylinders) from shift melts of copper anodes for a one-day period.

Both ends of each cylinder were subjected to XRF testing. Part of XRF test results are shown in Table 2.

Table 2

Series 4. Results of XRF testing of copper anode shift samples

Sample	Cu		Ag		Au	
	%	**±%**	ppm	± ppm	**%**	**±%**
801-1	99.488	0.017	1072.36	5.7	0.0032	0.0018
801-2	99.482	0.017	1068.66	5.7	0.0030	0.0018

802-1	99.553	0.017	1004.58	5.6	0.0029	0.0018
802-2	99.564	0.017	1009.45	5.6	0.0024	0.0018
803-1	99.666	0.017	982.55	5.5	0.0033	0.0017
803-2	99.573	0.017	980.68	5.5	0.0034	0.0017
804-1	99.531	0.017	983.11	5.6	0.0032	0.0018
804-2	99.528	0.017	985.68	5.6	0.0028	0.0018
Average	99.571	0.017	1010.88	5.6	0.00303	0.00178
CCL BR	99.30		1019.0		0.00265	

Conclusions:

1. XRF error for Au has been reduced in Series 4 by a half compared to Series 3.

2. Convergence of XRF data and CCL BR data for Cu, Au and Ag is at a good level (even though XRF has not been able to determine grades for S, Si, P, and Cr).

3. It has been proved that the objective of implementing XRF as copper anodes testing method can be addressed using EDXRF spectrometer RLP-21(LA).

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THE POSSIBILITY OF USING OPEN-PIT CONVEYOR TRANSPORT IN THE CONDITIONS OF THE TSANKH FIELD

Abstract

In many fields, trying to take conveyor transport, but because of the high cost of the conveyor complex and future possible breakdowns, even because of other doubts, complex conveyor transport is not fully applied. An unspecified problem is that the workability of rubber belt conveyors is deteriorating given cold climatic conditions, and the rubber conveyor belt itself takes up a large majority of the cost of the conveyor. Therefore, it is necessary to clarify the uncertainty regarding this topical issue.

1 Introduction

Currently, open-pit conveyor transport is used in some deposits of Mongolia, but not integrated conveyor transport. The problem is that in many fields, the ambient temperature drops sharply in the winter

season, so most engineering designers cannot solve the use of integrated conveyor transport in completeness due to the temperate climate and financing.

There is a manufacturer who offers stationary rubber conveyor belt of the UKLS type of general purpose with rubberized belt designed for transportation of granular rocks, small-sized rocks with an apparent density of not more than 3.5 tons/m^3, as well as piece goods in areas with a temperate climate at temperatures from -45 to +40°C, also for operation in a temperate climate, placement category 1 according to the state standard.

A rubber belts are made of general purpose and special: fire-resistant (non-flammable during slipping); non-electrified (with antistatic additives that prevent the ignition of the methane-air environment by surface electrostatic charges); frost resistant (up to -55°C) or heat resistant (up to +100° C). General purpose rubber belt operate at temperatures from -25°C to +60°C.

And also it should be noted that, besides the rubber belt of the conveyor, the following signs should be considered and according to these signs an analysis is carried out on the basis of a detailed report on the field and also on the basis of other data.

- By type of conveyor (straight line)
- By tilt angle (horizontal, tipping)
- By type of conveyor frame (hard frame)
- By destination (mobile)
- By type of freight flows (for ordinary freight flows)
- By according to the location of the carrier branch of the belt (with the upper carrier branch)
- By the cross-sectional shape of the load-carrying branches of the belt (with a flat rubber belt)
- By type of rubber belt (with a smooth rubberized belt)
- By the number of drives (multi-drive)

In brackets analyzed the result of alternatives.

2 IN-USE CONDITIONS (SEE IN FULL ARTICLE)

3 SELECTION (SEE IN FULL ARTICLE)

4 Conclusions

The field has a mountainous climate with sharply continental features. In the coldest month of the year, the temperature can fall below -40°C, in the field area, it practically does not fall below -

45°C. Based on this, it can be concluded that this does not exceed the temperature limit of the frost-resistant conveyors.

It should be noted that the cold in the region of the field is transferred much easier because of the dry air. Also in the region is not a big level of humidity, even in summer. This means that there is little contamination of the rubber belt, and durability increases.

In belt conveyors, the rubber belt is the most expensive and most wear part. Especially sharply reduced its durability during transportation of abrasive materials. And the field has a small amount of stripping work. At the expense of mining, coal of all grades, except anthracite, differs in relatively small abrasivity compared to the abrasivity of most minerals, as a result of which the task of protecting the belt from abrasive wear is not for coal. The introduction of rubber belt conveyors in the field contributes to the improvement of the technical level and efficiency of mining production and creates favorable conditions.

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SYSTEM RESEARCH AND MODELING OPERATIONAL AUTOMATIC CONTROL PROCESS OF HYDRO MONITOR EROSION ZEOLITE-SMECTITE TUFFES

The process of hydraulic fracturing of the massif during the development of the zeolite-smectite tuffs deposit in the Rivne-Volyn region by the mining of zeolite-smectite tuffs by hydro-well method was investigated under various conditions and methods of influence and the dominant parameters affecting the hydrodynamic erosion technology were identified. The residence time of the rock in a rarefied state is determined by the thickness of the layer, its water permeability, the change in pore volume during compaction and the duration of the dynamic load, destroying the structure [1-2].

Technological features of borehole hydro technology of mining of minerals and significant energy and resource intensities require the use of modern automation systems to achieve high technical and economic indicators [3-4].

The control system for hydro monitor erosion of zeolite-smectite tuffs requires the establishment of structural connections between the input and output parameters, the choice of controlled parameters, control effects, the development of the structure of the automation system and the selection of modern technical means of automation. It is established that the control effects at hydro monitor erosion are the pressure and flow of water, the speed of movement of the stream along the side of the face and the hydro monitor rotation angle, the telescope hydro monitor sections in the face feeding. [5-6].

The complexity and conditions for carrying out the technological process of underground hydro erosion create problems of operational control of technological parameters. The control of the process of hydro-monitor erosion will be carried out on the basis of the control of the distance between the nozzle of the hydro monitor and the rock of the face and the rate of blasting of the rock. Automatic control of resizing camera size will also improve the performance of the erosion process.

In the process of research the following algorithm of system operation is offered. The signal from the distance sensor enters the controller, which, by changing the distance in time, calculates the erosion rate and gives the control signal according to the proportional-integral-differential law for the frequency converter and thus changes the pressure of the water in the hydro monitor, which causes the change in the rate of erosion. When reaching a certain distance between the wall of the face and the nozzle of the hydro monitor, the controller gives a signal to the next section of the hydro monitor. Using a telescopic hydro monitor allows you to increase the size of the chamber without the use of high-pressure working agent. After pushing the last section of the hydro monitor, the pressure is increased to the maximum possible. To maintain a constant linear velocity of the stream on the wall of the face, a frequency-regulated drive is used to rotate the hydro monitor around the axis. With increasing distance from the nozzle of the hydro in the face of the wall, the linear velocity of the stream along of the face will increase, so the controller gives the control signal according law to the frequency converter and reduces the angular speed of the hydro monitor. After completion of the erosion at a certain depth the controller gives a signal about the need to change the position of the hydro monitor in height.

The simulation of the control system for hydro-monitor erosion allow to construct and investigate the logic of process control, to select the necessary control laws, and to search for optimal adjustments of the regulators.

The result of modeling the entire control system of hydro monitor erosion is the transient characteristics and schedules of the switching of the technological modes of operation, removed when setting the erosion rate and when adjusting the erosion rate regulator and the

velocity regulator of the stream along the wall of the face. Finding the settings of the controllers was carried out using the parametric optimization blocks from the Simulink library.

Transient characteristics show that the system is stable and has the necessary dynamic characteristics and indicators of the quality of transients.

Realization of this system in practice will provide high technical and economic indicators of the process of hydro-monitor erosion of zeolite-smectite tuffs.

The simulation model of the control system of the technological process of extraction of zeolite-smectite tuffs is used in the design and calculation of control systems for the process of hydro monitor erosion and is the basis for the construction of flexible control systems that will allow them to be used for extraction of various minerals**.**

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SELECTED PROBLEMS OF STRENGTH AND DEFORMATION PROPERTIES OF ROCK IN THE CONTEXT OF LABORATORY TESTS

Keywords: rock mechanics, uniaxial compressive strength, uniaxial tensile strength, bending strength of rocks, dilatancy, Young's modulus, Poisson's ratio, rock deformability, elastic energy, creep and relaxation of rocks, anisotropy of rocks.

The strength and deformation properties of rocks were the subject of research by scientists for many years and in many publications. In this paper, some interesting problems that have been and are the subject of researches at the Department of Geomechanics and Underground Construction will be presented.

1. Strength and deformation properties of rocks under tension.

The most frequently used material constant describing the strength properties of rocks is the uniaxial compressive strength, σ_C. This is mainly due to the ease of carrying out uniaxial compression tests as well as the great achievements in this field. In fact, however, rocks are failured on a micro and macro scale as a result of exceeding the shear and/or tensile strength. The behaviour of rocks under uniaxial tensile conditions is quite different from what was thought. Rocks in tension have anelasticity behaviour, the stress σ - strain ε characteristics are nonlinear, rocks undergo plastic

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deformations, and the values of Young's modulus E and Poisson's ratio are different than those in compression.

In geomechanical and geotechnical tasks, roof layers, ceilings of buildings and even walls of vertical workings are bended. In three-point bending tests of rock beams, the upper *fibres* are compressed and the lower - are tensioned. The ultimate bending strength σ_B should not be equated either with the uniaxial tensile strength σ_r, and still less with the compressive strength σ_c. In addition, the strength and deformation properties (e.g. Young's modulus E) of compressed and tensioned *fibres* are different from those characteristic of uniaxial compression and tensile tests.

3. Dilatancy as a harbinger of failure.

The failure of rocks under compressive stresses is preceded by a more or less pronounced phenomenon of dilatancy, i.e. an increase in the volume (of a rock sample). This phenomenon is due to the rapid propagation of cracks in the damage process. It seems advisable to search for functions approximating all three characteristics of stress σ - axial ε_z , lateral ε_Θ and volumetric strain ε_V to predict rock failure. One interesting solution is piecewise linear functions representing the behaviour of rock in the pre-failure domain [e.g. 10].

4. Behaviour of rocks under (true) triaxial compression.

Both rocks and soil are usually in a complex triaxial state of stress (and strain) $\sigma_1 \neq \sigma_2 \neq \sigma_3$. In some cases, this state of stress (and strain) simplifies to $\sigma_1 \neq \sigma_2 \neq \sigma_3$. Nevertheless, *True Triaxial Tests* (TTT) best describe the strength and deformation properties of rocks, especially on the possibility of testing the influence of indirect stress σ_2 on strength, deformability and fracture phenomenon. Despite the extensive knowledge so far about rocks (and soils) under triaxial compression, the search for new and verification of the existing strength criteria are still ongoing, e.g. interesting researches in [7] – a new strength criterion based on the theory of brittle failure of granular rocks.

Due to the volume limitations, only selected problems related to the mechanics of rocks and soils were indicated. Others were and are, for example, rheological properties of rocks, or research on the ability of rocks to accumulate elastic energy.

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THE WAYS TO OBTAIN MATHEMATICAL MODEL OF DRYING STATICS WITHIN A ROTATIONAL DEVICE

Low content of useful components in ore is the typical feature of process feedstock for nonferrous metallurgy. In this connection, the mined feedstock preparation is quite important procedure. Currently, more than 90% of nonferrous metal ore is prepared by means of washing methods.

Thus, it is necessary to analyze a drying process of the washing preparation method (both non-ferrous mineral concentrates and ferrous ones) by means of a rotational device. Moreover, the abovementioned should be used to develop a mathematical model to obtain optimum parameters of the drying process.

High intensity of heat exchange processes of drying and crushing results from the wet material processing in rotational flows. The matter is that the rotation flow becomes more and more popular in the context of national and foreign drying facilities. In terms of similar temperature modes, specific water capacity and efficiency of rotational driers are quite higher to compare with drum driers and a “boiling” bed. That can be explained by the possibility to apply high-temperature heat carrier; the developed surface of a solid phase; and availability of high relative velocities between the latter and the drying agent. The velocity may achieve 50-150 m/sec while being only 0.2-0.5 m/sec if a “boiling” bed is used. The available rotational driers differ in their designs, sizes, and various configurations of certain components.

Analysis of performance indicators of different facilities helps conclude that it is expedient to use the rotational devices to dry out wet concentrates since they are more economical to compare with "boiling" bed dryers and drum ones in terms of smaller specific metal intensity.

Owing to a short drying period by the rotational device, the required stabilization of parameters of the dried out material can be achieved if only the drying process is controlled automatically.

It is expedient to carry out theoretical studies of drying facilities, considered as processing facilities of power plants, using a method of generation and solution of a balance equation in terms of deviation from a mode specified in the process of the device calculation or a nominal operation mode.

The linearized characteristics of the pulverized drier as well as the "boiling" bed drier have been obtained as a result of solution of balance equations taking into consideration the regularities of heat-and-mass transfer and hydrodynamics.

Lack of accurate mathematical description of the processes, taking place within the rotational drying chambers, prevents from using the methods to formulate mathematically drying statics within a rotational device.

Thus, the most acceptable way to obtain mathematical model of drying statics is to determine experimentally the values, required to solve balance dependence between input and output performance characteristics of the object, taking into consideration quantitative ratios as well as heat-balance equations and material-balance equations obtained on the original variables.

Adequacy of the theoretical model may be confirmed while comparing design equations, describing the object statistics through the channels from input variables to the drying quality index, with the experimental equations.

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FLOTATION PROCESSING OF GOLD-CONTAINING ORE IN THE ANGRENSK ORE FIELD

The modern flotation process is carried out during the grinding of ore, when sulfide minerals in their bulk are separated from the aggregates of waste rock. With such a flotation, the various flotation properties of sulfide minerals are completely ignored and a large number of collectors are consumed for the complete conversion of both easily and difficult-to-float minerals into a foam product, which creates great difficulties for the selective separation of collective concentrates.

Improvement and intensification of the flotation process are mainly associated with the development of effective reagent regimes that make it possible to obtain high recovery of useful components with an improvement in the quality of the dispensed concentrates [1].

The characteristic features of the material composition of gold-bearing ores are the complexity of raw materials, a low content of noble metals in ores, a fine connection of valuable components with the host rocks among themselves and so on.

The aim of this work is to develop a cost-effective technology for the beneficiation of gold-bearing ores.

In our studies, the object of study was selected gold-bearing ores of the Kochbulak and Kyzylalma deposits. As a basis, the classical scheme of flotation of gold-bearing ores was taken, including grinding of ore, main, control and two cleaning operations of flotation.

To study the floatability of gold-bearing ores, experiments were carried out using the traditional collector reagent, potassium butyl xanthate (BKK). The experiments were held with different size classes.

During the flotation of the charge of ores from the Kyzylalma and Kochbulak deposits, the following optimal flotation mode was

determined using traditional reagents: grinding size% cl. -0.074 mm - 85; consumption of reagents: g/t, in grinding: soda ash 500; to the main flotation: BKK 120, T-92 80; in control flotation: BKK 60, T-92 20. Time of main flotation, min. - ten; control flotation - 10; 1 cleaners-7, 2 cleaners 5.

In the developed mode, an experiment was carried out in open and closed cycles, the results of which are given in table. 1.

Table 1

Results of experiments in flotation of the charge of ore deposits Kyzylalma and Kochbulak in an open cycle and on the principle of a continuous process

The name of product	Output, %	Content, g / t		Recovery, %	
		gold	silver	gold	silver
Open cycle					
Concentrate	3,5	187,35	920,64	87,6	54,4
Prompro-duct-1	4,4	2,75	119	1,6	9,45
Prompro-duct-2	0,7	16,2	199	1,5	2,5
Prompro-duct-3	5,0	7,1	72,0	4,7	6,5
Tails	86,4	0,4	17,57	4,6	27,2
Ore	100,0	7,55	55,8	100,0	100,0
Uninterrupted process					
Concentrate	5,4	128,6	643,7	92,6	63,2
Tails	94,6	0,6	21,4	7,4	36,8
Ore	100,0	7,5	55,0	100,0	100,0

As can be seen from Table 1, with flotation according to the principle of a continuous process with traditional reagents BKK and T-92, a concentrate with a yield of 5.4% can be obtained from the ore under consideration, containing 128.6 g/t of gold and 643.7 g/t of silver. with metal recovery 92.6 and 63.2%, respectively.

For flotation of the studied ore sample, a new reagent of the PS-1 brand was tested - cake, sulfur alloy, waste from the chemical industry of the Republic of Uzbekistan as a collector. The PS-1 reagent proposed as a collector for the flotation of the charge of ores from the Kyzylalma, Kochbulak and Ajibugut deposits gives the same results in terms of metal recovery as the expensive collector of the BKK brand [2].

Flotation concentrates obtained using PS-1 reagent are of a higher quality than in experiments with BPC: 214 g/t of gold versus 187.35 g/t and 920.64 g/t of silver versus 850.1 g/t in the open cycle and

140.9 g/t gold against 128.6 g/t gold and 721 g / t silver against 643.7 g/t in a closed cycle. The possibility of using the local reagent PS-1 for flotation enrichment of a mixture of gold-bearing ores of the Kyzylalma and Kochbulak deposits with obtaining practically identical results in terms of metal recovery when using the BPC reagent has been established.

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PUBLIC ADMINISTRATION OF NATURE MANAGEMENT AT THE REGIONAL LEVEL

State management of nature - is the activities of the state aimed at organizing the rational use and reproduction of natural resources, environmental protection, as well as ensuring legality in environmental and economic relations.

One of the main directions of development of economic potential of Ukraine is the development of the mineral complex and enterprises - users of subsoil, which form its basis. Prolonged intensive exploitation of mineral resources has led to deteriorating mining and geological conditions of field development, significant depletion of quality mineral reserves, reducing its competitiveness in the world market, the formation of an industry structure shifted towards heavy industries, the accumulation of long-term environmental consequences. Therefore, the rational use of nature in

the management of subsoil users is an urgent problem of building a modern economy, focused on the principles of sustainable development.

Activities in the field of exploration, use and protection of subsoil is an institutional activity based on the legislative and legal norms of the relevant bodies of the Ukrainian state to organize the study of rational use of subsoil to meet mineral needs and other needs of the economic complex, subsoil protection in their close relationship. communication with other natural objects, ensuring the safety of work in the use of subsoil, as well as the protection of the rights of enterprises, organizations, institutions and citizens in this area [3].

The state management of nature management is determined by the state ecological policy. State environmental policy is a system of goals and actions of public authorities and administration aimed at ensuring the environmental security of the state and meeting the environmental needs of the population. The basis for the formation of state environmental policy is the principle according to which environmental security is an important element and component of national security. Thus, a feature of environmental policy is the ability to choose the most effective methods of implementing practical measures in various spheres of public life to achieve the goals. This is in line with the definition of environmental policy in the international standard ISO 14001-97 as a policy that creates a basis for the operation and achievement of environmental goals and objectives. Hence the conclusion that there are two main models of environmental policy based on diffrent principles of its operation. The first model operates on the principle of "react and correct" and is focused on eliminating the consequences of environmental violations. Today, such a model of environmental policy prevails in Ukraine. The second model is based on the principle of "predict and warn" and is the most effective.

All branches of government take part in nature management: legislative, executive and judicial. Each of them performs its functions and includes units with special powers to regulate environmental issues[2].

The implementation of state environmental policy is carried out at three levels of government: national, regional, local, which, in turn, determines the appropriate territorial distribution of public interests

in the field of environmental protection. According to the Resolution of the Verkhovna Rada of Ukraine of March 5, 1998 p. № 188/98-VR "On the main directions of state policy of Ukraine in the field of environmental protection, use of natural resources and environmental safety" territorial distribution of public interests in the field of nature protection is determined by territorial volumes of natural geoecosystems and divided into: nationwide), regional (cover the territory within two or more oblasts and the Autonomous Republic of Crimea or extend to the territory of neighboring states and the water area of the maritime economic zone), local (cover the territory within the oblast, district).

Organizational management of nature management is carried out with the help of territorial and departmental principles. Territorial principle means that national government is territorial in nature. It applies to all nature users and all natural objects within the state as a whole or a certain administrative-territorial unit. For example, the national administration is carried out by the Cabinet of Ministers of Ukraine and the executive body of the regional council of people's deputies in the territory subordinate to it. The departmental department extends its actions only to a certain object of nature: water, land, forest, etc. It is not related to the administrative-territorial division, but extends to the use of a certain natural resource, regardless of the territory in which it is located.

Legislative functions of nature management and environmental protection belong to the Verkhovna Rada of Ukraine and local authorities. The executive function of nature management in the state belongs to the Cabinet of Ministers of Ukraine, executive and administrative bodies of local government, as well as specially authorized state bodies.

Institutional policy of subsoil use in Ukraine must have a solid legal framework. Normative legislative documents and bylaws of Ukraine, as a sovereign and independent state, have significant shortcomings that relate to the long-term prospects of use and are not able to fully protect natural resources from mining and geological intervention of neighboring states. Each region (oblast) of Ukraine must have a “Concept of integrated industrial development of natural resources assigned to this region”, because after the collapse of the USSR the established legal regime of nature management was

violated, which caused significant damage to the state economy and mineral dependence of Ukraine [1].

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JUSTIFICATION OF THE EFFICIENCY OF USING THE MODULAR DESIGN OF THE DISINTEGRATOR

In the mining and processing industry, the most expensive operations for the processing of rock mass are its crushing, drying and classification. Therefore, it remains relevant to solve the **task** of creating new equipment designs and substantiating their parameters in **purpose** to reduce energy consumption and increase productivity in the processing of minerals.

One example of such research is the developed at the Institute of Geotechnical Mechanics named M.S. Polyakov is a design of a two-shaft centrifugal disintegrator (1), which uses a less energy-intensive process of destruction of rock mass by counter flows of the crushed material, the direction of movement of which is set by rotating

rotors, while the collision energy of two counter flows is doubled and the material is crushed mainly by shear deformations, which are less energy-intensive, than crushing by impact on the lining (2).

As a result of subsequent experimental studies of a laboratory sample of this design of a two-shaft centrifugal disintegrator, opportunities for its further modernization were identified, which made it possible to create an experimental sample of a two-shaft centrifugal module (3), which simultaneously performs several operations for processing rock mass. The main function of this module is crushing the rock mass by counter flows with the possibility of its classification and drying.

The task of solving the problem of classification of rock mass during its crushing was set in the study of the processes occurring in the grinding chamber of the module. It was established that it is necessary to remove the material of the required size from the grinding chamber, since its further grinding leads to over grinding and, as a consequence, the loss of the necessary parameters for subsequent enrichment. In particular, when grinding tuff and basalt mined in the Rivne region of Ukraine, the particle size should not be less than a certain size, since with further magnetic and electrical separation, problems arose during the separation of over-crushed material particles.

The classification effect in the centrifugal module was achieved by the presence of a sieve in the grinding chamber and installing the casing on shock absorbers with the possibility of using vibration action on the grinding chamber and the rock mass.

Removing the finished product from the working chamber makes it possible to increase the productivity of the installation due to an increase in the space for loading the initial product and to increase the grinding efficiency, since grinding in a layer, especially of small particles, is more difficult and energy-intensive (4).

The need to use the drying operation in this centrifugal module is due to the properties of various types of materials that affect their grinding. Many materials, especially less than 5 mm, in these types of centrifugal equipment are crushed only in dry form, since when a certain moisture content of the material is exceeded, it not only does not grind, but also begins to clump and stick on the walls of the working chamber and rotor bars, which can lead to equipment

breakdown. This operation is carried out by supplying and then removing heated air into the working chamber of the module.

One of the examples of this type of material is finely dispersed fly ash from thermal power plants, the processing of which is an urgent task, since its dumps are technogenic deposits, occupy significant areas and pose a threat to the environment and human health. Ensuring low humidity of fly ash is important not only for its effective crushing, but also for its subsequent processing to extract carbon, which in these dumps is up to 35%.

As a result of the experimental studies of the two-shaft centrifugal module, its main parameters were established: when crushing the rock mass below the average strength, the rational mode of operation of the module is ensured when the rotors rotate up to 3000 rpm, the vibration amplitude of the grinding chamber is within 5 mm and the frequency of rotation of the unbalances of vibration exciters 1500 rpm It was also determined that the use of classification for grinding allows to increase productivity by 30%, while the classification efficiency was ensured within 65%

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IMPROVED EFFICIENCY OF HARD ROCK BLASTING WITH HOLE CHARGES IN KRYVYI RIH IRON ORE BASSIN

In Ukraine, over 140 kt of explosives are consumed annually for industrial needs, 70% of which being used by mining enterprises. International mining practice has proven efficiency of transition to TNT-free explosives. Issues of using TNT-free explosives in rock blasting are considered in [1-3]. By implementing state environmental programmes, the enterprises applying explosives to ore blasting at sinking and stoping mean to use TNT-free green explosives without diminishing ore blasting quality.

In Kryvyi Rih iron ore basin, open pit mining enterprises use TNT-free explosives almost universally, which is not the case with underground ore mining.

Application of water-filled explosives which are widely used in larger downhole charging at open pits is rather complicated in case of vertical and inclined blastholes of 105mm-110mm in diameter for underground ore blasting. The main reasons for that include absence of effective charging equipment and problems with keeping gelatinous explosives in such blastholes.

That is why there are loose explosives applied to form blasthole charges. The TNT-containing Zernogranulit 79/21 is used for hard and flooded rocks blasting.

The issue of improving efficiency of ore blasting while using loose explosives has always been essential for underground ore mining.

Currently, due to high prices for industrial explosives, this problem is especially acute. We suggest the following technical solutions as ways to increase efficiency of longhole blasting based on loose explosive charges and reduce corresponding expenditures at the same time:

- application of axial-hollow charges;

Longhole axial-hollow charges of loose explosives are characterized by high-velocity detonation. Two-layered detonation with a shock wave in the gas layer (a channel wave) as the leading element occurs there. The detonation wave initiates destruction of a surrounding explosive and is maintained due to reduction of the gas layer by explosion products.

The wave velocity turns out to be higher than in a solid charge. This results in initiating the explosive charge along the blasthole and obtaining more uniform high-quality fragmentation of ore, especially at the blasthole bottom.

After shocking the blasthole bottom, a cumulative flow of explosion products created by axial-hollow explosive blasting generates a pressure change that initiates a counter propagating detonation wave enhancing the explosion.

Thus, in case of infeasibility of application of TNT-free explosives to providing high-quality fragmentation of ore materials, axial-hollow charges can be a temporary alternative here.

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THE SURVEY OF INTER-WELL SPACE DURING URANIUM MINING BY THE METHOD OF IN-SITU RECOVERY

All operating uranium deposits can be divided into 2 categories according to the mining method. The first category includes deposits where mining is carried out using traditional methods of development, such as open-pit and mine (underground). Open-pit development of deposits is usually used at a shallow depth of occurrence of uranium, the mine method is used at a deeper occurrence of uranium in the subsoil. Currently, the largest uranium deposits in Australia, Niger, Canada and Namibia are being developed by traditional methods [1].

The second category includes deposits that are developed by a relatively new method of in-situ recovery (ISR). The key feature of a method of in-situ recovery is in the use of a system of wells and the supply of solutions containing various chemical reagents through them. The world's largest uranium deposits being developed by ISR method are located in Kazakhstan, which account for about 40% of the world's production [2]. This method favorably affects the economic efficiency of mining, and significantly reduces the negative impact on environment [3]. However, the in-situ recovery method has disadvantages, such as the complexity of controlling and monitoring of the leaching process.

The complexity of the geological and technological conditions at the ISR uranium deposits requires the use of highly sensitive methods of monitoring the deposit mining process. Due to the fact that there is no direct contact with natural components during the process of in-situ recovery, geophysical methods of exploration and modeling of subsoil are widely used in the industry. During the

construction and operation of technological wells in the ISR uranium mines, the following well logging methods are used: gamma-ray logging, electrical logging, induction logging and others. The use of gamma-ray logging allows to obtain data on the lithological composition by measuring gamma radiation in the horizons penetrated by the well. This data is further used to design graphic model of the subsoil. Electrical logging and induction logging methods are used to monitor the movement of solutions in the subsoil and control the technological process.

The small logging radius of a commonly used geophisical survey methods, which normally doesn not exceed 1 m, significantly limits the range of geophysical survey of interwell space and the design of 3D visual models of the subsoil. Accurate modeling of the interwell space can only be possible in conditions of homogeneous geological structure of the horizons, when the rocks deposited uniformly, and the thickness of the ore intervals and the lithological structure from well to well differs insignificantly. The accuracy of modeling the interwell space decreases inevitably in the conditions of a complex lithological structure and uneven thicknesses of ore intervals.

For an in-depth study of inter-well space and clarification of lithological and filtration characteristics, the method of radio wave geointroscopy can be used (RWGI). The method of RWGI of the inter-well space is based on the measuring of the intensity of electromagnetic waves absorption by rocks located along the path of their propagation. The cross-well measurement scheme is shown in Figure 1.

Typical measurement procedure can be described as follows. A transmitter is placed, loaded on an isolated electrical antenna in a well №1, and a receiver with an antenna of a similar design is placed in a well №2. The amplitude of the axial component of the electric field is measured along the well №2 with a fixed position of the transmitter in the well №1. After each measurement the transmitter in the well №1 is shifted by a certain step and the measurements are repeated. Numerous overlapping of transmission rays in different directions (tomographic survey) provides a high level of detail in the exploration of the interwell space.

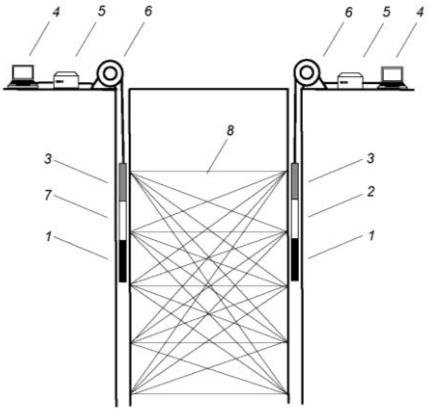

Fig. 1 [4]. Measuring installation for radio-wave oscillations and the scheme of tomographic shooting. *1* - antenna; *2* - repeater; *3* - optical isolation unit; *4* - computer; *5* - repeater; *6* - logging elevator; *7* - transmitter; *8* - transmission rays

Experimental work carried out at one of the deposits, located in the Republic of Kazakhstan, showed the high efficiency of the radio wave geointroscopy method. The use of radio wave geointroscopy in uranium mining by in-situ recovery, especially with a complex and inhomogeneous lithological structure of the subsoil, improves the accuracy of data on the geological structure of interwell spaces and improves the quality of their modeling.

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CONTROL OF GEOMECHANICAL PROCESSES USING INTELLIGENT ALGORITHMS ON THE BASIS OF FUZZY LOGIC METHODS

Geomechanical systems are monitored for safety of mining operations under partial uncertainty of the rock massif behavior under load, irregularity and randomness of the distribution in space of the properties and structural features of rocks, variety characteristics of roadways supporting and other poorly predictable factors. These uncertainties often do not allow monitoring and predicting of processes in geomechanical systems.

In such conditions, fuzzy control systems are especially useful, since processes in a geomechanical system are too complex to analyze using traditional quantitative methods, when incoming informative parameters cannot be reliably interpreted due to the impossibility of establishing accurate criteria for evaluating the source data.

The technical implementation of control systems embodying intelligent methods and algorithms is based on the use of computers and microprocessor tools.

In order to prevent emergency situations caused by the lost geomechanical system stability due to the uncertain behavior of the rock mass, a new fuzzy controller was designed which could generate an additional control signal. For the two-coordinate fuzzy controller, it is proposed to use the input parameters “Deviation” and “Derivative deviation”. To obtain the value of the derivative, a differentiating element was introduced into the fuzzy controller structure. At the output of the controller “Output”, a control signal is generated, which is one of the control criteria in the system for ensuring

the assessment of the state of the geological environment, including mine roadways and means for their maintenance. It can also be used as a correction signal to control signals, which generated by classical control systems.

For the fuzzy controller using mathematical theory of fuzzy sets, methods for implementing fuzzy logic algorithms (fuzzification, inference and defuzzification) were validate for converting input and output signals and linguistic rules were designed in order to control parameters of the geomechanical system; procedure of organizing computational processes and software models were developed for analyzing the fuzzy controller process.

With the help of the Cauchy problem solved by Runge-Kutta method of the 4th order, designed a software model of the proposed system which simulated the system operation. The model has proved operability and static stability of the developed algorithms.

Information and digital hardware technologies were improved to be used in automated monitoring safety system. As a result of the research, it has been established that the spectrum of the initial aperiodic signal is uniquely related to the spectra of imaginary periodic oscillations. Therefore, the spectrum of the pulsed signal from the monitored geomechanical object is the sum of a finite number of convolutions of direct Fourier transforms of imaginary periodic signals and displaced unit rectangular pulses, which makes it possible to automate the control of the object in real time based on the spectra of selected periodic signals.

New algorithms are proposed, which reject false values, convert digital signals from the time domain into the frequency domain, and improve reliability of and reduce volume of geotechnical information transmitted. The methods and the algorithms can be used for improving existing and developing new mine-safety systems.

Control of geomechanical processes using intelligent algorithms on the basis of fuzzy logic methods can be carried out by software by generating and transmitting danger signals, as well as initiating the creation of guidelines for the implementation of technical measures, which ultimately will ensure the effectiveness of warning personnel about possible emergency situations and increase occupational safety on mining enterprises.

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ASSESSMENT OF MINING SHOVEL AND DRAGLINE'S OPERATION SAFETY BY ITS

The safety of any machine depends on its level of reliability, maintenance performance and quality, and arrangement of maintenance and service. Most of Mongolian mining companies had been using mainly Russian-produced machinery and equipment, but in last two decade, the use of high-mechatronic mining machines, produced in Germany, the United States of America, South Korea and Japan, has increased due to improvement in the investment and foreign relations of Mongolian mining sector.

In general, about 30% of the total operation costs of the mining industry are spent on the shovels and the draglines, with an average availability of 0.75 and a downtime of 46-58% in the calendar time, indicates a lack of reliability.

The level of reliability of an shovels and draglines depends on many factors, such as the mine and geology condition, regional climate, operators skills, and optimal planning of maintenance work. So, mining shovels and draglines safety is determined by their reliability level.

As adverse factors affecting to the reliability of the excavator increase, reliability and efficiency of the excavat decreases. In addition, the lack of machinery and spare parts production in Mongolia has led to a shortage of spare parts, availability of units, and a lack of overhaul capacity, which reduces operational efficiency.

Mining machine manufacturers are pursuing policy of ensuring the machine's ability to operate through periodic inspections and maintenance without repairs in order to protect the interests of customers, create favorable operating conditions and ensure a level of safety and reliability. For example, Caterpillar rope shovels and hydraulic excavators operating at the Oyu Tolgoi and Nariin Sukhait

mines are recommended to be maintenance and service interval, as 100-500-1250-2500-5000 hours.

Companies such as Komatsu, Hyundai, Doosan, etc., which produce medium excavators, follow a 50-250-500-750-1000-2000 motor hour for maintenance interval.

Although mining machines, included shovels, draglines and excavators are produced based on high technology, the maintenance interval proposed by the manufacturer is not precisely adapted to the conditions of utilization and technical realities of the machine are not taken into consideration.

The specifics and conditions of our country are not taken into consideration of maintenance system recommended by the manufactures of excavators used in the mining sector.

Therefore, the reliability indicators were studied based on operation statistics of the Baganuur mine shovels and draglines.

Then, reliability level changing were defined by depending on the factors, within the framework of this study. In addition, regression analysis and system dynamic methods have been used to estimate how the reliability of the excavator affects the safety of the machine.

System dynamic model for safety of machine, depend on reliability was developed, based on the following principle:

- defining and estimating main parameters of reliability;
- developing causal loop diagram and stock diagram;
- modeling system dynamic for safety of shovels and draglines via VinSim.

At last, we can say that we can use the system dynamic model for safety of shovels and draglines for their assessing, monitoring and prognosing safety level just in time.

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STUDY OF METHODS OF ENRICHMENT OF DUMP TRAILS OF THE COPPER CONCENTRATING FACTORY AGMK

One of the world's most important problems is the disposal of industrial waste from the mining industry obtained during the enrichment of various ores. On the one hand, man-made wastes are valuable products containing a significant amount of noble and non-ferrous metals, they do not require extraction, transportation and grinding, which greatly reduces the cost of their processing. On the other hand, man-made wastes are stored in tailing dumps, occupy vast areas and pose a certain environmental hazard to the environment [1].

The object of research is waste, the so-called dump tailings of a copper concentrating plant (MOF) of JSC "AGMK".

The aim of this work was to study the material composition of samples, analyze the content of chemical elements and develop methods for their extraction from industrial waste.

For research, a sample of running ore, processed at a copper concentration plant, with a size of 2.5 mm and original tailings was taken.

The material composition of the waste of the Almalyk MPF and their products was studied by chemical and mineralogical analyzes. As a result of chemical analysis, it was revealed that the samples taken from the flotation tailings of the MOP AGMK are characterized by a typical aluminosilicate composition: 45.4; 49.72; 55.34; 55.36; 61.57; 64; 46; 64.91; 69.72% SiO_2 and 7.37; 15.49; 22.1; 23.05; 22.16; 26.77; 12.2; 10.93% Al_2O_3, respectively.

The mineral composition of the MPF wastes is represented mainly by quartz, feldspars, sericites and, in subordinate amounts, dark-colored and secondary minerals.

Pyrite is the most abundant ore mineral in OOF samples. Chalcopyrite, sphalerite, galena, molybdenite, and iron oxides are also common. According to the results of analytical studies, the content of some elements in the tailings of the MOP AGMK exceeds the clarke content in the earth's crust, such as tellurium, palladium, selenium, bismuth, molybdenum, iron, etc. Also, significant contents of copper, gold, silver and rhenium were recorded in the wastes of the MPF. In the study, native gold was not noted, probably gold may be a part of sulfides. Based on the above data of mineralogical, chemical and ICP-MS analyzes, it can be concluded that the processing of tailings is expedient when developing an optimal technological scheme for the complex extraction of valuable components.

Recommended technological scheme for processing old tailings includes: single-stage grinding up to 67% of class-0.071 mm; classification of crushed material in a hydrocyclone; the main control operation of the hydrocyclone discharge; I cleaning of the main concentrate; classification in a hydrocyclone and regrinding of hydrocyclone sands from concentrate I cleaning; additional flotation of middlings (tailings 1 cleaning + control concentrate).

The following reagents were used to extract copper, molybdenum and other metals from the dump tailings of the MOP AGMK by flotation: collector - butyl xanthate, kerosene, shale resin, spindle oil; foaming agent - T-92.

Quicklime was used as a medium regulator. To conduct flotation experiments, the sample was shredded to a size of -0.074 mm, class 85%. During flotation of tailings of MOP AGMK, the output of rough concentrate is 4.4-10.0%.

In this case, the extraction of copper in the rough concentrate from the original industrial waste is in the range of 41.1-60.8%.

The copper content in the rough concentrate increases to 0.87-1.7% from 0.13-0.16%.

The highest copper recovery when used in the main flotation collector - BKK-25 g / t, foaming agent T-92 60 g / t is 60.8%, while

the recovery of molybdenum and gold is 40.3% and 60.0%, respectively.

Thus, the expediency of using the flotation beneficiation method for extracting valuable components from the dump tailings of the MPF and obtaining a low-grade copper concentrate containing copper, molybdenum, gold, silver and rhenium, suitable for processing at the existing AMMC production, has been experimentally shown.

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PECULIARITIES OF ACIDIC FRACTURING IN CARBONATE RESERVOIRS

Worldwide, the main method of oil flow intensifying is recognized as hydraulic fracturing (HF), which can increase oil production in multiple times. As studies of domestic and foreign scholars have shown, hydraulic fracturing is a highly efficient way to intensify oil and increase oil recovery factor of low permeable reservoirs with low productivity. In wells where productive section is represented with high and medium permeable reservoirs, but with

reduced permeability layer of bottomhole formation zone (BFZ), the result of fracturing is often significant, up to 100% reservoir irrigation.

Although performance of wells fracturing in the early stages of well operation under the conditions of fracture-pore collectors can get quite high flow rates of oil, but this effect is usually short-term, then comes the progressive products irrigation, increased heterogeneous headway increases, working layer thickness is only 30-40% ultimate oil recovery is low [1].

Is also known that the repeat of HF does not give an expected rate of oil flow and leads to the intensification of drowning. This limits the method in tens of thousands of depleted wells.

Therefore, the optimal solution is the use of hydraulic fracturing wells only in depleted wells with low permeability of reservoir in which the man-made factors are greatly reduced.

Studies in the field of improving the technology of hydraulic fracturing, dedicated to selection of proppant agent and breakdown agent are actively investigated at present. The current state of the problem is highlighted in details in works [1-3]. The highest hydraulic efficiency can be achieved by selection of wells for treatments and optimization of cracks parameters, providing a balance between the reservoir and filtration characteristics of bed and cracks is taken into account with geological and physical properties of the object. The effectiveness of hydraulic fracturing process is directly related to the conductivity of the fracture. Normally to achieve a high conductivity of cracks the propping agents are used.

Other methods include use of emulsified oil fluids as breakdown agent. In industrial practice emulsion systems are used widely and their potential is far from exhausted. Particularly active they are used to improve the basic techniques of bottom-hole formation zone treatment (BFZT) and productivity stimulating. One of the promising ways to improve hydraulic acid fracturing is used in a liquid fracturing acid-oil emulsion.

Acid-oil emulsion is a dispersed system which medium is commercial oil and dispersed phase – aqueous hydrochloric acid. The main properties of acid-oil emulsions are inherited from water-oil emulsion, which at a phase ratio of 40/60 to 60/40 with

anomalous properties. Water oil emulsions of reverse type (oil in water emulsion) have high viscosity and resistance to fracture.

Studies have shown that acid oil emulsions (AOE), based on water-oil emulsions phases at a ratio of 40/60 to 60/40 are also have regulated physicochemical parameters in a wide range of variables. The use of acid oil emulsions (acid globules in oil medium) based on pressing in of globules in the channel pore that is smaller than the size of acid globules that leads to the breakdown of the oil film and the acid comes into contact with the rock.

Deep penetration into the formation provides technology of acid fracturing, based on the use oil acid emulsion as a liquid fracturing [1]. After the acid fracturing, surface cracks randomly off ledges formed by uneven chemical activity of minerals that make up the rock formation to hydrochloric acid. Further development of the fracture network in the reservoir is carried out the injection of acid mixture of slow action [2,3].

Acid mixture has two functions: provides the development of cracks in the gap depth of the reservoir and is an actively working agent in reaction with rock formation. As of liquid of crack development, it has high penetrating ability, but as a working agent it has the level of activity with the carbonate rocks at the level of hydrochloric acid.

Composition of fracture oil acid fluid: commercial oil with a volume part of 60%, formation water 36-38%, hydrochloric acid 2-4%. Hydrochloric acid is pre-mixed with formation water. Then the acidified water is mixed with oil. The viscosity of oil emulsion acid is in the range from 150 MPa s at shear rate of 500 to 450 at 5. Increasing the viscosity of the emulsion is achieved by the introduction of water-soluble oxidizing emulsion by mass 0,25-0,5%, such as potassium persulfate [3].

Regulation of the oil acid emulsion lifetime in formation conditions is achieved by varying the concentration of hydrochloric acid. In the range of the lifetime of the emulsion between 0,5 to 3 days hydrochloric acid concentration varies from 0,2% to 3%. Thus, expanding the range of viscosity required injection in breakdown agent reagents mudding the crack and lowering the effective depth of penetration into the formation. This is confirmed by comparing the

results of acid fracturing of formation with the results of acid treatment performed in the same fields of carbonate reservoirs.

To increase the performance wells during hydraulic fracturing is used a science-based method of non-reagent regulation of viscosity, lifetime and reacting capacity of oil acid fluids by the use of nanopatterning technology that provides an increase of effective depth of penetration into the formation.

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TOWARDS IMPROVED SHAFT MAINTENANCE

The mine shaft is the backbone of underground mining. Mines depend on it for personnel transport; escape way in case of emergency; conveyance; ventilation; supply of engineering services to underground such as electricity, compressed air, diesel, explosives, water, building materials etc. as well as disposal lines for water or communication lines and radio links. Under the climate of volatile mineral prices and declining mineral reserves, mining companies are focused on increasing productivity and this depends on the availability of the mine shaft(s). Shafts are influenced by permanent hoisting activities with heavy loads, bad rock conditions,

environmental conditions, nearby mining activities and potentially by accidents, all which will result in damaged shaft walls and their components. Thus, shafts must be regularly inspected and maintained to avert any unplanned shutdown.

As it has been accepted globally, the future of mining is automation and the Mines of the Future are will be focused on applying technologies and processes that provide more effective and quicker underground checks, with less risk to personnel. Maintenance strategies have been developed to meet the unique requirements of shafts. Whereas there is no perfect strategy for shaft maintenance, an assessment of the maintenance strategies in relation to the requirements of mines in the field of shaft maintenance reveals that a blend of strategies can be helpful in meeting the maintenance requirements of the individual shaft components.

Shaft inspections lie at the core of any shaft maintenance strategy. To detect and track the deterioration of the shaft and its components, regular and timely inspections need to be undertaken for appropriate remedial measures to be taken during shaft maintenance. Nowadays, the technology for monitoring and inspection is well advanced and the Mines of the Future are geared towards autonomous shaft inspections. Automated mine shaft inspection requires a developed real-time technology to aid in early detection of defects to reduce the probability of accidents and lost time injuries for mine personnel thus increasing the safety and efficiency of shaft operations.

This paper reviews the current shaft maintenance and inspection strategies with a view of determining the optimal strategy. A criticality assessment of the shaft components using Failure Mode, Effect and Criticality Analysis (FMECA) tool demonstrates that the ropes, shaft lining and guides are the most critical. The assessment of maintenance strategies is made on their strength in meeting the requirements for mines. Thus, Multiple Criteria Decision Making (MCDM) methods, namely Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) are used to weight the criteria and to evaluate the maintenance strategies respectively to determine the most optimal. Predicative maintenance and reliability-centered maintenance are the most optimal.

Key words: shaft maintenance, shaft inspection, maintenance strategies, FMECA, AHP, TOPSIS

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MICROPROCESSOR SYSTEM FOR CONTROL OF HYDROMECHANICAL AMBER EXTRACTION

Amber mining requires the latest technologies and improvements in technical and technological means to intensify the mining process, which achieves higher productivity and efficiency, as well as reducing the negative environmental impact on the environment. The introduction of hydromechanical method of amber mining, which does not require expensive exploration and reclamation works, is characterized by minimal capital and operating costs, and has the prospect of improvement by controlling the rate of amber rising from sand deposits by changing air flow and oscillation frequency becomes on time. [Malanchuk Z., V Korniyenko, Y. Malanchuk (2016)]

The process of amber extraction using hydromechanical mining technology takes place in the following stages:

- lifting the amber to the surface using a vibrohydraulic intensifier by means of vibration, water and air supply;
- collecting the amber with the top layer of sandy deposit and loading it on the vehicle by means of loading equipment (loader, excavator, scraper);
- transportation of the collected amber by means of the dump truck to the line of enrichment and sorting;
- enrichment and sorting of the obtained mass (separation of amber from sand and sorting by size classes).

The main mean of the extraction process is that the deposit is saturated with water and activated by mechanical excitation (vibration) to form a continuous suspension layer of a density at which there is an ejection force that raises the amber to the surface of the deposit.[Malanchuk Z., Malanchuk E., Khrystyuk A. (2016)]

The synthesis of modern microprocessor control systems for mining requires the establishment of structural relationships between input and output parameters of the object, the correct choice of controlled parameters and control effects, and then the selection of appropriate sensors, actuators and microcontroller. Analyzing the results of research, we found that the main regulatory parameters in hydromechanical amber mining are water and air flow rate, frequency and amplitude of oscillations of the working body, adjustable - the density of amber-containing medium and the rate of amber ascent. [Ye. Malanchuk, V. Korniienko, V. Moshynskyi, V. Soroka, A. Khrystyuk, Z. Malanchuk (2019)]. The main disturbing factor influencing the regulating and regulated parameters is the physical and geological properties of the formation. Based on this, we have developed a microprocessor system that controls the process of hydromechanical amber mining by measuring the main process parameters and the impact on the electric drive of the installation to ensure optimal process conditions.

Coordination of the hydromechanical complex of amber mining is provided by a microprocessor system, which is responsible for the management of production: management of individual production sites and facilities; control of the technological process of amber mining and transportation, as well as the state of individual responsible nodes, regulation (if necessary) of processes by remotely changing the settings of regulators that stabilize the supply of working agents: centralized accounting of the product, material and energy costs. We recommend using a one-stage control structure of the complex, in which control and monitoring of the entire process is carried out from a single central control point, where the control and measuring equipment is installed. Here comes all the necessary information about the flow of technological processes in different areas.

When carrying out the main technological process (actually extraction) stabilization of parameters of working agents should be provided. For this purpose, control valves and diaphragms are installed on the pipelines and the parameters of the working fluid are measured.

Based on the analysis of the results of experimental research, we have developed a microprocessor control and management of the main technological parameters of the mining process, which allows to intensify the process of amber mining up to 95% of total reserves by extracting small fractions.

To ensure a quality of control process of the hydromechanical extraction of amber, it is necessary to ensure high-precision measurement of the parameters of the flow of agents, the frequency of mechanical oscillations and the density of the obtained medium. In addition, it is necessary to provide reliable technical means to ensure changes in water and air consumption, as well as means of mechanical impact on the sandy environment. The proposed control system ensures the performance of all the above tasks.

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ABOUT THE CONNECTION OF GAS RELEASE FROM THE COAL-BEARING LAYER UNDER DEVELOPMENT WITH THE INTENSITY OF COAL SEAMS PROCESSING

The main source of gas release in modern coal mines is the coal-bearing stratum that is being worked.

The relationship between the intensity of gas release and the activity of movement of mined rocks was established several decades ago. The highest levels of gas release are associated with precipitation of the main roof and the development of processes of rock movement towards the earth's surface when the treatment face is removed from the split workings. Methane release into mine workings is possible only from the zone of displacement of rocks with a break in their continuity. Methane release can also occur from stratification cavities at the contacts of rock layers with different strength properties in degassing wells.

The phenomenon of reducing the specific methane flow rate to the treatment mine is established in parallel with the influence of the displacement of the mined rocks with an increase in the intensity of mining of flat coal seams. Under the intensity of seams mining is meant the level of coal production and the corresponding movement of the clearing face. Knowledge of the mechanism of formation of methane release from the coal-bearing strata under production is necessary for safe mining of gas-bearing coal seams. The research works are almost absent up to the present time, in which the intensity of coal seam mining (the level of coal mining or the speed of face moving), the development of treatment works and gas release from the sources, that are being worked, are jointly considered. Researches in this area are very relevant.

The aim of the study is to develop a scheme of the influence of treatment workings on the formation of zones of active displacement of the coal-bearing and the possible intensive release of methane

from them, as well as to establish the factors that determine gas release relative to its release per unit area of the developed space.

The idea of the study suggests that the amount of releasing gas depends on both the speed of movement of the treatment face and the intensity of movement of rocks above it and the degree of development of cleaning works at the excavation site.

The research methodology envisages the consideration of experimental data on methane release in relation to the developed scheme of the influence of clearing workings on the formation of zones of intensive displacement of rocks and gas release from the coal-bearing strata that are being worked.

The result of the study is a diagram of the location of methane release zones in the coal-bearing strata that are being worked according to the formation of the displacement muld, on the earth's surface and the degree of development of cleaning works at the excavation site.

According to the developed scheme, a sliding muld which is divided into two half-mulds is formed on the daytime surface under the influence of cleaning works. One of them is stationary, which is formed above a split mine. The second one is dynamic, it is formed as the cleaning face moves. These half-mulds can be divided into certain periods of their formation with the help of characteristic points. The section of the earth's surface half-muld, located above the split mine, corresponds to the initial period of the earth's surface displacement under the influence of a moving treatment face. When the clearing face departs from the split mine at a certain distance, the maximum subsidence is reached at a certain point, and further movement of the clearing face practically does not affect the processes of active movement of the worked rocks and the earth's surface.

Similarly in terms of intensity there is a shift of the mined rocks above the treatment face in the coal-bearing strata. By analogy with the earth's surface, a half-muld of subsidence with characteristic points is formed in it.

Several assumptions were made, which were checked and confirmed by experimental results.The assumption of similarity of the processes of gas discharge from the undermined coal-bearing rock strata while removing clearing mines from split furnaces in the

initial period of operation of the extraction sites (at lees main roof) and methane release treatment above clearing face refer to them.

The results of observations on the development of cleaning operations and gas release at fifteen excavation sites of four mines were attracted to the analysis.

For each excavation site, monthly movements of the clearing faces are pre-established and the amount of gas released during this time period is experimentally determined.

The established facts show that in order to reliably determine the specific gas release per unit area of the developed space, it is necessary to take into account the zones of active displacement of the mined rocks.

The theoretical and experimental studies of gas release from the coal-bearing strata, that were done by clearing works, allowed us to make the following conclusions:

- they were established in the conditions of four mines on 15 excavation sites distinctive features of specific gas release, per unit area of the developed space, which are determined by the development of cleaning works and the speed of movement of the cleaning face;

- the main factors determing the specific gas release are the area of part of the developed space, which affects the active stages of rock movement and the time period required for the formation of this area of the developed space.

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THE STUDY OF THE FEATURES OF THE SUBSTANTIAL COMPOSITION OF COPPER-MOLYBDENUM ORE KALMAKYR DEPOSITS

In the Republic of Uzbekistan, the reserves of non-ferrous metal ore are mainly concentrated in the Almalyk ore field. The Kalmakyr

deposit is unique, which significantly surpasses foreign analogues in the extraction of copper-molybdenum ores. The ore of this deposit is processed by the Almalyk Mining and Metallurgical Combine. In addition, the prospective Youth field has been explored with a large reserve of copper, molybdenum, gold, silver, rhenium, tellurium, selenium and sulfur [1].

Currently, the development of an economically efficient technology for flotation of copper - molybdenum ores in order to increase the recovery of valuable components is an urgent task. This article is devoted to the study of the material composition of ore samples from the Kalmakyr deposit taken from deep horizons.

Non-ferrous metal ores, including copper-molybdenum ores, have a number of characteristic features that determine not only the choice of their processing technology, but also the technology of deposit development. The main ones are the complexity of raw materials, the delicate connection of valuable components with the host rocks with each other, the low content of non-ferrous metals in ores, etc.

The material composition of the ore sample was studied by spectral, chemical, granulometric, mineralogical analyzes.

Semi-quantitative spectral analysis in the average ore sample is determined in%: Si>1; Al>1; Mg>1; Ca 0.8; Fe>1; Mn-0.03; Ni 0.001; Ti - 0.1; Cr - 0.002; Mo - 0.02; Z2 - 0.006; Cu - 0.48; Pb-0.01; Zn - 0.01; Na - 0.8; Ba - 0.08; Co - 0.002; V 0.006; Ga 0.002; Be 0.001; J<0.001; SV <0.001; Ar 0.001; Au<0.001. By chemical analysis in the average ore sample determined in%: SiO_2-56.5; Fe_2O_3 - 7.37; FeO - 3.08; TiO_2 - 0.45; MnO-0.05; Al_2O_3 - 12.0; CaO - 3.7; MgO - 4.2; Na_2O - 0.46; K_2O - 4.79; Stot - 2.09; SO_3 - 2.74; P_2O_5 - 0.38; CO_2 - 1.90; H_2O - 1.4.

The results of sieve and chemical analyzes are shown in Tables 1 and 2.

Table 1

Results of sieve analysis of the average ore sample

Size class, mm	Output, %		Containing copper,%	Distribution by class,%
	Private	Totally		
-3+2,5	11,60	11,60	0,84	9,07
-2,5+1,4	16,42	28,02	0,77	11,80
-1,4+1,0	10,63	38,65	0,85	8,42
-1,0+0,5	21,02	59,67	0,91	17,81

-0,5+0,25	22,95	82,62	1,24	26,5
-0,25+0,1	14,0	96,62	1,60	20,90
-0,1+0,074	2,9	99,52	1,79	4,80
-0,074+0,0	0,48		1,73	0,70
Ore	100,0	100,0	1,07	100

Table 2

Results of the chemical analysis of the studied ore sample

Components	Content, %	Components	Content,, %
SiO_2	53,0	MgO	7,6
Fe_2O_3	4,52	Na_2O	0,31
FeO	5,47	K_2O	3,22
MnO	0,12	S	-0,93
Al_2O_3	14,40	$S0_3$	0,35
CaO	4,38	P_2O_5	0,13
CO_2	2,64	Cu	0,48
$-H_2O$	2,0	Au, g/t	0,57
n.n.n.	6,0	Ag, g/t	2,8

Based on the study of the material composition of ore samples, the following conclusions can be drawn:

The valuable components of the ore are pyrite and chalcopyrite. The most widespread nonmetallic minerals in the samples are quartz, feldspars, chlorites, sericite, carbonates, biotite, and hornblende. The presence in ores of significant amounts of such minerals as sericite and chlorite, which compose fine and fine-scale aggregates, impair their technological properties [2].

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ANALYZING THE POSSIBILITY OF DEVELOPING THE ZHARTAS ALLOTTMENT WITH THE METHOD OF IN-SITU LEACH MINING

The Zhartas allotment is located in the Ulytau district of the Karaganda region, 30 km north-north-west of Zhezkazgan city. The area of the allotment is 10.9 km^2.

The geological structure is attended by terrigenous deposits of the Carboniferous system: the Beleuta suite of the lower-middle sections ($C_{1-2}bl$), the Taskuduk suite of the middle section (C_2ts), the Zhezkazgan suite of the middle-upper sections ($C_{2-3}dž$).

The Mesozoic-Cenozoic erathem in the area of the allotment is represented by formations of the weathering crust along siltstones, to a lesser extent along sandstones.

The Cenozoic deposits are mainly developed in the valley of the Zhilandy river, as well as in the northeast and southeast of the allotment.

The Neogene system is represented by deposits of the Pavlodar suite.

The deposits of the Quaternary system are represented by alluvial and deluvial-proluvial deposits of the Pleistocene-Holocene.

Copper mineralization is localized in gray-colored sandstones in the lower subsuite of the Taskuduk suite of the Middle Carboniferous, as well as in gray-colored sandstones of the upper member of the upper subsuite of the Beleuta suite of the Lower-Middle Carboniferous.

The ores are mainly represented by copper sulfides: chalcopyrite, bornite and chalcocite. Copper mineralization has the form of filling pores and voids or replacing cement, individual grains of fine-medium-grained gray-colored sandstones with metalliferous

solutions. Mineralization is also presented in the form of separate crystals or solid masses of a nesting shape, confined to the selvages of cracks made with calcite-quartz-barite material [2].

Studying the area of work can be conditionally divided into three periods: pre-war, post-war, present day.

The first geological studies in the area of work began in 1903, in connection with the discovery of the Zhezkazgan copper deposits and were of the reconnaissance nature. The first geological survey on a scale of 1:420000 in the Zhezkazgan-Ulytau region was carried out by I.S. Yagovkin in 1925-1928.

The second period covers the time period from 1946 to 1978. Geological maps of medium and large scale were compiled, explanatory notes were written, a wide range of geological and geophysical works was carried out.

The work carried out since 1980 belongs to the present day period.

In the period 2015-2017 prospecting work was carried out at the Zhartas allotment, as a result of which it was concluded that the allotment was unpromising for the further development and was classified as an off-balance one [3].

These conclusions were made on the basis of classical understanding of the economic efficiency, when a deposit is mined by open (a quarry) or closed (a mine) methods. Such methods always require serious capital expenditures; it means that they need large volumes and concentrations. This means that a lot of ore occurrences and small deposits in Kazakhstan will remain off balance in the near future, due to small volumes of minerals.

The technology of in-situ leach mining (ILM) can become a worthy alternative to classical methods of developing deposits of a number of minerals [1].

The essence of in-situ leach mining of minerals consists in the selective transfer of the useful component to the liquid phase by the controlled movement of the solvent through the ore in natural occurrence or through the pre-crushed ore massif and rising the solution dressed with metal to the surface.

The limited use of hydrometallurgical methods in the copper industry is mainly caused by small reserves of oxidized ores and the

complexity of the associated extraction of silver and gold. For this reason, leaching is mainly used for treating poor ores with unprofitable contents of precious metals, the waste rock of which does not enter into chemical interaction with the solvent [4].

To assess the possibility of developing copper by in-situ leach mining at the Zhartas allotment, it is necessary to carry out a complex of geological and hydrogeological tests. However, for some parameters, a preliminary estimate can be made based on the available data.

The preliminary assessment shows that the Zhartas allotment is a promising area for the development by the WUL method. This conclusion can be made based on the depth, copper content and thickness of ore-bearing rocks. Hydrogeological conditions and infrastructural development are also taken into account.

To substantiate the economic feasibility of developing copper at this ore occurrence, it is necessary to carry out the laboratory testing of the enclosing rocks and ore, as well as extended hydrogeological and engineering-geological studies.

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METHOD OF CONDUCTIVITY FOR MONITORING OF QUALITY OF MINERAL RAW MATERIAL

An important meaning during the carrying out of the process of enriching has a maintenance or increasing of metallurgical value of ore, which is determined by the presence of useful and harmful admixtures, for example, for iron ore useful admixtures are manganese, chrome, nickel, titan, vanadium, cobalt, harmful – sulphur, phosphorus, copper, arsenic, zinc, lead, tin.

To metallurgical properties of ores, determining the quality of the produced concentrate, such, as recovery and basicity. Under recovery we understand speed of taking away of oxygen from a mineral by gas-repairer in the process of melting, under basicity the attitude of oxides of calcium and magnesium toward a silica and alumina in ore. One of parameters, allowing to estimate quality of the received concentrates is a of change conductivity which depends on admixtures, on one hand, and on other – on absorption oxygen on-the-surface of the enriched ore.

Minerals, applied in the process of enriching in most cases, have semiconductor character, in this connection possibility of application of the electronic approach to the problems of enriching of minerals, control and of the quality of minerals management, appears which supposes direct correlation between chemosorption and electronic properties of the grounded up mineral. From here appeared the necessity of experimental determination of electric descriptions of the activated ores with the set purpose: to find correlations between mechanical activity and electronic structure of these objects.

Difficulties, related to verification of electronic theory, are aggravated by doubts in reliabity of the experimental material used for this purpose. It is specified in works, that in the conditions at which the most of the data on the conductivity of minerals were got,

– i.e. by the method of direct-current on the powders - electric descriptions of not so much object are measured, but contacts between grains of powder, and that on the basis of such information it is impossible for sure to differentiate the charged and unloaded forms of adsorption.

The purpose of this work is to develop the highly sensitive method of control of quality of concentrates on metallurgical properties of ores, based on measuring of conductivity in an appendix to research the surface of polycrystalline minerals.

Researches of electric, dielectric and some other properties of ores, in a highlydispersed (polycrystalline) form, after the process of despersivity, showed that the behaviour of such systems can be described, using a two-phase (two-layer) model: areas with semiconductor conductivity (actually material of object), with intermittent relatively thin dielectric layers (intergrain contacts).

Such two phase model is suitable not only to the case of the pressed powders (with simple mechanical contacts between grains) but also to powders, sintered at a high temperature (higher 600-800 °C), when thin bridges (bridges, necks, “structure of swiss cheese”) appear between grains.

The approximation analysis of properties of the system on the basis of this model shows, that measurings on a direct current and on low frequencies give information mainly about properties of contacts between grains of powder, and measuring on high-frequencies, shunting contact resistances, expose properties of the studied matter itself.

We will consider more concrete, how characteristic of the got TVE-curves is conditioned.

The specific type of these graphs is created by dependence of conductivity on the number of factors (electronic, adsorption, topochemical) the relative deposit of which is determined by chemical nature of object and is different in different temperature areas. Basic from these factors are as follows.

A - The typical for semiconductors convertible growth of conductivity with a temperature by the law of Arrhenius, characterized by the large range of values of E_σ for different matters – from 0 to a few eV.

B - Desorption of gases and steams (oxygen, water), which is the most intensive at warming up in vacuum till 200-300 °C. And changes of conductivity caused by this are not only different in interval of value, but also (for minerals of *n* - type and *p* - conductors) are contrary in sign.

C - Restoration in a vacuum (removal of the lattice oxygen) with formation of greatly defect or quagimetallic structures, that is most marked in area of 300-400 °C and for different matters greatly depends on energy of grate.

D - Other topochenical and other processes in a grate (grinding down, decomposition of remaining hydroxides and carbonates, structuring, crystallization and so on) - if temperature of preliminary processing it is not high enough.

The method of TVE-curves opens wide possibilities for the different variants of "monitoring" of process of enriching. We will bring a few illustrations of it.

The exposure of remaining (nonenriched) phase, not noticed already skiagraphy, was carried out on the example of hydrooxide phase, remaining in ore at not enough high temperature of thermolysis.

Finding out of new superficial mixture in the process of grinding of the oxidized quartzite appeared possible on the most initial stage of formation of this mixture, when a skiagraphy method was powerless.

We will add that conclusions done on the basis of TVE-curves conform with by information of other used methods – roentgenophase analysis of contact difference of potentials, magnetic receptivity and EPR.

It is necessary to suppose that in a perspective, the method of TVE-curves can be widely utilized in combination with roentgenophase and other analyses as standard or as an express-method of control of process of enriching.

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ALTERNATIVE SOLUTIONS FOR DISPOSAL OF TECHNOGENIC PHOSPHOGYPSUM DUMPS

Due to the activities of large chemical enterprises, significant dumps of phosphogypsum are formed. They are being constantly accumulated and have not been widely used in the industry. Such a situation can be seen not only in Ukraine but in the whole world too.

The total volume of phosphogypsum that is produced in the world before 2006 is estimated at 6 billion tons, and the annual production of phosphogypsum is about 160 million tons worldwide. The growing demand for chemical fertilizers, as a result of which phosphogypsum dumps are formed, is growing every year. And because of this the amount of phosphogypsum in the dumps will only increase. [1].

Technogenic deposits of phosphogypsum occupy significant areas of land and harm the environment. Therefore, their processing and use is an important scientific and applied problem.

There are different ways of utilizing phosphogypsum and they are already used. The main areas of phosphogypsum`s use in the national economy are:

- the agriculture, as fertilizers and for the amelioration of acidic soil;
- as pavements;
- as mineralizing additives in the firing of cement clinker;
-as a regulator of the cement hardening time;
- the cement industry, for the production of building materials, production of gypsum binders and hydraulic additives;
- the chemical industry, to obtain sulfuric acid, sulfur, ammonium sulfate, cement or lime;

- for the production of construction products using unprocessed phosphogypsum (blocks and panels - in a mixture with fly ash (from electrostatic precipitators) and lime; bricks - pressing phosphogypsum in a mixture with a binder derived from phosphogypsum);

- as a filler: in the production of paper instead of kaolin, in the paint and varnish industry and in the production of plastics, glass, ammonium nitrate instead of traditional materials;

- mines of coal and other industries - to fill the fixing space and calculation of security strips;

- extraction of rare-earth metals, the demand for which is increasing every year [2,3].

However, none of these methods is currently used, due to the heterogeneous structural and chemical composition of phosphogypsum, as well as due to the possible radioactivity of certain components [3,4,5].

Besides, new spheres of phosphogypsum usage are being explored:

- the creation of X-ray protective construction. The expediency of creating X-ray protective structures from a composite material based on phosphogypsum has now been substantiated. However, further research is needed on the effect of composite materials based on phosphogypsum binders on the effectiveness of protection against gamma and X-ray radiation.; [6]

- use of phosphogypsum for the revegetation of contaminated soils (after oil pollution or fuel oil) [7];

- to apply phosphogypsum during the revegetation of drilling cuttings, which are formed and stored on the territory of the drilling site [8];

- the use of phosphogypsum in biotechnological processes of sewage sludge disposal [9].

New alternative solutions for the use of phosphogypsum have not yet been widely used in the national economy. However, it is necessary to look for solutions due to a large number of deposits with the help of which it will be possible to use recycled phosphogypsum in several possible ways.

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SUBSTANTIATION OF THE APPROACH TO INCREASING THE ACCURACY OF THE INFORMATION SUPPLY OF THE MECHANICAL SINGLE-SPIRAL CLASSIFIER DURING CRUSHING-CLASSIFICATION OF ORE

Ball mills operating in a closed cycle with a mechanical single-spiral classifier (MSC) are widely used at concentrating plants in the first stages of grinding ores. Ball mills have a rather low value of the mechanical efficiency when forming a new surface, not exceeding 1% [1]. According to the authors of [2], the efficiency of rotary mills traditionally used for grinding is 0.4...2%. According to the author of work [3], ball mills have a rather low value of efficiency - from 2 to 20% of the energy consumed by the technological unit is spent directly on the work of material destruction. Such a low value of the efficiency, in addition, reduces the low efficiency of the separation of solids by size in the MSC. Improving this parameter will increase the efficiency of the ball mill in the grinding cycle. However, the obstacle here is the lack of an approach for improving the separation of solid and the sufficiently low accuracy of information for its implementation.

The authors of this publication have developed an algorithm for determining the liquefaction of the pulp at the entrance to the MSC, which ensures the separation of the solid according to a given size. However, this is guaranteed only with a certain information support for the automatic control of solid separation in the MSC.

The purpose of this work is to improve the accuracy of information support for the MSC in the grinding-classification of ores.

When controlling the separation of solid by size of the MSC, it is necessary to apply a control action to its input in the form of a given solid/water ratio. Considering that the parameters of a solid vary in a random way, they must be both accurately measured and qualitatively filtered, obtaining an average value. The consumption of ore to the mill, water to the mill and additional water to the classifier are measured quite accurately. It is necessary to filter the signals of the consumption of ore and sands by digital filtering, since it is carried out up to hundreds of kilohertz [4], which corresponds to the conditions of these controlled objects. As a filtering algorithm, one should choose the calculation of the current average value of the signal at a given time interval [4]. Studies have established that the signal of the ore flow meter should be filtered for at least 2.01 s [5], and for the sand product - 10 s or 20 s, 30 s, etc. Considering the state of the material in the classifier bath, which accumulates within 30 minutes, it is advisable to filter the parameters during this period of time, but taking into account the possible change in the composition of the pulp. Then

the flows of ore, sands must be averaged, for example, according to for 10 s and 30 s and the accumulated sums must be increased for the results obtained, having previously reduced them by the preliminary filtration results for the data of 30 min. The sum of the accumulated new data will give the average solid consumption in the cycle. Water flow signals may not be filtered. The choice of the duration of the discreteness time interval is determined by the nature of the change in the random process. Usually, for the full period of the highest frequency harmonic of a random process, it is necessary to take 5...10 reference points [6]. Signals of ore consumption should be taken into account in 0.5×10^{-3} s, and sand consumption in 2×10^{-2} s. Such signal processing will provide high accuracy in assessing technological parameters with an acceptable measurement error. However, an obstacle here is the relatively low accuracy of the circulating load estimation.

A review of the development of means for measuring the circulating load in closed cycles of ball grinding of ores showed that it is impossible to improve the accuracy of assessing this technological parameter using existing approaches. It is possible to increase the accuracy of identification of the circulating load on the basis of the sand product located in the inter-turn space of the MSC spiral, where there is no material dynamics, which significantly reduces the measurement accuracy. In addition, the sand contains an almost unchanged amount of moisture of about 12% [7]. The most suitable identification point is the sand chute where material is discharged into the sand chute. It is known a priori that the consumption of sands during unloading is uneven. Therefore, it is in such conditions that it is possible to most accurately identify this technological parameter.

It is possible to identify the circulating load by establishing the regularities of the ascent of sands from the inter-turn space into the sand trough of the MSC. To do this, it is necessary to establish the regularities of the location of sands along the axis of their distribution and to solve this problem, develop a new method of modeling.

Thus, an approach has been found and substantiated to improve the accuracy of information support for the MSC during grinding-classification of ores by choosing accurate measuring instruments of technological parameters and digital filtering of their signals with

finding the average value at specified time intervals and measurement intervals. To improve the accuracy of identification of the circulating load, it is necessary to develop a new method for modeling the regularity of the sand location between the turns of the spiral along their axis of occurrence.

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DEVELOPMENT OF A TECHNOLOGY FOR PROCESSING COPPER ORE IN ONE OF THE DEPOSITS OF UZBEKISTAN

The study of the material composition and the development of technology for the beneficiation of non-ferrous metal ores is relevant.

Spectral analysis in the average ore sample determined in%: Si>l; M>1; Mg>l; Ca>1; Fe>1; Mp-0.1; Ni 0.003; Ti-0.1; Cr 0.003; Mo - 0.003; 7.g-0.002; Si-0.4; Pb-0.005; Zn-0.03; Na-0.8; Sr-0.01; Ba - 0.04; Co-0.003: V-0.02; Ca-0.002; Be<0.001; Sc-0.001; Rb<0.001; Ag<0.001; Au<0.001.

According to the data of chemical analysis in the sample are determined in%: SiO_2-53.0; Fe_2O_3-4.52; FeO-5.47; TiO_2-0.8; MnO - 0.12; $A1_2O_5$-14.4; Ca>0 -4.98; MgO-7.6; Na_2O -0.31; K_2O -3.22; So_6sh-1.08; Sc ,, -0.93; SO_3> -0.35; P: CF-0.13; CCA 2.64; H_2O - 2.0; n.n.n.-6.0; Au-0.57ye; Ag -2.8 ye; Cu -0.48.

The valuable components of the ore are copper, gold and silver. In the sample, Cu is 0.48%; Ai - 0.575 USD and Ag - 2.8 c.u. The main ore minerals and gold concentrates in the sample are pyrite and chalcopyrite. The main nonmetallic minerals in the sample are quartz, feldspars, chlorites, sericite, carbonates, biotite, and hornblende.

The presence in the ore of a significant amount of sericite and chlorite, which break down fine-fine-flake aggregates, impairs their technological properties.

Flotation experiments with different consumption of butyl xanthate. The results of the experiments are shown in table 1.

As you can see from the table 1 sample of ore is floated with the maximum effect at a consumption of BKK-20+10 g/t, while 88.7-91.2% of copper is extracted into the rough concentrate. In addition to xanthate, the experiments varied the consumption of lime in grinding, sodium sulfide, T-92. Potassium butyl xanthate was fed in a mixture with isoprolic in a 1:1 ratio (BKK+IPKK). Before cleaning the rough concentrate was subjected to grinding to a size of 98% Cl - 0.074 mm.

Table 1

Results of flotation experiments for ore samples at various xanthate flow rates

Fortification products	Output %	Copper content%	Copper recovery%	Consumption of BKKv main cont.fl., g / t
Concentrate	13,75	2,73	75,1	5+2,5
Intermediate product	9,8	0,51	9,9	
Tails	76,45	0,098	15,0	
Ore	100	0,5	100	
Concentrate	16,28	2,52	85,37	10+5

Intermediate product	10,70	0,20	4,45	
Tails	73,02	0,067	10,18	
Ore	100	0,48	100	
Concentrate	20,45	2,22	89,1	
Intermediate product	8,37	0,26	4,33	0+10
Tails	71,18	0,047	6,57	
Ore	100	0,51	100	
Concentrate	18,7	2,47	88,7	
Intermediate product	10,15	0,22	4,2	30+15
Tails	71,15	0,052	7,1	
Ore	100	0,52	100	

As a result, the optimal mode of ore flotation was determined. Consumption of reagents, g/t: for grinding: lime-1200; in the main flotation: sodium sulphide-50: a mixture of BPC and IPKK (1:1) - 20; spindle oil-10; control flotation: sodium sulphide - 20; a mixture of xantothanates - 10; finishing cycle of copper concentrate: additional grinding - 98% Cl - 0.074 mm. Purification without reagents. Main flotation time: min-15; control flotation, minutes - 10; I peeling, minutes - 5; II cleaning, minutes - 3. In the developed mode, experiments were carried out in open and closed cycles, the results are shown in Table 2.

As can be seen from Table 2, with flotation in the optimal mode of copper ore, it is possible to obtain a copper concentrate containing 24.18% Cu in an open cycle, with an extraction of 83.12%. IN . closed cycle, the copper content was 20.22% with its extraction 86, 36

Table 2

Results of experiments in flotation of copper ore in an open cycle and according to the principle of a continuous process in an optimal mode

Fortification products	Output %	Copper content%	Copper recovery%
Open cycle			
Concentrate	1,65	24,18	83,12
Promproduct-1	9,42	0,25	4,9
Promproduct-2	4,11	0,60	5,18
Promproduct-3	4,2	0,22	1,90

Flotation tail	80,62	0,029	4,90
Ore	100	0,48	100
According to continuous process principle			
Concentrate	2,05	20,22	86,36
Flotation tail	97,95	0,066	13,64
Ore	100,0	0,48	100

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INCREASING OF CONSTRUCTION CRUSHED STONE PRODUCTION EFFICIENCY DUE TO USAGE OF CRUSHERS WITH WAVE PROFILE OF ROLLS

Production of crushed stone includes usually drilling and blasting operations with further crushing of lumpy rock mass in several stages

together with classification of marketable products. KMD cone crushers are often used at the last crushing stage, that leads to the enhancing of lamellar part in crushed stone [1], its cheapening and reduces its consumer properties. At the same time, crushed stone with minimal yield of lamellar grains is needed for production of high-strength concrete products, in construction of roads and bridges due to increasing the grains frame packing density, and also the reduce in stresses concentration in concrete, the elimination of frame lamellar grains destruction under flexural loading [2].

As the alternative, we recommend using of crushers with wave profile of rolls [3] after KMD crushers. These crushers will correct the shape of grains from the lamellar one to the cubical one. It is set as a result of scientific research fulfilled, that such shape of rolls creates enhanced flexural stresses in lamellar particles. Here, the equivalent destruction stresses is minimum 6 times more than the same stresses in crushers having smooth rolls [2].

The additional crushing stage leads to the inevitable final product size reducing. We will compensate it by the increase in KMD crushers unloading size, that will additionally enhance their output and increase the liner service life. The only limitation here is the compressive strength of crushed ore. But, many of Ukrainian open pits extract stones having compressive strength up to 150 MPa, favorable for roll crushers implementation.

As to the cost efficiency of the described variant, it is necessary to fulfill a comparative analysis of the case of selling of the crushed stone in fractions from 40 to 70 mm and from 20 to 40 mm of usual lamellar grains yield and the case of its additional crushing in wave-profiled roll crushers and resulting in fractions from 20 to 40 mm, from 10 to 20 mm, from 5 to 10 mm and the rest less than 5 mm.

In the case of the direct selling of fractions from 40 to 70 mm and from 20 to 40 mm, their price will be 155 UAH/t.

Crushing of the mentioned stone fractions in DV-10x5.5 crusher of “Factory of industrial equipment “Progress” Ltd, having wave-profiled rolls and the gap increased up to 25 mm, will result in

products of approximately 30 percent cubical crushed stone of fraction from 20 to 40 mm of 170 UAH/t price, 25 percent of fraction from 10 to 20 mm of 220 UAH/t, 35 percent of fraction from 5 to 10 mm of 265 UAH/t and the rest less than 5 mm of 50 UAH/t. The products average price will be 204 UAH/t.

Output of DV-10×5.5 crusher with the gap increased up to 25 mm will make 72 t/hr, the drive power is 45 kW, the price of crusher having profiled rolls will be 2.0 million UAH. Power consumption of additional crushing operation will make not more than 0.556 (kW·hr)/t, that will result in 1.0 UAH/t for 1.83 UAH/(kW·hr) tariff. Additional costs on the crushed stone classification will also make not more than 1.0 UAH/t.

So, the additional profit for the additional crushing of stone fraction from 40 to 70 mm will make 47 UAH/t. It will make 13.5 million UAH for two-shift operation during the year (249 working days). The estimated payback period of new DV-10×5.5 crusher doesn't exceed one year.

The results of fulfilled analysis are recommended for designing of equipment of technological lines for processing of different construction stone materials having compressive strength up to 150 MPa, such as limestone, granite, basalt and some others.

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CONSTRUCTION OF DEPENDENCIES OF PARAMETERS OF THE MAXIMUM SLOPE OF DAMS TAILING DUMPS CPP AMMC USING SOFTWARE

Tailing dumps are dangerous for nature and humans. Destruction of enclosing hydraulic structures (dams) of tailings dumps leads to disastrous consequences. Therefore, State mining technical supervision of the Republic of Uzbekistan develops measures to improve the operation of the objects under consideration and improve control over them, including licensing of operation, development of regulatory documents, training of personnel, conducting research [9].

Guidance and regulatory documents on the organization of monitoring and assessment of stability at hydraulic structures regulate the methods of calculating dams and dams of the tailings storage for stability, sedimentation and filtration, and also require information on the physical, mechanical and strength characteristics of ore dressing waste, methods for determining them, types and methods of field observations, their frequency and accuracy. Thus, the first priority in terms of ensuring the safety of tailing dumps is to develop a methodology for monitoring and evaluating their stability, including the interpretation of the results obtained and the forecast of the state of the enclosing structure [9]. In our conditions, the object of research is-dams of tailings dumps of AMMC processing plants, which, the purpose of the work is to determine the stable parameters of the lower slope for cases of its flatter laying (m>5). The collapse of the lower slope along a flatter profile allows to increase the height of the dam with the same stability as the slope m=5 [5,6]. Profile parameters (fig.1).

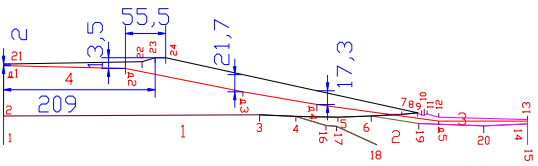

Fig. 1. Bottom slope diagram (data from Hydroproject 2014) the numbers of contour points of layer fracture and levels of depression

The height of the embankment is 75 m.

Average laying of the bottom slope: m=5 when building up to the level of 510 m. The position of the depression curve is assigned theoretically- based on the results of analysis of actually obtained full-scale curves.

Checking the stability of the initial slope (m=5, H=75 m)

Method. The calculation of slope stability is done according to the program [9] that implements calculations of the stability of a soil slope based on the seismic forces according to Building regulations 2-A. 12-62 and using the 3 discretization methods the shear: G.Cray (the method is precise and recommended interdepartmental Commission of state construction committee), *K*.Tertsagi (for slopes with m>2.5 leads to an underestimation of k_{min} (stability coefficient k_{min} - minimum value), Chugayev *R*. according to Building regulations [8] a criterion for the stability of the dam is the value of the stability ratio, defined by expression

$$k_s = \frac{R}{F} \geq \frac{\gamma_n \gamma_{fc}}{\gamma_c}.$$

where R - is the calculated value of the generalized *load-bearing capacity* of the "structure-base" system; F - is the calculated value of the generalized *force effect*; (γ_c,γ_n,γ_{fc}) - reliability coefficients, respectively, for: *calculation* method, *class* of construction, *combination* of loads, defined in the same place: γ_n=1.25(1st class of construction), γ_{fc}=1.0(main combination of loads) , γ_{fc}=0.9(special combination of loads) , γ_c=0.95 (simplified method).

Therefore, the *standard value* of the stability coefficient for the main and special combination of loads, respectively, is determined from

$$\frac{\gamma_n \gamma_{fc}}{\gamma_c} = \frac{1.25 \cdot 1.0}{0.95} = 1.316. \quad \frac{\gamma_n \gamma_{fc}}{\gamma_c} = \frac{1.25 \cdot 0.9}{0.95} = 1.184.$$

Building dependencies of the maximum slope parameters on m.

The parameter dependencies on m are shown in summary table 2.

Table 2

Parameters limit (for K.Tertsagi) slope

m	α °	H , m	*L* , m	*R* , m	*X* 0, m	*Y* 0, m
5	1 1.31	7 2	3 60	3 26	4 55	3 89
5 .25	1 0.78	8 2	4 31	3 60	4 95	4 18
5 .5	1 0.30	9 3.5	5 14	4 50	5 46	4 99
5 .75	9 .87	1 08.5	6 24	5 52	6 11	5 95
6	9 .46	1 28.0	7 68	6 68	6 99	7 00

In figure 3 a graph of the H(m) dependence is shown , which can be used to pre- select the maximum slope height.

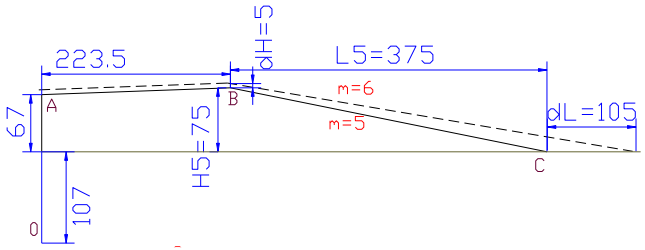

Fig. 2. Bottom slope diagram

Conclusions

The value of the maximum height of the dam 75 m when laying the slope 5 raises doubts about the stability control method to Tertsagi. We received 72 m in this case. - For slopes with *m*>5, the maximum height increases in comparison with *m*=5, but keep in mind the corresponding growth of the slope extension. From table. 2 it can be seen that *L* increases by more than 2 times. - The actual

value of *m* should be determined most carefully the Difference in slope steepness for extreme cases does not exceed

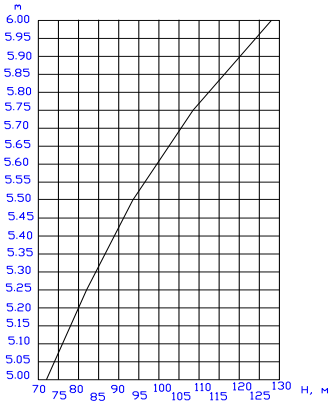

Fig. 3. The graph of the H(m) dependence

2 - The conditionality of the strength characteristics of the Foundation and dam soils is largely preserved to this day.

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STUDY WATER DESORPTION BY DIFFERENT CARBONATION DEGREE COALS

Nuclear magnetic resonance method (NMR) was used for investigation of fossil coals humidity dependence from metamorphism stage of coal seams, that located on the same horizons. Samples were taken from horizon h=975 m in mine named by A.I. Gayevy from six seams (Table 1). Samples had differed humidity and belonged to three stages of coalification: Zh (seam $m^{1/5}$), K (seams l'_8, $k^{2/5}$, $k^{1/5}$), OS (seams k_3, k_2). Spin-echo spectrometer [1] was used to record spectra of experimental samples, which was milled to fraction of 2...2.5 mm, for determination of spin-spin T_2 and spin-lattice T_1 relaxation time.

For approximation of spin-echo signal amplitude relaxation spectrum was used one-component approximation. Obtained values of relaxation times make it possible to calculate values of T_1 and T_2, which characterize state of fluid, that contained in pore space and sorbed on coal substance surface and in solid volume [2].

For understanding regularities observed on NMR spectrometer for samples with wide range of humidity, same coals samples were saturated with water steam for a long time up to humidity value of 2%. To calculate activation energy of water desorption process E_a and effective diffusion coefficient D_{eff} in moisture-saturated samples, they were dried at three temperatures. D_{eff} values defined by formula

$D_{eff}=r^2tg\alpha$, where r is average particle radius in fraction and α is kinetic curve slope of desorption process [3]. During calculating E_a was assumed that Arrhenius dependence of D_{eff} from temperature was fulfilled.

Table 1

The experimental samples and results

№ of sample	1	2	3	4	5	6
Coal rank	Zh	K	K	K	OS	OS
Seam	$m^{1/5}$	l'_8	$k^{2/5}$	$k^{1/5}$	k_3	k_2
Humidity, %	0.62	0.72	0.49	0.80	0.74	0.63
E_a, kDj/mol	5.07	29.1	20.2	19.0	19.1	23.4
D_{eff}, 10^{10} m^2/s:						
60 ºC	2.44	2.51	4.71	1.66	2.58	2.24
80 ºC	2.71	4.55	7.12	3.10	3.81	3.33
105 ºC	3.04	8.77	11.22	4.75	4.62	5.17

For extreme values of humidity and diffusion coefficients of samples 3 and 4 was observed inverse correlation. It means that at higher humidity, diffusion parameters take minimum values for one type coal (coal rank K). Diffusion coefficients differ in 2...3 times, although activation energies are close to each other for these samples. Feature of these seams is that the $k^{2/5}$ seam is classified as "threatened", and the $k^{1/5}$ seam – as "outburst hazardous".

Proposed method for studying moisture-containing coal samples makes possible to characterize connection degree of fluid molecules with surface active centers in coal samples pore space. Value of spin-spin relaxation time T_2 obtained from NMR spectrum is weighted average of $T_{2,c}$ and $T_{2,f}$, where first value characterizes hydrogen-containing component of coal solid matrix in dried sample, second refers to fluid. Then $T_2=(1-f)T_{2,c}+fT_{2,f}$, where f - is mass fraction of hydrogen nuclei, that is part of fluid. Taking into account that carbon content in coal for this stage of metamorphism $T_{2,f}$ can be calculated from equality $T_{2,f}=f^{-1}[T_2-(1-f)T_{2,c}]$ [3].

In addition, as a result of drying in measuring process of spin-lattice relaxation T_1 it`s possible to obtain dependence suitable for moisture content determination in mined coal sample.

So, during this study were obtained NMR data dependences on moisture content of coals, that characterize changes in porous structure of coals depending on metamorphism stage and outburst properties of coal seams, which located on same horizon.

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ASH AS AN ALTERNATIVE RESOURCE OF RAW MATERIALS

The technique refers to the ways of enrichment of dispersed materials having electrical properties. It can be used for enrichment of clayed carbon-containing materials that have undergone heat treatment, for example, ash from thermal power plants.

The technique ensures obtaining a carbon-containing fraction with a carbon content of up to 50% and high-ash waste with ash content of 98%.

The purpose can be reached in the following way: the fuel combustion is performed at a temperature of 900-1800 °C at a fuel flow rate, the corresponding excess air coefficient of 1-2, and a voltage of 20-30 kV in the first field of high-resistivity electrostatic precipitators, while the ash enrichment occurs directly in the electrostatic precipitator.

Ash component of the ash is captured in the first field of high-resistivity electrostatic precipitators, while carbon-containing particles slip through this area and are caught in the second field, or directly in front of the smoke exhauster. At the same time, the highest possible voltage (close to the breakdown) is being maintained in the second field of the high-resistivity electrostatic precipitators. The temperature of the dust-air mixture is above 100 °C.

The variations of the excess air ratio during heat treatment and the voltage on the electrodes forming corona in the process of separation have shown an unexpected result, namely, a product containing up to 78% of carbon is collected in the second field and after the electrostatic precipitators. The separation efficiency is enhanced, firstly, due to the reduction of adhesion properties of the system at a temperature above the dew point; secondly, as a result of the individual movement of particles in the dust-loaded air stream under the action of the electric field, in contrast to conventional ball electrostatic separation in the electronic drum separator.

When the temperature of the dust-air mixture is below the dew point, the electrical resistance of the system dramatically decreases due to the condensation of water vapor, which leads to a deterioration of the product separation and capture.

The product has beneficial properties and can be used as a substitute for low-sulfur fuel in metallurgical processes, as a heat insulating filler, low-cost sorbent, etc.

The collection electrodes in the first field of the high-resistivity electrostatic precipitator collect a product which is an aluminosilicate fraction with an ash content of up to 98%. The fraction is a dry loose mass, which does not require additional preparation for use in construction, in the preparation of various suspensions, etc.

The separation properties of the high-resistivity electrostatic precipitator with a relatively weak electric field are based on the fact that particles with different resistivity are captured with different efficiency. Fly ash particles about 50 μm in size with a resistivity greater than 10^2 ohm·m are captured effectively, while unburned coal with the particle size of about 120 μm and a resistivity of less than 10^2 ohm·m easily lose the negative charge as they arrive at the collecting electrode. As a consequence, they acquire a positive

charge and are repulsed by the collection electrode, re-entrained in the gas stream and carried out of the high-resistivity electrostatic precipitator.

There is an assumption that coal ash particles of an irregular shape may give off their charge, even without touching the electrode, as a result of a corona discharge that occurs between a grounded electrode and negatively charged particles.

In the second field of the high-resistivity electrostatic precipitators operating with relatively high voltage (close to a breakdown), coal particles show less tendency to be repulsed from the collecting electrode due to the electric field strength.

More than 50% of coal particles pass through the second field and settle on the collection electrode of this field. After leaving the high-resistivity electrostatic precipitator, the uncaptured carbon particles are trapped by well- known methods, e.g. air cyclones, sleeve filters or other devices installed in front of the smoke exhaust.

A decrease in the excess air coefficient, and consequently, in the velocity of the gas stream, is accompanied by underburn in the boiler, which leads to an increase in the amount of carbon-containing particles in the stream. In case of low coal combustion, it is possible to obtain products with the value exceeding the value of unburned coal taking into account the cost of its handling and processing.

The carbon content of the enriched product was obtained with an excess air coefficient α=1-2. At higher values, the effect of enrichment is sharply reduced and heat losess increase. With a reduced excess air coefficient (less than 1.0), the percentage of underburn can exceed 80%, which makes the process economically disadvantageous. In addition, the abrasive wear of metal surfaces rises. When excess air coefficient is raised (α=2), the concentration of carbon in the enriched carbonaceous product decreases dramatically, which is also ineffective. The tables show that the quality of the resulting products is determined by the excess air coefficient and the voltage applied to the electrodes. Voltage below 0.95 of breakdown results in a decrease in carbon content of the enriched product. Thus, the composition (% of the component content in the finished product) can be adjusted and set by varying the excess air coefficient and voltage applied to the electrodes.

The proposed method of electric enrichment of a clayed carbon-containing product will provide the production of desired aluminosilicate and carbon-containing raw materials. The aluminosilicate product may be used as a main component in the manufacture of wall products and in the brick industry, and as an additive to various mixtures. The carbonaceous product may be used as a low-cost sorbent and a substitute for low-sulfur fuel in metallurgical processes, as a heat-insulating additive and for other purposes.

An ash processing technique and a plant operating in conjugation with TPP will allow obtaining products of specified quality irrespective of the conditions of coal combustion at the TPP. This, on the one hand, excludes building new ash dumps at the TPP, and on the other hand, allows the production of sorbents of oil products and heavy metals, heat-insulating coatings for steel casting, low-sulfur reductants, fuels, and raw materials for building materials.

UDC 622

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UTILIZATION OF MINE WASTE TO PRODUCE SUSTAINABLE HOUSING BRICKS FOR ARTISANAL MINERS AND THE SURROUNDING COMMUNITIES - A CASE STUDY OF MKUKI, TAITA TAVETA COUNTY, KENYA

Artisanal mining in Kenya contributes 60% of the gemstone mining revenue. In spite of this, the poverty levels among the artisanal miners remain high and the housing conditions dilapidated. More often than not, poor housing leads to poor health.

While the gemstone industry contributes largely to the jewelry industry it poses a threat to the natural eco systems. The artisanal miners leave large heaps of rock and overburden on the land that is also the home of various wild animals. The artisanal miners also incur huge costs in moving the overburden from one area to another. Living in poor conditions is characteristic of these artisanal miners.

This study sought to utilize mine waste-overburden, rocks (which contain limestone) and mine water to make sustainable bricks. Provide solutions to better housing and added economical channels for the artisanal miners and the surrounding communities. The surrounding communities usually make bricks for construction using soil dug out of the ground. This leads to further environmental degradation.

The bricks provided better housing resulting in better health, and reduced the effects of mining on the environment. When sold to the surrounding communities, the bricks provided additional sources of income. This improved the overall social, economic and health status of the area.

Key Words: Over burden, Mine Waste, Gem Stones, Artisanal Miners, Communities, Sustainable Mining.

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ZEOLITE-SMECTITE TUFFES AS A MINERAL MULTIPURPOSE RAW MATERIAL

Numerous studies by geologists of the Rivne expedition have established significant deposits of tuffs in the region. According to their forecasts, the resources of tuff raw materials in the Rivne region alone are hundreds of millions of tons and are practically inexhaustible [1].

The greatest interest in these studies are tuffs, located along the southwestern border of this distribution, where they lie shallow from the earth's surface and are available for opencast mining. Over a large area, they are converted by hydrochemical processes into zeolite-smectite tuffs, which have found widespread industrial use.

It was established [2] that the tuffs of Rivne region are the products of a volcanic eruption of basaltic magma, about 600 million

years ago. They are composed of volcanic ash and sand, cemented and subsequently recrystallized under the action of hot groundwater. Therefore, tuffs in some places have completely turned into zeolite-smectite rocks, which contain a significant amount of useful components and trace elements (iron, copper, titanium, cobalt, etc.) [3]. Stocks of tuff raw materials within the basalt quarries of Rivne region with a total area of 86 hectares with a deepening of 10 m are estimated to reach 20 million tons.

The main areas of use of tuffs include:

- agriculture - as a mineral fertilizer, seed preservation, feed additives for animals and birds, plant nutrition stabilizer;
- environmental - reclamation of radioactive contamination of soils, underground burial of toxic substances, wastewater treatment;
- construction - production of building materials (bricks, tiles, ceramic tiles), production of cement and expanded clay, pigment for paints and colored concrete.

Despite this list of valuable properties of zeolite-smectite tuffs, their availability, the presence of high content of valuable trace elements such as copper, iron, titanium, manganese, there are currently no developments for the extraction of these components in industrial conditions. Their use as such will significantly increase the potential of the raw material base for industry, but to address this issue requires research on the geotechnical features of tuffs, in particular, the peculiarities of their ore preparation, enrichment in the integrated use of raw materials in waste-free technologies.

Today the two most characteristic technologies of tuff extraction are considered. The first of these is the use of downhole hydraulic production (DHP) for the erosion of tuff in places and their transformation into a hydraulic mixture in the form of pulp, which rises to the surface and stored for dehydration. The second technology is simple, as it consists in the processing of dump tuff during quarry mining of basalts. Layers of tuff in this case are either under the overburden or in the underlying rocks and, as a rule, are not mixed with basalt, and shipped to the dumps. During the operation of quarries, such dumps have millions of reserves of valuable tuff raw materials, which over the years of storage have

been exposed to moisture and temperature, as a result of which they have become weak and do not require multi-stage crushing and grinding schemes. The availability of this raw material and the rich component composition indicate that the method of processing dump tuff is the most acceptable. Examination of the state of tuff formation to the surface not only in the area of existing basalt quarries indicates the possibility of open development of tuff deposits.

Thus, the reserves of tuff raw materials in the Rivne region allow for their long-term industrial production. First of all, they are affordable and have ample opportunities to use. The presence of a rich microelement composition allows to conduct research on complex industrial processing of tuffs, a deeper study of their properties and on this basis - to improve the technology of production and expand the scope of use.

Intensive studies of tuff composition over the last decade have shown that its mineral composition requires a comprehensive approach to processing, as it is a source of valuable raw materials for industry. The presence of native copper, titanium, iron in quantities of industrial interest, requires improvement of mining and processing technology.

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DEVELOPMENT ISSUES ON THE MINING MACHINERY MAINTENANCE PLANNING AND ITS MANAGEMENT

In Mongolia, mining extractive and processing industries are a leading business sector of social and economy field and making up enormous foreign and domestic investments. Therefore, mine industries main purpose is to increase the production and profit and to decrease the losses based on related study.

The economic benefits of any mining industry were depended by optimal management of operation and properly decision making related to technological issues. One of them and too important issue is to provide efficient and constant operation service for mining operating machineries with the lowest possible cost.

Since, our countries foreign trades and markets and the mining industry investment have been expanded well, the mining industry has been using many different types of machineries with different powers. However, we are still in urgent need of complex policy to provide constant and efficient operational running for these machineries.

The downtime of mining machineries are mostly caused by the repair time and waiting time on machinery parts. Mining machineries get repaired mostly after the break down, or as it is instructed by the manufacturers. The operating expenses for these machineries cost from thousands of currencies to millions.

The studies related to selection, exploitation, operation and maintenance mining machineries are mostly based on its' usage statistics. These studies, based on statistical data bases have some insufficiency because of were not assess to the mining and technical condition of machineries, technologies and mining operation. As the technic technologies and mining machineries evolve all around the world day by day, it is required particular repair and maintenance planning and management that suites for each individual machine. Now and in the future, it is one of the most important issues we are facing. Therefore, to provide constant and efficient running and machinery repair servicing benefits with the lowest cost, we need

system dynamic modelling for repair planning considering the technical and technology condition, mining operation.

To solve the above issues, causal loop diagram and stock flow diagram was developed by calculating the technical and technology condition, mining operation, each machines life time, technical support and repairing plan.

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GEOMECHANICAL DIAGNOSTICS – THE BASIS FOR RATIONAL AND SAFE ENVIRONMENTAL MANAGEMENT

The problem of ensuring the safety of mines and ore quarry mines is determined by the following reasons. First, the transition of mining to great depths is characteristic of coal, ore and non-metallic deposits. The complexity of the tasks that arise in this case cannot be overestimated. These are local and global collapses of roof rocks and blockages of workings, rock bumps, coal and gas emissions, dust and gas explosions, which not only significantly reduces the economic performance of enterprises, but also affects personnel injuries, including fatalities. Secondly, the coal mine and the ore quarry mine are distinguished from other industries by the fact that jobs are constantly changing in time and space, while the extremely complex

mining and geological conditions of mining significantly complicate the reorganization of technological processes. The stability of surface and underground structures is determined by their operating time. That is, it is possible to solve the problem only by introducing methods and means of effective monitoring of their condition for the timely implementation of preventive measures and repair work.

Geomechanical monitoring includes methods of mining geophysics (ultrasonic, seismic, shock wave, seismoacoustic, electrometric, radio wave), as well as methods of mechanical and radiometric control. They make it possible to quickly assess the physical and mechanical properties of rocks, the parameters of anomalous zones (inelastic deformations, support and hydrostatic rock pressure), to identify rock mass inhomogeneities (karsts, tectonic faults, zones of moisture, increased fracturing, interfaces of rocks with different physical properties). Taken together, these scientific and applied developments constitute the necessary technological base to ensure geomechanical safety, which is determined both by the natural properties of productive strata and by the influence of technogenic factors. The devices and equipment were brought up to prototypes, manufactured in one-off batches and partially put into serial production. The technological and methodological base of the proposed monitoring is regulated by industry regulations.

For a long time, there was a belief that around geomechanical structures, mine workings, wells and boreholes, only zones of fracturing, bearing pressure and geodynamic zones are formed, which are superimposed by the influence of tectonic and technogenic dynamic influences. The existing model representation of the geomechanics of physical processes occurring around mine workings, without taking into account synergetic effects, does not reflect the features of the behavior of the massif weakened by the workings, and the control of such objects becomes difficult and requires prompt processing of a large volume of measurement results. It is proposed to apply a real model of the rock mass taking into account its destruction, to determine the orientation of the main crack systems based on taking into account the layering of the rock mass and natural structural defects, to establish the beginning of the rock mass destruction by the forces of rock pressure and to estimate

the decrease in the strength of the destroyed rocks. For an express assessment of the state of the destroyed rock mass or the moisture saturation of the backfill of the goaf, it is rational to use electrometric control. These studies can be both additional to modeling and an independent control element to determine the destruction zone and the volume of water accumulation.

With increasing depth and increasing stresses, the regular structures of rock and soil massifs change over time and become more and more complex. The criterion for the transition from a regular, complexly organized structure to chaos is its stability in relation to small excitations. A decrease in the stability of structures leads to the need to move from their deterministic description to a probabilistic one, taking into account the effects of self-organization of the rock mass. An important role in changing the properties and state of the investigated elements is played by the technological features of the workings, namely: methods and means of penetration; type and model of attachment, cyclicity and repeatability of elements; mining and geological conditions and physical and mechanical properties of rocks, tectonics, hydrogeology and gas content. Peculiarities of mathematical modeling in complex mixed deterministic-chaotic systems, including parameters, criteria and admissible errors of iterations are determined. The practical significance of modeling in this case is that it allows to take into account the number of elements in the system, specific masses and elastic connections between elements, the diversity of these connections, to set virtually any exciting effects, to assess the response to these effects when modeling dynamic processes in geotechnical and geomechanical systems. The parameters of the chaos generator for full-scale modeling of chaotic influences are substantiated. The author's program of the Lorentz generator with parametric coefficients for the microcontroller is developed and tested. A simplified computational scheme for determining the harmonic composition of acoustic and electrical signals by the method of twenty-four ordinates has been developed, which allows to ensure signal processing in real time with sufficient accuracy.

The Institute of Geotechnical Mechanics of the National Academy of Sciences of Ukraine has created the necessary foundations for the transition of coal mines and ore quarry mines to a qualitatively new level of field development with high safety and

efficiency. The geography of the development implementation covers the coal mines of Donbass, the Lvov-Volyn basin, potash and gypsum mines, the mines of Kryvbas and the Zaporizhzhya iron ore plant. Separate monitoring elements were used in diagnostics of tunnels for various purposes: railway tunnel Lotsmanskyi, metro tunnels (Dnipro city), Dnipro-Donbass and Dnipro-Ingulets canals, Nikopol drainage system (Dnipropetrovsk region). Comprehensive control was carried out with the proven methods of mine geophysics and repair of dams of the Dnieper hydroelectric power station, Krasnopavlovsk and Karabutov reservoirs, the docks of pumping stations of the Dnieper-Donbass canals, the Transcarpathian flood and Kakhovka irrigation systems, culverts.

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DRY SEPARATION TECHNIQUE OF COAL IN MONGOLIAN PLAINS AND DESERTS

Abstract

The optimum technique for coal separation in regions with limited water resources is dry separation technique, which is much more cost effective in both initial set up and operation in comparison to water-based separation techniques. Coal is can be found evenly throughout Mongolia. Brown coal (lignite) is found commonly in eastern Mongolia regions and bituminous coal is common in the southern, central, and western regions of Mongolia. Most of Mongolia's coal, 62% of the total coal in Mongolia is in the plain and desert ecosystems. The average yearly rainfall in these areas is less than 150 mm. Not only fresh water source is rare, but the water source for mining purposes is nearly absent. Surface water is extremely rare and moisture level in the soil in these regions is minimal which makes the environmental recovery process much longer and has the danger to pollute underground water. Because the Hoshoot and Hurengol coal mines In western Mongolia are faced water shortage and the coal was formed in layers of rocks, their coal content is ashy. The coal content in southern Mongolia near Tavan

Tolgoi coal mine is rich, but still has extremely limited water resources. They prefer dry separation technique in this region. This technique is economically beneficial since it is environmentally friendly, waterless, and does not require wide range of infrastructure. It cuts down the need of transportation of water and water recycling facility. Dry separation process can be done in the cold weather. There are many different dry separation techniques in used in mines. It is important to determine the optimum technique for the given coal type.

When using the dry separation technique, the physical characteristics and components of the coal is important. When dry separating larger pieces of coal, the movement of speed on concentrating table and in meandering movement. The medium size coal pieces are separated by weight through vibration and air dense process. Small size coal pieces are separated by airflow separation process efficiently. Dynamic comprehensive characters are used separate coal rather than individual characters like particle size, weight, and density. It is characterized by the velocity in air. The characteristics are defined by the difference in velocity in air. The greater the difference, the greater the efficiency. The lesser the difference, the less separation. Additional physical-mechanical characteristics like density, flexibility, and fractions are used to increase the efficiency of coal separation. Separation technique is set by the methods of increasing the unique characteristics. Dry coal separation method must be highly efficient and capable of producing multiple grade products, adjusting the product type without changing overall process (ash content), low cost, and outdoor production.

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RISKS WHEN DRIVING MINING WORKS

The mining industries of Ukraine is the main sectors of the Ukrainian economy and are characterized by difficult mining conditions and complex technological processes. The risks associated with mining are huge losses.

The analysis of risk factors that have a significant impact on the pace of development workings, made it possible to establish the main ones. The main risks are an increase in rock pressure, gas content and complication of mining and geological conditions of development in general. The study of the seam development conditions showed that the factors that make the maximum contribution to the increase in risk are the following: low-amplitude disturbances, accidents and breakdowns of equipment, hydrogeological, temperature and sanitary conditions, ventilation level, Among the main strategic risks is the problem of lack of qualified personnel.

In Ukraine in steep-grade coal and ore mines sinking the raise working is a costly and laborious process

The rising carried out are the drilling - and - blasting that is characterized by a high level of labor intensity and injury rate. The length of the rising workings is determined by the height of the storey and the angle of inclination of the coal seam or ore body. With

an increase in the length of the working, productivity and the rate of advance decrease. The raise workings in the rock mass pass through rocks with hardness from f=3-6 to 16-18 on the scale of M.M. Protodyakonov. The raise advance is characterized by a low level of safety, high labor intensity of all technological operations, low monthly rates of advance, unsatisfactory sanitary and hygienic working conditions, significant labor costs, the need for frequent repair of a communications.

A promising method is to carry out rising workings in one blasting operation by breaking borehole charges into a non-chargeable borehole of increased diameter (compensation cavity), which was developed at the Institute of Geotechnical Mechanics named by N. Poljakov of National Academy of Science of Ukraine [1].

The technology of rising workings by blasting borehole charges onto the compensation cavity is that a set of boreholes with a diameter of 105 mm is drilled to the charging depth, and the central borehole is expanded with a plasmatron to the entire height of the rising one up to a diameter of 500-600 mm.

The rising workings are formed by breaking and crushing the iron ore mass by successive blasting of borehole charges into the compensation cavity [2].

With this method, the main parameters of drilling operations are: volume and location of the compensation cavity; the number of holes in the set and their diameter; lay-out diagram hole and distance between them; charge design; blasting sequence and deceleration intervals.

In magnetite quartzites with a hardness of f=15-20 on the scale of M.M. Protodyakonov was worked out the technology of sinking 4 rising workings in one explosion. The experience of thermal expansion of the holes of a plasma installation is described in the article [3].

The essence of the process consists in the combined technology of creating compensation cavity for the entire height of the rising and consists in the fact that a set of holes with a diameter of 105-110 mm is drilled by a mechanical machine along the route of the rising, and the central hole is used in the capacity of compensation cavity,

which expands plasma heat generator with a capacity of 150-200 kW of a given shape (ellipsoidal or cylindrical) up to a diameter of 500-600 mm for the entire height of the rising.

The modernization of the material and technical base of the mining industries should be carried out through the introduction of new technologies for the extraction of coal and ore.

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DETERMINATION OF THE RELATIONSHIP BETWEEN PHYSICAL PROPERTIES AND SWELLING OF NEOGENE CLAYS

The Quarternary period has left a significant legacy for ground engineering and construction projects with a complexity of ground conditions which interpretation and understanding are crucial for the success of any such schemes. The relict Quaternary environment presents the engineering geologist and geomorphologist with a terrain that is inherently complex with a superimposition of

processes that have led to a lateral and vertical variability of ground and groundwater conditions [1].

Special attention should be payed on specific soils (collapsing and swelling soil) during the geotechnical survey, because subfoundation should be designed according their features. The main specificity of swelling and collapsing soils is a significant decrease of their bearing strength after getting wet [2]. Clays are usually subjected to volume strain as a result of swelling. Measuring clay swelling properties is time consuming and requires special expensive equipment. Considering foresaid, the purpose of this work is attempt to identify the relationship between the physical characteristics of clays and their relative swelling.

The initial data represent a complex of physical properties and relative swelling characteristics (ε_{sw}) of clays. The materials were obtained as a result of geotechnical surveys at future construction sites.

Sites is orographically part of the Kazakh shallow hills and is located within the Tengiz-Balkhash watershed. In general, the landscape of the site is a wavy plain, complicated by a hillocky area [3]. Geographically, all sites under study are located within Karaganda area (Central Kazakhstan). Stratigraphically, the clays belong to the Neogene period.

The Neogene sediments strata occurs throughout the entire territory of the Central Kazakhstan hillocky area and has been studied rather poorly. Green, greenish-gray montmorillonite clays with manganese "buckshot" are widespreaded, partially with gypsum and lenses of marl, which belong to the Aral Formation of the Lower-Middle Miocene age. In the lower part of the set, you can find layers of coarse-grained sand and enrichment of clays with iron oxides, which gives them a spotty color in some areas. Recent deposits, represented by red, reddish-brown clays, are allocated to the Pavlodar Formation. The entire clay set is characterized by rare inclusions of gypsum druses and a large number of nodules and lenses of a marly composition. In some areas, the clays are sandy and contain small fragments of bedrock [4].

During the research water content (W), liquid limit (W_L), plastic limit (W_P), plasticity index (I_P), liquidity index (I_L), soil density (p), dry soil density (p_{cyx}), void ratio (e), degree of saturation (S_r), relative

swelling (ε_{sw}) were obtained for 102 clay samples. All of the above indicators were included in the correlation analysis to isolate the most capacious and effective characteristics of physical properties from the entire dataset, correlating with the relative swelling of the clay.

As a result of processing, coefficients were obtained for each pair of indicators. After correlation analysis to predict the relative swelling by the method of multiple linear regression, the following properties of clays were selected: water content, plasticity index, fluidity index, dry soil density.

To test the regression equation signification, F-test was counted. The regression equation is statically significant, since the observed value of F_{exp} (6.64) > F_{crit} (2.00). The critical value was determined at a significance level $\alpha = 0.10$ and the number of freedom degrees $k_1 = m = 4$, $k_2 = n\text{-}m\text{-}1 = 97$ (where *n* is the number of observations, *m* is the number of factors).

Comparing the absolute values of the observed t-statistics with the critical t_{crit} (1.66), we can conclude that according to the Student's T-test, parameters intercept and water content are statistically insignificant and therefore removed from the equation. The rest of the selected clay properties (I_P, I_L, p_{dry}) are statistically significant. In this paper, all hypotheses and conclusions are presented using a 10% significance level.

This means that the possibility of error in accepting various statistical hypotheses and drawing conclusions based on statistical analysis is 10% [5].

The regression equation has the following form $\varepsilon_{sw} = 0.54I_P - 11.39I_L + 40.11p_{dry}$. The coefficient of multiple correlation is 0.46, coefficient of determination is 0.22.

As a result of the research, the following was done:

- a geomorphological and geological description of the area are given;

- a statistical analysis of the Neogene clays dataset was carried out to identify the relationship between physical properties and swelling of Neogene clays.

Using of statistical analysis methods on the example of soils (clays) in Karaganda area help to assess the possibility of creating a regional mathematical model of Neogene clay properties, appliance of which will reduce the cost of laboratory research.

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INNOVATIVE TECHNOLOGY OF EXPLORATION OF OIL AND GAS DEPOSITS IN AZOV-BLACK SEA REGION OF UKRAINE

The primary hydrocarbon deposits – Odessa, Bezymyannoye, Subbotin, and others- are confined to the Black and Azov Seas' shelf

structures. They amount to more than 346 million tons of oil equivalent and are being exploited in shallow waters of the Black and Azov Seas. According to the geological structure analysis, significant prospects are associated with the local structures of the continental slope and the deep-water part of the Western and Eastern Black Sea depressions.

The construction of deep-water wells to explore and produce hydrocarbons in these zones is twice as capital-intensive as shelf operations and therefore requires new methodological and methodological approaches.

For this purpose, we tested the latest low-cost geological-structural-atmo-geochemical technology (STAGS) during fieldwork. The technology is based on a complex of tectonic, morphological, geodynamic, paleo-sedimentary, bio-litho-seismo-stratigraphic, thermometric, and gas-geochemical methods.

The technology involves a complex of field and laboratory studies according to the following scheme: geo-structural, neotectonic studies, decoding of aerial and space photographs, the geological structure of the corresponding productive horizons, including the creation of stratigraphic sections based on the complex of litho-bio-seismic-stratigraphic methods, thermometric and gas-emission studies (Rn, free hydrocarbons), processing of experimental data and creation of various cartographic materials.

The analysis of the geological structure of the deposits discovered in the Mesocaenozoic sediments of the Carpathian-Crimea-Azov-Black Sea segments of Tethys has proved that a significant number of them are associated with erosion wedge-shaped olisthostrome formations confined to paleo-river systems. The most significant deposits are associated with fracture zones and marginal parts of the deep-water discharge cones that comprise the continental slope's transition zone – the deep-water depression. The canyons of the PaleoDunai, PaleoDnestr, PaleoDnieper, PaleoKalanchak are associated with the faults. They dissect the whole surface of the slope from the upper edge to its foot. On the longitudinal profiles of the canyons, one can see the stepwise structure, which reflects geological events in the region, particularly the reorganization of structural-tectonic, morphological and geodynamic plans in the corresponding geological epochs. The eroded rock complexes

constitute significant areas of thickness and volume at the foot of the corresponding ledges.

In the East Black Sea depression, a large oil field under exploitation (Subbotin structure) is linked to the paleo-Kuban river system. On the structure of Sibbotin, the calculation of the forecast oil and gas perspective contours was made by STAGS before the drilling work. The allocated oil and gas prospect was confirmed by drilling of well Subbotin-403. Bio-litho-seismo-stratigraphic, structural and tectonic studies performed by us made it possible to create a Subbotin structure model to identify productive stratoform forecast horizons to clarify the geological structure of the Kerch Shelf of the East-Black Sea Depression.

According to STAGS technology, the hydrocarbon resources of the northwestern shelf of the continental slope and deep-water trough of the West Black Sea Depression (British and Sklonnaya) are reasonably promising. The prospect of oil and gas-bearing capacity of the Subbotin structure based on stratigraphic criteria is associated with deposits of Lower and Upper Cretaceous, Paleocene, Eocene, Oligocene (Maikop Oligocene-Lower Miocene Formation Complex), and Neogene. The developed models contribute to cheaper gas production on the shelf.

Only the Eocene, Oligocene (Maikop), and Neogene production complexes were explored by drilling into the Subbotin structure. The main productive complex of the Southern oil and gas province, the Paleocene, was not explored.

In structures where deep drilling is not available, STAGS is the only straightforward technology to verify the oil and gas potential. Our work confirms this at three sites on the Kerch shelf and the East Black Sea basin's continental slope.

Based on the STAGS results, several promising areas were identified, and the prospects for their gas and oil-bearing capacity were determined. Interpretation of seismic survey results made it possible to identify promising contours within local structures with high reliability even in the absence of a dense observation network. It has confirmed the expediency of STAGS application at the early stages of hydrocarbon exploration to increase the reliability of local,

polygonal surveys in the Carpathian-Black Sea segment of Tethys, where similar fields are being developed – in Ukrainian Carpathians and Romania.

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METHODS OF INCREASING HYDROCARBONS AT THE FINAL STAGE OF FIELD DEVELOPMENT

The industrial problem of the oil industry is due to the fact that as a result of more intensive development of easily extracted oil fields, the share of hard-to-extract reserves is constantly growing, which requires the use of new methods to increase oil recovery.

Nowadays, dozens of different methods of influencing oil deposits and increasing oil recovery (primary, secondary, tertiary) are known, studied and implemented in industrial practice. Among them there are four main groups [1]:

1 - hydrodynamic methods - cyclic flooding, change of the direction of filtration streams, creation of high pressures of injection, forced withdrawal of liquid, and also methods of influence on a bottomhole zone of a formation;

2 - physico-chemical methods - flooding with the use of active impurities (surfactants - surfactants, polymers, alkalis, sulfuric acid, micellar solutions);

3 - gas methods - water-gas cyclic influence, displacement of oil by high-pressure gas, injection of hydrocarbon dioxide, nitrogen, flue gases;

4 - thermal methods - displacement of oil by heat carriers (hot water, steam), parocyclic treatment of the reservoir, intralayer combustion, use of water as a thermal solvent of oil.

The use of methods to increase oil recovery from deposits is determined by geological and physical conditions. Known methods are characterized by different potential for increasing oil recovery from deposits (from 2 to 35% of balance reserves) and various factors of their application.

Injecting CO2 into the reservoir is one of the most effective ways to increase oil recovery. Carbon dioxide, like hydrocarbon solvents, provides a very high recovery rate and is devoid of their main drawback - high cost. Carbon dioxide or carbon dioxide forms a liquid phase at temperatures below 310 °C. At temperatures above 31 ºC carbon dioxide is in the gaseous state, at a pressure of less than 7.2 MPa - from liquid to vapor.

The principle of application [2] of CO_2 is based on the dependence of the viscosity of liquids in formation conditions on the amount of CO_2 dissolved in them. For example, the dissolution of CO_2 in oil reduces its viscosity by 10-50%. This increases the volume ratio of oil with dissolved gas to 50%.

The increase in the volume of oil contributes to the growth of the volume of pores occupied by oil, creates favorable conditions for its movement. Reducing the viscosity of oil leads to an increase in its mobility. In this regard, to achieve a given coefficient of oil recovery spend less amount of displacing agent.

Due to the solubility of CO2 in reservoir water, the initial viscosity of water increases markedly, as a result of the ratio of oil

and water mobility increases. Carbon dioxide in the system also reduces the surface tension at the oil-water interface. The efficiency of oil displacement by carbon dioxide is determined by both the increase in the coefficient of coverage and the displacement. The increase in the coverage ratio by area and volume is due to the improvement of capillary absorption and equalization of the mobility of water and oil.

The ability of carbon dioxide to dissolve well in oil and water is the most important property, which causes high efficiency of oil displacement using carbon dioxide.

Carbon dioxide is quite soluble in water. However, this process is limited. It is affected by pressure, temperature and degree of mineralization. Thus, with increasing pressure at constant mineralization and temperature, the solubility of carbon dioxide in water increases. With constant mineralization of water and pressure with increasing temperature, the process is ambiguous. At [3] constant pressure and temperature with increasing mineralization, the solubility of CO_2 in water decreases. Depending on the specific conditions, the solubility of carbon dioxide in water can reach 20%.

Thus, with the increase in the content of dissolved CO_2, depending on the composition of oil, pressure, degree of pressure increase and temperature, the viscosity decreases by 2-15 times compared to the initial one with zero carbon dioxide content, and for more viscous oils to a much greater extent than for less viscous.

With increasing pressure at constant initial composition of oil and temperature, its viscosity with dissolved CO_2 takes less and less value. This is due to the increase in the content of dissolved carbon dioxide in the oil.

Thus, carbon dioxide [5] when interacting with oil, water and the porous phase causes a change in the physicochemical properties of the latter.

Carbon dioxide or carbon dioxide forms a liquid phase at temperatures below 31 °C. At temperatures above 31 °C carbon dioxide is in the gaseous state, at a pressure of less than 7.2 MPa - from liquid to vapor.

It is known that it is very difficult to extract residual reserves of oil, especially viscous and saturated with water, and when pumping carbon dioxide, which dissolves well in oil, increases its volume and

reduces viscosity, on the other hand, dissolves in water, increases it in viscosity. Thus, the dissolution of carbon dioxide in oil and water leads to the equalization of the mobility of oil and water, which creates opportunities for higher oil recovery, both by increasing the displacement coefficient and the coverage ratio of the oil deposit.

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SUBSTANTIATION OF PHYSICAL AND MATHEMATICAL MODELS OF BLASTHOLE DRILLING PARAMETERS IN HARD ROCKS DURING URANIUM ORE MINING

Uranium mining currently occupies a significant place in the energy structure of the EU countries, the USA, Japan, and Ukraine. In terms of total uranium reserves, Ukraine is among the top ten countries in the world. Only proven reserves can provide for more than 100 years the need of Ukrainian nuclear power plants in natural uranium. Uranium reserves of the Kirovograd and Nikolaev regions, explored and approved by the State Committee for Reserves.

The relatively low content of uranium in the ore deposits of Ukraine is distinguished by different mining conditions, which determine the quality of the produced uranium concentrate [1]:

- large sizes of uranium deposits, allowing the use of high-performance development systems;

- carrying out mine workings without fastening and creating large-size treatment blocks due to the high strength of ores and surrounding rocks;

- ensuring a normal radiation environment at workplaces without the use of special methods, limited only by sufficient ventilation, due to the low content of uranium in ores;

- the monomineral nature of the ores makes it possible to simplify the processing of ore and obtain high-quality uranium concentrate;

- the deposits are located in a well-developed territory with a developed network of transport routes.

Carrying out mine workings by drilling and blasting on solid rocks (strength factor *f* on the scale of prof. M.M. Protodyakonova = 12-20) is one of the most important components of the technological process. At the same time, the choice of a rational technology that ensures the optimal speed of underground workings is the main condition for achieving high technical and economic indicators of mining intensification.

The most convenient methods for studying the influence of technological parameters of drilling and blasting operations on their efficiency are methods of physical and mathematical modeling.

The analysis of the stress state of the rock mass in the vicinity of a mine working, carried out by the drilling and blasting method, consists in calculating the time-varying stress field during the unloading of the rock mass from the rock pressure and the disturbance imposed on it during the propagation of a compression wave from the explosion of an explosive charge and a tensile wave reflected from the bottomhole surface. The unsteady stress-strain state of the rock mass is solved by a system of equations considering blasting operations in a mine working [2].

The transition of rocks from the stressed to the unloaded state can be estimated by the mathematical description of the process by applying the Coulomb-Mohr strength condition, which takes into account the possibility of fracture occurring both as a result of shear and as a result of separation. The solution of equations on a certain time interval can be obtained using the finite-difference method [3]. Using the proposed mathematical model, it is possible to carry out

calculations for various layouts of blast-hole charges exploded simultaneously or in a specific sequence.

Justification of rational parameters of drilling and blasting operations can be implemented using the method of physical modeling of stresses around the working, in the bottom of it and during its execution. These include the photoelasticity method or the optical-polarization method [4]. The peculiarity of this method lies in the ability of some transparent materials under the influence of the stresses arising in them to temporarily acquire the properties of birefringence of polarized light. To implement this method, in compliance with the geometric and power similarity, models are made with working elements and drilled holes in the face.

The prepared model is installed between the pressure plates of the press and loaded. Polarized light is passed through the loaded model. Passing through the model, which is in a stressed state, the polarized light is decomposed into two beams, the light waves of which are oriented in the planes of action of the two main normal stresses. With the interference of light waves, several stripes appear on the analyzer screen - isochromes, colored in different colors of different intensities. By the color of these stripes, one can judge the stress state of the model, since each isochrome corresponds to a certain level of difference between the maximum and minimum components of the principal stresses.

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SOME FEATURES OF FORMATION OF HEAVY MINERALS PLASER DEPOSITS WITHIN THE MIDDLE DNIEPER REGION

Ukraine has a powerful industrial base of titanium. The major resources of Ukraine's titanium are concentrated in large ilmenite and complex ilmenite-rutile-zircon alluvial and beach-submarine placers [1].

The most important and rich for heavy minerals is Middle Dnieper region, which is contains the Samotkan group of placers. There are two large deposits Malyshivske (Samotkanske) and Motronivsko-Annivske. These objects located in Dnipropetrovsk oblast, in the articulation area of two large platform type structures - Ukrainian Shield (US) and Dniprovsko-Donetsk depression (DDZ) and covers the northern -eastern slope of the shield.

The Archaea age plagiogranites and migmatites are the oldest rocks within the investigated area, which lie at a depth of 50-120 m.

Geologically, it is an ancient buried placer of heavy minerals, which was formed in the shallow sea [3, 4].

The Motronivsko-Annivske placer of titanium-zirconium ores at the time of formation is consistent with the neotectonic activation that occurred at the beginning of the middle Miocene. The field was formed in shallow sea conditions. Before the transgression of the water basin there was a denudation-accumulation plain. In the structure of the historical-dynamic geomorphosystem of this territory, deposit was located in the Lykhiv and Verkhivtsev historical-dynamic basin morphosystems [2]. The border between structures ran along the watershed of the southwestern - northeastern extension and divided this

placer deposit into 2 parts, the main of which was located in the east. Watersheds were declining in some places, and interception of hydraulic systems of neighboring basin morphosystems could occur here. Even before the beginning of transgression, and then with its development, neotectonic uplifts of the vaulted structure of the foundation over which the ore body of deposit is located began. These uplifts had a differentiated block character. The areas of individual blocks are hundreds of m^2 - the first km^2, they form larger groups. In the paleorelief they corresponded to the islands, shoals, raising the bottom of the reservoir. Valleys, valley-like extensions, and isometric forms are dated to the blocks and their groups that lagged behind in the uplifts.

We have analyzed the databases of 1135 exploration drilling wells were created at the Motronivsko-Annivske deposit by the method of interval testing of 18,947 analyzes of mineral composition. Different mineralogical coefficients can be used in the study of neotectonic movements.

We investigated the vertical zonation of the structure for the placer deposit "body» by the yield of the heavy fraction. Consider the features of the accumulation of heavy minerals that have the greatest industrial significance.

It was found that the dynamics of neotectonic movements during activations significantly influenced the processes of morpholitogenesis and oregenesis of placer deposits of Samotkan group. This is confirmed by quantitative indicators (coefficients) of the material composition of placers. They allowed us to study the vertical and horizontal structure of placers, to establish the rhythmic accumulation of productive strata. On different neotectonic blocks the number of rhythms was 1-6 (rhythms). In the sea basin where placer was formed, this caused permanent changes in the conditions of morpholitogenesis and placer oregenesis [2].

The considerate placer deposits are complex. The main minerals of titanium are modified ilmenite, leucoxene, rutile. Except these minerals, the ore layer also contains zircon, staurolite, distene, sillimanite, niobium, tantalum, scandium, vanadium and others [5].

In the world consumption of mineral deposits, complex coastal-marine placers are virtually the single source of whole rutile, more than 95% of zircon, and more than 70% of ilmenite. We have a number of well-explored placer deposits (with demonstrated

reserves) that can satisfy the internal consumption for some ten years. Heavy mineral deposits within the considerate region and Ukraine generally are characterized by high concentrations of ilmenite, rutile, zircon, and other minerals; enough good geographic-economic and mining-technological conditions; and average mineralogical-technological properties of sands (middle clay content and fine-grained structure). We analyzed specific features of the mineral composition of the Ti-Zr placers; the mineral composition and grain size distribution of titanium sands; physical, chemical, and morphostructural properties of heavy minerals; and other parameters. The most important conclusions obtained from the chemical analysis are related to the contents of useful components and detrimental impurities. Contents of the major oxides vary within a relatively narrow range. Results of detailed investigation show that heavy minerals of various placers in Ukraine can be represented by varieties with different physicochemical properties and other specific features.

Thus, the conducted research of features of formation of heavy minerals placer deposits allowed to receive important scientific results, that improving development of placer deposits.

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MODELING OF WEDGE DESTRUCTION OF CYLINDRICAL ROCK SAMPLES

One of the important information characteristics required to control the stress-strain state of the rocks and their effective destruction during disintegration is the ultimate strength and residual strength of the samples, determined from the diagrams "*longitudinal stress - deformation*" of their out-of-limit destruction.

The Coulomb criterion of maximum effective shear stresses on slip lines is used to describe the wedge-shaped fracture of rocks [1].

Upon fracture, a crack forms on the slip area (SA). As the crack develops, some of the material is released from the load. With knowledge, according to the plane deformation model, at each moment the values of the coordinates of the tip of one or two cracks, it is possible to determine the bearing part of the sample material, which is equal to the initial area of the latter minus the part that came out from under the load during the crack propagation along the SA. The part of the specimen released from the load is determined by the values of the abscissa of the crack tip as $x = yctg\alpha$, where y is the ordinate of the *OY* axis, α is the angle of inclination of the SA at the crack tip relative to the abscissa axis x. Knowing the stresses σ_y at the crack tip, its coordinates and the regularities of the distribution function of contact stresses on the bearing part of the specimen, it is possible to develop a model of specimen failure based on the Coulomb criterion and a method for calculating the parameters of the diagrams in the presence of values of four property indicators - shear resistance limit, external (contact) and internal friction, modulus of elasticity.

First, we describe the concept of sample failure (Fig. 1). The sample is subjected to a vertical load and contact shear stresses arising from contact friction, directed against transverse deformation,

into the interior of the specimen. The center of the coordinate axes is located in the upper left corner of the sample.

On the upper plane of the left longitudinal half of the specimen, the contact shear stresses τ_K have a positive sign, and on the bottom, they are negative.

On the right half, the signs have opposite meanings. Note that under the action of a vertical load, the sample acquires a convex shape. Therefore, the shear stress pairing rule is applicable at the corners of the sample.

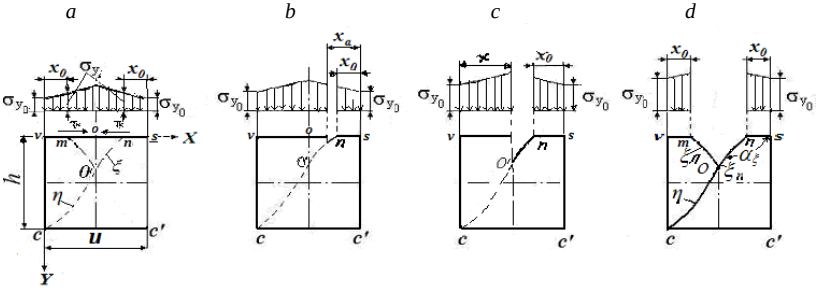

Fig 1. Scheme of wedge formation during compression of a rock sample: *a* - at the moment of pre-destruction; *b* - at the moment of formation of the wedge edge; c - at the moment of formation of the wedge edge; *d* - at the moment of wedge formation

To describe the formation of a wedge-shaped fracture of a cylindrical sample, we use the law of distribution of contact stresses according to L. Prandl.

$$\sigma_{yi} = \sigma_{y_0}\left(1+\frac{2f_c x}{h}\right), \qquad (1)$$

where σ_{y_0} - vertical normal stress at a corner point of the sample, Pa; F_c - contact friction coefficient; x - abscissa of the point under consideration, m; h – sample height, m.

Considering that the area of the circle is equal to $\pi u^2/4$ we write down the strength formula on the transcendental branch of the "*longitudinal stress-strain*" diagram, we write it down finally in the form

$$\sigma_c = \frac{4p}{\pi u^2}\left(\frac{\pi u^2}{4} - \frac{u^2}{4}\left(\arcsin 2\sqrt{ux_\xi - x_\xi{}^2} - 2\left(1 - 2x_\xi\right)\sqrt{ux_\xi - x_\xi{}^2}\right)\right)$$

Further, by the method of iterations on a PC, we determine the parameters of the true and conditional diagrams "*longitudinal stress - deformation*", which researchers receive on presses with a truncated-wedge shape of destruction of cylindrical samples as a function of the transboundary branch.

Conclusions

An important conclusion should be drawn from the analysis of the diagrams: the slope of the out-of-limit curve $\sigma_c = \Psi(\varepsilon)$, the so-called decay modulus *M*, which is taken by researchers as a constant material characteristic, similar to the elastic modulus E, depends on the numerical values of rock properties and is not constant. Rocks are a material of increased fragility. The roundness of the out-of-limit branches of the diagrams reflects the nonlinear relationships of stresses and areas emerging from the load during the crack propagation.

It should be noted that Hooke's law is observed on the load-carrying part of the sample, that is the true diagram looks like a straight line, despite the fact that conditional diagrams have nonlinearities.

To confirm the reliability of the proposed model, the calculated values of the ultimate strength were compared with experimental data borrowed from the inventory. The average convergence was 85.2%.

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MULTIPROFILECOLOGICAL DANGER IN A REGION WITH DEVELOPED EXTRACTING INDUSTRY

Contradictions between the socio-economic sphere and the natural environment give rise to problems of ecological danger, the formation of which is characterized by the presence of industrial production, inefficient use of natural resources, landscape transformation, insufficient level of ecological awareness. These factors have a negative impact on the environment and contribute to the deterioration of public health. It is important to monitor the manifestations of ecological dangers.

The formation, development and manifestations of ecological danger in the Kremenchug industrial region, characterized by specific features of regionalization, spatial structuring of ecological dangers [1]. The main consequences of ecological dangers have been identified: pollution of environmental components with harmful substances contained in waste, problems in artificially created hydrosphere objects, damage to structures and deterioration of public health under the influence of man-made earthquakes (mainly explosions in quarries).

The landfill is a significant factor in the formation of ecological dangers. It is operated for a long time (more than 40 years) with violations of environmental requirements (no waterproofing, no drainage). Groundwater around the landfill is contaminated with heavy metal ions, phenols, petroleum products. The measured [2] concentrations of ions of iron, lead, manganese, oil products, phenol in groundwater exceed the MPC by 4-26 times. As a result, the water in the wells of the surrounding villages does not meet the standards and is not suitable.

The evaporator pond located in the northern part of the region creates an ecological danger, which is manifested in the unsuitability

of the consumption of water from underground horizons for household and drinking purposes.

A significant problem of the region's hydrosphere is the mass development of blue-green algae in the Kremenchug Reservoir. This is evidenced by the intense "blooming" of water in the summer, which is facilitated by a significant amount of nutrients coming from wastewater, as well as the saturation of water with organic matter [3]. Negative consequences - the emergence of hygienically dangerous situations, mass death of fish, problems at water intake and treatment facilities of water supply systems.

We also studied the harmful factors of physical impact - man-made earthquakes. There are a significant number of explosive quarries in the region. The high concentration of man-made earthquake sources and the location of the latter in residential and industrial areas with a developed network of communications and structures, taking into account the geological conditions of the region, significantly enhances the influence of positionality (taking into account not only seismic waves) ecological dangers.

The structure of the system of monitoring of ecological danger states at technogenic earthquakes is offered. Including the following stages:

- identification of sources of man-made earthquakes;
- determination of the degree of manifestations of danger by measuring the speed of displacement of the soil or structural elements of structures;
- analysis of the impact of earthquakes on public health based on the study of data from the objective control of medical institutions and the survey;
- establishing the correlation of experimental data with the results of the population survey and visual observation of damage to structures and structures.

In the Kremenchug industrial region the following consequences of manifestations of technogenic earthquakes are established: formation of cracks and scattering of plaster in residential and industrial buildings. The sources of man-made earthquakes, near which the most dangerous objects are located, have been identified. Damage to their integrity poses a threat to human life and health, as well as can lead to environmental pollution [4].

A fairly high level of ecological danger forms a bridge across the Dnieper River, which is affected by two quarries. Also the object of the increased ecological danger is the dam of the Kremenchug hydroelectric power station that is caused by "neighborhood" of a granite quarry. In addition, on the dam, as on the bridge, there is an intensive movement of road and rail transport. Thus, the simultaneous manifestations of dangers of different genesis increase the negative impact on these objects. It is established that the increase in the speed of the car from 40 to 60 km/h entails an increase in the intensity of oscillations 1.5 times on a defect-free road and 2 times in areas with defects.

Regarding the minimization of the consequences of ecological dangers, in particular, man-made earthquakes, the expediency of improving the positional characteristics of its sources is substantiated, namely the artificial change of environmental parameters in order to limit the area of mechanical waves to hazardous objects:

- carrying out on the way of propagation of waves of low-power explosions for crushing of firm breeds;
- construction of near-surface protective structures filled with porous materials - the displacement speed is reduced by 2.6 times;
- formation of a network of green plantations (trees with a developed root system, which is an elastic network that absorbs mechanical vibrations due to elastic forces) - the intensity of the impact is reduced by 1.4 times.

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MODEL OF RELIABILITY NON-RESTORABLE COMPLEX TECHNICAL OBJECT OF MINING EQUIPMENT

The developed model is intended to obtain the probability functions of no-failure operation (or the distribution function) of the time-to-failure for object as a whole and all its structural elements according to available information on the reliability indicators of component elements. object.

The developed model is intended to solve the problems of assessing the reliability of aging objects, therefore, we need to use the laws of distribution perating time to failure, taking into account degradation processes in materials of different types elements. Failures generated by various degradation processes are usually called gradual [1]. Nowadays, it has become generally accepted that gradual failures occur due to the fact that the value of a certain defining parameter reaches the maximum permissible value. Failure models based on the concept of the determining parameter are commonly called probabilistic-physical (WF-models) [2].

The most universal model of gradual failures is the diffusion non-monotonic distribution (DN-distribution) [2].

The reliability model makes it possible to obtain estimates of the reliability indicators of individual structural elements and the object as a whole based on information about the reliability indicators of the elements lower design level. The reliability model represents the hierarchical structural structure of an object. The structural elements of certain u-th constructive level are a sequential (in the sense of reliability) connection of the elements of $(u + 1)$-th level included in it. Individual structural elements can be a redundant group (parallel connection) of the same type elements. Thus, using the reliability model, presentation of hierarchical structural structure is combined with an arbitrary serial-parallel reliability structure of an object,

which is an acceptable representation for most technical objects encountered in practice.

The DN-distribution is used as a failure model for all elements and the object as whole.

DN-distribution is considered to be an adequate gradual failure model for both electronic products and various mechanical assemblies and elements.

An important advantage of the DN distribution is also the fact that its form is preserved during the transformations of the reliability structure of the system. It is this feature of the DN distribution that made it possible to apply it to a system with a hierarchical structure.

The software implementation of failure model is developed in the Delphi programming system.

The hierarchical constructive structure of an object is programmatically represented using list data structures (using TList lists).

The elements of lists are objects (instances of Delphi classes) that represent individual structural elements of a technical object. Such objects encapsulate all the necessary data related to individual structural elements, including the parameters of DN-distributions failure times.

Information about the composition, structure and reliability indicators of the object's elements is stored in the database of the model built using tables in the InterBase DBMS format.

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CURRENT STATE AND PROBLEMS OF DEVELOPMENT OF THE COAL INDUSTRY OF UKRAINE

Today, the state mines of Ukraine are in a more than deplorable condition. Most coal companies are bankrupt and continue to exist only through government support and a temporary moratorium on property seizures and bankruptcy. Almost all the property of these enterprises is under arrest or tax lien. The accounts payable as at 30.06.20 amounted to UAH 29,318.3 million, which is by UAH 4,840.2 million or by 19.8% more than at the beginning of the year.

Due to the lack of sources of capital investment, it is impossible to develop production and upgrade fixed assets. Due to the lack of mining equipment, coal mining in 14 pits is carried out with down hole hammers. As a result, the high cost and non-competitiveness of coal products of state-owned coal mining enterprises significantly exceeds market prices and requires constant state support. The volume of coal production in the public sector is declining from year to year: over the past 15 years it has fallen from 24 million tons to 4.1 million tons per year. Last year alone, the reduction was about 2 million tons.

At the same time, Ukraine is actively increasing coal imports, and by some types of coal it has already become a net importer. Imports of coal products, due to the deficit of domestic energy and coking coal over the past three years increased from 15.6 million tons to 21.4 million tons [1-2].

Wage arrears in state-owned mines are "chronic." In 2019, the share of the state budget in financing the wage fund was 60%. But this only temporarily reduces the degree of stress in the coal regions, but does not systematically solve the problem of mines. The state budget expenditures to support the state coal industry increased from UAH 1.9 billion in 2016 to UAH 4.6 billion in 2019. However, these funds are mainly used to pay arrears of wages and electricity consumption.

They have been trying in vain to reform the coal industry for almost the entire independence of Ukraine. It is clear that since 2014 this task has been complicated by the war in Donbass, where coal mining enterprises are concentrated.

The shortage of own coal and the chronic loss of the industry are explained by the fact that on the balance of the state remained mostly non-profit mines with the highest cost of coal production. At the same time, insufficient investments in new construction and renewal of fixed assets of such enterprises do not allow to modernize production and create additional problems of operation and safety. It is significant that 96% of domestic mines have been operating without proper reconstruction for more than 20 years, and 2/3 of the existing equipment has reached the end of its service life.

Another layer of problems is the lack of effective regulatory solutions, including fiscal ones, to prevent further negative environmental impact of coal enterprises. Currently, the rental rate for coal is 20 times lower than the rate for natural gas production, and the environmental tax does not apply to coal market players at all.

A separate problematic aspect of the sphere is the high level of market concentration. Thus, more than 80% of the coal mining market is currently controlled by the private company DTEK Energo.

The difficult situation at domestic enterprises during the crisis, the lack of necessary development and stability, reflects insufficiently considered opportunities or unused resources.

To solve the problems of the coal industry it is necessary to approach from a scientific point of view. The dynamics of development of the coal industry will depend on the success of the restoration of coal enterprises on the basis of modernization of technological equipment and radical reform of relations in the coal market. The main task in this sector is to transfer the coal industry to a subsidized and self-sustaining regime. Thus, for the qualitative and effective development of the coal industry it is necessary to: develop methodological approaches to assessing the sustainability of enterprises by economic indicators; to develop economic and mathematical models of sustainability of the development of the system of coal mining enterprises in the conditions of ecological and social constraints; in the energy security system to ensure the

monitoring of risks associated with the processes of globalization, and on this basis to ensure the implementation and regulation of state policy to prevent, minimize and overcome them; on the basis of the state order to provide carrying out of scientific researches on introduction of the newest scientific developments in manufacture of coal products and the equipment serving it; to develop and implement programs of economic development of coal regions of Ukraine for short-term and long-term perspectives with use of methodology of effective management of stability of system of the coal enterprises; to monitor labor safety at coal mining enterprises; to introduce effective forms of interaction between the supervisory authorities and mine owners, which will be aimed at improving the safety of miners and respect for all social rights of workers; develop forecasts for the potential use of coal enterprises.

Therefore, the necessary steps for systemic change in the industry are the following:

• Privatization of assets of state-owned coal enterprises and attraction of investors to their restructuring and modernization.

• Elimination of unprofitable mines with social protection of workers.

• Strengthening antitrust legislation in order to maintain a balance of market influences and create conditions for competitive pricing.

• Abolition of tax preferences and bringing the rent in line with the rent for gas production.

• Establishment of taxes and fees for emissions of harmful substances, removal of rock to the surface, as well as fines for burning dumps, which will help reduce the negative impact of coal mining companies on the environment.

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SECTION

"MACHINE BUILDING AND AUTOMOBILE TRANSPORT"

UDC 656.13: 681.3

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TRANSPORT SYSTEMS IN ORGANIZATION OF FREIGHT TRAFFIC IN ROAD TRANSPORT

Road freight services play an important role in the country's economy. Every year, the volume of goods that need to be moved from one point to another increase. Ukraine has a special feature - a high share of transportation costs in the price of goods. This is a result of the inefficiency of logistics business processes. Irrationally planned routes and lack of transport control significantly increase the costs of enterprises. Then there is a shortage of specialists in the field of logistics, the task of optimizing fleet costs in recent years has been solved with the introduction of satellite car monitoring systems at enterprises.

In the conditions of growing competition of transport companies, the tasks of creating and improving methods for the operational management of the transport of goods by road are burning issues. Management in a broad sense is a determined impact on any object or process that results in both qualitative and quantitative changes in variables that determine the state of an object or process, and certain goals are achieved. The main management functions are planning, operational management, accounting and control. The aim of operational management (situational management) is the

implementation of operational plans and the response to deviations in its actions [1]. Operational management measures are taken if the performance indicators deviate from the planned ones. Management is focused on providing the main groups of quality indicators on the characteristics of freight traffic categorized by

- indicators of timeliness of the transportation;
- indicators of safety of transported goods;
- economic indicators.

Traditional mathematical methods of decision-making have proved their viability and practical significance for solving a number of transport management tasks:

- fastening consumers to suppliers of a similar or similar cargo;
- consolidation of customers for road transport enterprises;
- determination of the priority of detour of points on the route;
- distribution of fleet of rolling stock by types of transportation;
- calculation of hourly charts, determination of the shortest distances on the road network;
- calculation of rational routes of rolling stock movement.

Since random disturbing influences effect the transportation process, there is a need to use the tools of queuing theory. One of the main tasks of the theory is to determine such characteristics of the system that provide a given quality of functioning, for example, minimum waiting time, minimum average queue length [2].

The presented methods allow solving technological problems of a narrow focus, which cannot eliminate the uncertainty of the goals and criteria of the transportation process and not the optimal schemes of organizational structures. In a number of cases, the solution of one, the most important task, does not allow to improve the parameters of the functioning of the motor transport system as a whole [3].

The circumstances that determine the need to create methods for managing road transport, which will not have the above drawbacks.

A situational approach, which is based on the need for an adequate response of the road transport system to the emergent situations in the implementation of the transport process, can be referred to promising ones. Nowadays, the method of situational management based on semiotic models is fundamentally developed.

Theoretical and methodical issues of preparation of information, mathematical and software were solved. As a methodological basis is used to identify specific patterns of human thinking and their formal description. The software complex forms a situation in a number of ways and determines its place in one of the classes of standard solutions. It is assumed that a finite number of standard solutions correspond to an almost unlimited number of real situations.

Based on the system approach, as one of the basic principles of logistics, the process of transporting goods by road can be presented in the form of a system whose inputs are the need for transportation and the availability of a certain type, number and technical condition of the rolling stock, and the way out is the timely delivery of goods to destinations.

Demand for freight transportation is determined by the rapidness of life of modern society, the new nature of economic processes that require continuous turnover, and close transport links between countries and continents. The exchange of goods and services makes it possible to make a profit. High demand for cargo transportation is also formed due to the Internet, which provides free access to many information resources and greatly simplifies communication between participants in the process of cargo transportation.

To conclude the process of managing cargo transportation is a complex and versatile task, due to one of the key indicators is the quality of transportation. The aggregate of the most essential natural properties of transport products, which determine the degree of its suitability to meet the needs of production and the population of the country in a timely and complete way.

The essence of the quality of transportation, like any other product, lies in its consumer value the same transportation is capable of satisfying the necessary need to a different degree, which is, having a different quality. If the quality of transportation improves in the interests of the consumer, the quality indicators acquire a value form; therefore, the essence of the indicator is not only in consumer value, but also in real value.

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JUSTIFICATION OF PARAMETERS OF CONSTRUCTION OF ELEMENTS OF CONVEYOR ROLLERS ACCORDING TO THE CRITERION OF STRENGTH

Of all the existing types of conveyors, despite the limitations of size, abrasiveness and poor resistance to shock loads, belt belts are becoming more common in the mining industry. They account for more than 12% of the total volume of bulk cargo, which is due to high productivity and the possibility of full automation of the transport and handling process. Its use instead of rail and road industrial transport allows to solve more effectively the general plans of the enterprises and to provide delivery of mass loose freights (coal, ore, sand, etc.) on big distances (to 100 km and more).

However, a significant disadvantage that hinders the use of belt conveyors is their high cost and rapid wear of components, due to the saturation of the structure regardless of the type of roller bearings (rigid GOST 22645-77 and garland roller bearing) (hinged rollers)

GOST 25722-83 (ST STV 1331-78)) the same type of assembly units, conveyor rollers and belt between which there is friction. Under conditions of high concentration of abrasive particles there is an intensive wear of the body of the conveyor rollers. That is why recently used conveyor rollers with polymer components with higher abrasion resistance. However, polymers have excellent physical and mechanical properties, which forces manufacturers to reinforce with additional structural elements.

The purpose of this work is to substantiate the design parameters of polymer rollers of conveyors by the criterion of strength.

Among quarry (downhole, assembly, transfer, lifting, main, dump) and underground (downhole, drift, inclined, Bremsberg) belt conveyors it is possible to allocate traditionally accepted design of GOST 25722-83 (ST SEV 1331-78) in which are applied unified elements.

The peculiarity of unified belt conveyors is that the elements of which they consist are adopted as a single standard size of one belt width, regardless of the total power of the drives. So the main parameters of roller bearings are determined depending on the width of the belt and standardized according to GOST 22645-77 "Belt conveyors. Roller supports. Types and basic sizes ". This standard applies to all types of rigid roller bearings except garland roller bearings, which are similar in design to the roller bearing housings.

To establish the values of the main parameters of mining conveyors, consider the main types of conveyors produced in the post-Soviet territory.

The main parameters of conveyors, which significantly affect the design and life of the roller, include: weight performance; speed of movement of a tape; width and type of tape; diameter, weight and length of rollers; working conditions.

Among the mass-produced conveyors the following were most widely used: 1L80U (1L80U, 1L80U-2), 2L80U (2L80U, 22L80U-01, 2L80U-10, 2L80U-11), etc.

The main functional parameters of conveyors that have found their application in the mining industry are given in table. 1.

The set service life for conveyors ranges from 2.6 to 6 years, but the service life of conveyor rollers is 1.2 years, which is a

characteristic feature of intensive wear of the elements due to friction.

Figure 1 shows two variants of the design of rollers with a polymer body, which at the cost of manufacture have almost the same price. One of the problems in the manufacture of polymer rollers is the need for additional rigidity. Insufficient rigidity of the roller body leads to significant deformation and destruction.

To ensure the addition of structural elements in the form of a metal pipe (Fig. 1,a) or an additional bearing assembly (Fig. 2,b).*a* *b*

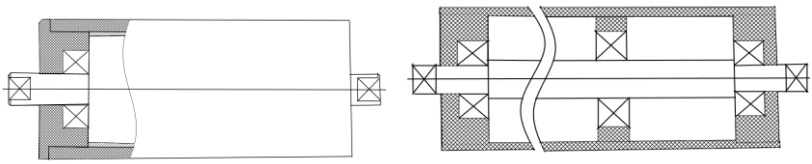

Fig. 1. Designs of polymeric rollers

To determine the optimal design by the criterion of strength, calculations were performed by the finite element method. The results are presented in Fig. *2a,b*.

a *b*

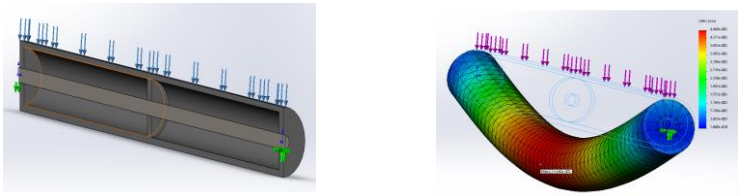

Fig. 2. Calculation scheme (*a*) and research results (*b*)

Comparison of the obtained distributions of deformations and stresses indicates the advantage of the option with an additional bearing assembly. So the maximum displacement of the roller reinforced with a metal pipe is 2.5 times greater than the design option with an additional bearing assembly.

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DESIGN AND FABRICATION OF LOW-COST DRONES FOR HUMANITARIAN ACTIVITIES USING MATERIALS LOCALLY AVAILABLE IN UGANDA

Abstract

This project paper presents the design and fabrication of a low-cost drone for Humanitarian Activities (HA) using materials locally available in Uganda. A drone is an unmanned Aerial Vehicle (UAV) or aircraft. Drones have different classes grounded on their “usage” like for photography, aerial mapping, and surveillance. Generally, there are four distinct kinds of drones; multirotor drones, fixed wind drones, single rotor helicopter and fixed wind hybrid VTOL [1]. We mostly used locally available materials to design and fabricate our fully functional drone specifically for Humanitarian Activities (HA). Top materials used in drone making include carbon fiber-reinforced composites (CRFCs); thermoplastics such as polyester, nylon, polystyrenes; aluminium; batteries and others. The material which we couldn’t procure locally was carbon fiber which was procured from abroad. The rest of the other materials were readily available at the (mechanical and electronic waste) dumping sites around Kampala and Mukono. Consequently, the actual multirotor drone was fabricated and tested. Our drone flight was about 8 minutes for ten different tests. It was able to carry a load of 1 kilogram. However,

the following challenges were encountered during the implementation of the project. These include among others, unavailability of some materials locally like carbon fiber, microcontrollers, and good battery to sustain the drone while on a flight for a long time as this affected our drone flight time and flight stability. The main objective of the project was to minimize the cost of fabricating a drone. The paper recommends that components such as electronic speed controllers be researched into and built from the ground up locally. In conclusion, drones are growing more popular by the day and revolutionizing the way the world works and plays. Our preliminary conclusions suggest that the use of drones could be a viable model for humanitarian efforts in times of distress and a shortage of essential medical supplies.

KEYWORDS: Unmanned Aerial Vehicle; Robot; Drone; Construction; Humanitarian Activities (HA).

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RESEARCH AND DETERMINATION OF PARAMETERS OF HYDRAULIC DRIVE OF TECHNICAL WATER FILTER WITH SCREEN FILTERING ELEMENT

Technical water filters with a screenfiltering element are used in water treatment at enterprises of heavy-duty industries.

Forced rotation of a brush dirt collector of the screen filtering element can be performed using the energy of water being filtered if no external energy source is present. The water is in the pipeline under a pressure range from 0.1 to 1.6 MPa.

Water in the pipeline contains particles of mechanical impurities. Usage of the known types of hydraulic drives, which are designed to operate on clean water, is problematic. Thus, creation of a new hydraulic drive, which operates on water with impurities, is required.

Patent [1] is selected for development of the construction.

Object of development is construction of a hydraulic drive for a technical water filter with a screen filtering element.

Purpose of the research is to justify and calculate the parameters, and design a construction of the hydraulic drivefor a technical water filter with a screen filtering element.

One of the main parameters of the new hydraulic drive, which can operate on water with mechanical impurities, is the torque produced by the drive. Thehydraulic drive torque must overcome the following resistances: the resistance in bearings, the resistance in a face seal of the dirt collector and the resistance of the dirt collector brush during brush sliding on the filtering element screen. The resistance in dirt collector supports and in the face seal are calculated according to the known methodologies [2]. The total friction resistance of the dirt collector brush is a sum of friction resistances of every wire bristle of the brush. An experimental unit is created for determining the friction resistance of a single wire.

The single wire of length L is cantilever fitted in the experimental unit.The free cantilever end is leaned on the screen and the wire is moved along the screenunder the action of a force P, which is parallel to the screen, while measuring the wire deflection. Maximum deflection is assigned such that the internal stresses in the wires do not exceed the yield point of the wire material. The experiment results are processed using MathCAD software. A cubic dependency between a force on a brush and a deflection of brush wiresis established.

The research results allow calculating the required hydraulic drive torque depending on the parameters of the brush dirt collector (length, diameter and a number of wire bristles in the brush dirt collector).

The main hydraulic drive parameters for a specific dimension type of a screen filter are calculated using the research results. A set of design documentation for ahydraulic drive of a screen filter for technical water is developed using SolidWorks software.

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THE FEATURES OF TOOL WEAR DURING PLASMA-ASSISTED MACHINING OF HIGH-STRENGTH MATERIALS

The purpose of this paper is to develop further the machining process for items made of difficult-to-machine materials, viz. to research and scientifically substantiate the process parameters of plasma-assisted machining of surfaces of items made of high-strength steels and alloys in order to increase machining productivity and ensure the required quality of the surface layer of a machined item.

The fracture of the tool blade and the intensity of its wear are largely conditioned by the level of force and temperatures that arise during the cutting process. In this regard, it is considered appropriate to examine the effect of the preliminary plasma heating of the work-piece on the nature of the distribution of force and thermal loads acting on the front and rear surfaces of the tool.

As a result of the research done, data were obtained on the temperature fields in the work-piece material when heated by a plasma arc scanning relative to the surface being cut. A drop in the intensity of loading of the front surface of the cutting wedge over the entire contact area of the cutting blade and shavings has been revealed in comparison with machining without heating.

The durability of hard-alloy tools when used for cutting difficult-to-machine materials is conditioned by the brittle fracture of the cutting edges, which is due to the high pressure on the contact areas of the cutting blade. The value of the average pressure on the front surface of the cutting wedge is related to the dynamic hardness of the tolerance range cut-off material [1-3].

The distinctive feature of the cutting tools' wear during plasma-assisted machining (PAM) consists in a relatively short running-in time of the tool (or even its absence) and subsequent virtually linear tool flank wear land size / time response characteristic. This corroborates the fact that the contact surface of a hard alloy is mainly subject to adhesion processes. In pearlitic and martensitic steels, a sharp decrease in the intensity of the cutting blade load is observed due to the transfer of the tolerance range cut-off material into the state of overcooled austenite. Plasma-assisted turning of titanium alloys is also characterized by a similar course of contact processes with a special mechanism of structural-phase transformations in the cut-off layer of the tolerance [4].

The analysis of the results of theoretical calculations and experimental data makes it possible to draw the following conclusions.

1. When cutting difficult-to-machine materials, plasma preheating of the work-piece reduces two- to threefold the level of maximum and average loads applied to the tool blade.

2. The drop in normal loads conditions a decrease in tensile stresses on the front surface of the cutting wedge, which increases the reliability of the tool and makes it possible to use large feeds.

3. The drop in the maximum and average normal contact loads caused by plasma heating prevents chipping of the cutting edge of a hard-alloy tool and a loss of the plastic strength of the blade thereby ensuring a decrease in the intensity of the growth of the cutting edge's curvature radius.

4. Changing the loading conditions of the blade during PAM leads to a specific nature of the blade's wear, which preserves small curvature radii of the cutting edge making it possible to operate successfully the tool with large flank wear lands.

5. The use of preheating of the work-piece raises the temperature of the metal both in the shavings and below the surface being cut,

which leads to a deeper and more uniform heating of the blade. This reduces thermal stresses and has a beneficial effect on the strength of the hard-alloy tool.

6. By its physical nature, tool wear during PAM is mainly of an adhesive character and has a minimal intensity at the cutting edge area corresponding to the location of the heating spot.

7. In intermittent cutting processes under the conditions of plasma heating, the number of cycles of thermomechanical loading of the hard-alloy plate before the formation of fatigue cracks in the latter is one and a half to two times higher than the value of the same characteristic when machining an unheated work-piece.

8. The possibility of successful operation of tools with significant flank wear lands allows PAM to be carried out in the mode of intensive blade wear bringing the flank land size along the blade's back surface to half or more of the cutting plate's thickness.

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DESIGN OF EXPERIMENTS IN OPTIMIZATION OF MOTOR PARAMETERS

Keywords: Grey relational analysis, Taguchi method, faults, rotor bar, model, simulation, Excel.

Abstract. The most popular type of motors in use are squirrel-cage induction motors. Electrical, mechanical, and electromagnetic behaviors of actual induction motors need to be understood in order to understand key frequencies of motors with and without faults. Experiments on motors, conducted in a laboratory setting, are expensive and limited because the motor should be broken to create the fault to be studied. Another motor is again needed to be broken to study a different fault. Large capacity motors are generally not allowed to break because of cost and safety factors. Therefore, it is better to study the actual motor on a computer. It is called simulated motor if the actual motor is studied on a computer.

A simulated motor saves an enormous amount of time and money. Motors of any capacity, with any type of fault, can be studied if a motor could be simulated in Simulink MATLAB or other software. But, the output values of the simulated motor should be very close to the values (target) on the nameplate of the actual motor for being exactly the same motors.

Therefore, the goal of this paper is to find the optimum input parameters that make the minimum difference between outputs and targets by using an excel spreadsheet as evaluated by the Taguchi method and Grey relational analysis. The Taguchi method and Grey relational analysis are defined separately in the study. The new equation was developed based on this study. The fixing coefficient was found out during research work.

The output values were obtained without using software programming based on the new equation developed during the research work. Therefore, the Taguchi method and Grey relational analysis are able to be calculated using Excel, because everybody knows Excel very well.

The results of the paper are that the outputs of the simulated motor were almost identical to the nameplate data on actual motor, indicating that our methods and models can be used to simulate a healthy motor, allowing us to now use our simulation to examine motor faults experimentally.

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JUSTIFICATION OF DESIGN MODELS OF DRUMS OF MINE WINDERS ЦР

Reducing the steel intensity and increasing the strength of the drums of mine winders are an important scientific and technical challenge. To solve it, a reasonable choice of the design model of the loads of the split drums of mine winders is required. Influence of loads from the winding and unwinding rope, the drum's own weight on the stressed state of the drum; stringer reinforcement of drum shells for their strength have not been previously studied. The purpose of the work is to justify computer models of drums of mine winders ЦР – 6х3,4/0,6.

The drum of the winders has single, split, cylindrical, welded construction. Each part of the drum, adjustable and jammed, has a screw thread on the outer surface for a rope. The shell ring perceives external uniformly distributed loads over the entire generatrix of the shell or part of it from the tension of the ropes.

The solid drum model was developed at SolidWorks for research purposes. Assumptions: in the model, each turn of the helical groove is replaced with an annular one; it is sufficient to examine 1/8 of the drum, since the pressure on the grooves is an axisymmetric load. The loads were analyzed for: beginning, middle and end of lifting a loaded skip.

An influence matrix is constructed that represents the dependence of the radial displacement of an arbitrary groove on the radial pressure that was applied to the bottom of a given groove. The

coefficient of weakening in the rope turns due to deformation of the shell when winding the rope on the drum has been determined. To determine the weakening coefficients, an algorithm was developed in the MathCAD package, which implements the process of sequentially putting on metal rings, taking into account the calculated influence matrix for simulating the winding of the rope. A mathematical model of changing the tension of the ropes with account for their weight is obtained. A computer model of loading the drum by the pressure of the winded rope turns has been synthesized.

To study stresses in the Simulation application in a solid model, split at 104 ° by parting lines to define loads. For the application, the braking load model is made in two parts: braking torque and horizontal force. To take into account the weight of the wound rope, the body of a complex rope shape was modeled with a rigidity equal to that of rubber.

Drum stress was investigated for solid drum models without reinforcement and with stringer reinforcement. In the course of the study, several stringer designs were modeled.

To connect gussets and foreheads, an automatic welded seam without edge preparation was modeled. To determine a rational scheme for applying pressure from the turns of the wound rope to the drum shell, the pressure on each groove was investigated.

Of the loading schemes, the smallest stress is given by the scheme with pressure on each groove, taking into account acceleration and weakening coefficient. But in each case, the maximum stresses are at the gusset plate at the edge of the weld hole.

For a more detailed study of the interaction of the shell, head and gusset with a simulated automatic weld with a lack of root fusion, an assembly of the sector (1/16) of the drum and welds was created. Forehead with gusset is one part, and welds are the second.

The calculation of the stress-strain state is carried out when modeling a welded joint by an assembly.

This pressure is transmitted through the gusset to the forehead, and the latter bends so much that it moves away from the edge of the gusset, and a gap arises between them. With the second new design of stringers, which are welded to the front faces opposite the gussets, the stress concentrators have shifted to the edge of the gusset plate (the so-called "inner corner" type concentrator).

As a comparison, the calculation of stresses in a drum with reinforcements in the form of ribs, which are welded along the radius of the foreheads, was carried out. The maximum stresses are determined at the edge of the gusset plate opposite the rib, forming a concentrator of the "inner corner" type.

For those gussets that are removed from the rib, the concentrator remains the same. It is proposed to abandon the reinforcements, and the adjacent foreheads are moved to the central hub of the displacement mechanism so as to reduce the cantilever part of the shell of the jammed part of the drum.

The study of the influence of the length of the cantilever part on the stress-strain state of the drum was carried out on a model representing $^1/_8$ of the drum part.

Conclusions

1. Loading in the form of a braking torque can be neglected, since its share in the stress-strain state of the drum in the worst case of loading (at the end of the lift) is 0,8%.

2. The share of maximum stresses at asymmetric loads in the SSS of the drum at the end of the rise is 4%. Therefore, unbalanced loads can be neglected.

3. Compared to the drum model with stringers, the model without them reduces stresses by 31,1%. Use the model without stringers and take into account the loading only by the pressure of the rope turns.

4. Imitation of a weld with a lack of penetration of the root of the seam revealed a lack of rigidity of the foreheads when performing drums with stringers that are not welded to the foreheads.

5. The use of stringers welded to the foreheads, rib stiffeners and gusset reinforcement generates "inner corner" type concentrators without increasing strength.

6. The minimum stresses on the shell are achieved when the front of the jammed drum is displaced by a distance equal to the width of two grooves.

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ORGANIZATIONAL AND ECONOMIC ASPECTS OF USED TIRES RECYCLING

Used tires that are being stored at the junkyards cause damage to the environment. Due to the rapid growth of the number of cars this problem can become more severe in time.

Numerous ways of recycling used tires are known nowadays. Namely using them as are, thermal, chemical and mechanical recycling.

Mechanical recycling, which is the most widely spread, involves few stage shredding as well as removing metal or textile corduroy. Technological process consists of such operations as removal of dirt and non-rubber studs from used tires, removal of wire beads, cutting rubber into the pieces of 200×200 mm, thick and thin shredding of cut pieces of rubber, removal of metal corduroy, separating textile corduroy and its removal using an air stream, classification of crumb rubber. As the result of such recycling crumb rubber of different fraction is received, as well as metal and textile corduroy, both of which are sellable goods. The method of shredding of used tires has the least negative impact on the environment comparing to other methods.

The total mass of used tires which are due to be utilized every year in Rivne region is about 1822,8 t/year. In this region, we see it useful to start one technological line to utilize used tires, with the productivity of 0,5 t/hour, taking into account double-shift work day. The cost of aforementioned technological line is about $10-43 thousand depending on the manufacturer.

The functioning of technological line with the profit of 5% will ensure the investment payback period of 0,8-3,2 years.

The problem is that estimated numbers are a resource potential of used tires in Rivne region only. Used tires as a recyclable resource

are uneven in different areas of the region. It's transportation as cheap primary commodity with a low bulk density is economically impractical.

The aim of the thesis is to suggest the organizational structure of collecting and utilizing used tires based on division of technological process of its recycling which enables to lower transportations costs.

Used tires have a bulk density of 80-120 kg/m3. And if the chunks of rubber are transported after partial recycling its bulk density goes up to 500-600 kg/m3. This enables to increase the index of exploitation truck's load-carrying capacity and lower the transportations costs. Thus it is logical to divide technological process of recycling used tires in two parts: initial and deep recycling.

For initial recycling used tires would be brought from the recycling points. Initial recycling should involve removing wire beads with hydraulic hooks cutting rubber into the pieces of 200*200 mm on the cutting shafts. The process of initial recycling is little automatized and demands a lot of handwork. At the points of initial recycling up to 15% from the total recycled mass of metal corduroy is produced, which can be sold as a scrap metal at a price of $80 per ton.

After initial recycling prefabricated product (pieces of rubber) would be transported to the point of deep recycling which involves two-stage shredding, removal of the metal corduroy leftovers with magnetic separators, removal of textile corduroy with vibrating screen and pneumatic flow and separation of rubber into different size grades using vibrating screens. Commodity received during the process of deep recycling is crumb rubber, which can be sold at a price of $200 per ton.

Suggested organizational structure of collecting and recycling used tires includes three levels. The first level should include functioning recycling points, which can be created at repair shops, scrap metal collection points or other recyclable goods collection points. The form of business process is a sole proprietorship. These proprietors receive the income from trading used tires to the points of initials recycling.

The second level should include functioning points of initial recycling, which can transport used tires from the recycling points.

The distance of transporting is up to 30-50 kilometers. The form of business process is a sole proprietorship. The main income of these proprietors is provided by selling wire beads as scrap metal and trading prefabricated product to the deep recycling points.

The third level should include functioning recycling points to recycle pieces of rubber received at the points of initial recycling. Prefabricated products are taken to these facilities from the distance up to 200 kilometers land vehicles. The income is ensured by selling rubber crumb and textile corduroy to the consumers.

Among the collecting points, initial recycling points and deep recycling points the according contracts should be drawn.

This structure of used tires utilization process enables to lower the transportations costs due to increasing the load capacity index up to 40%.

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CALCULATION OF MODERNIZED SCREEN DESIGN

The structure of the vibrating screen needed improvement to increase its efficiency. Two vibration exciters that consist of two

parallel shafts with eccentric mass are usually used in the well-known design screen. Shafts are driven by two electric motors. Vibration exciters are fixed on the screen with a flange connection. The solid-state model of the upgraded design has been created using SolidWorks programme. Two vibration exciters are used instead of two unbalance vibration motors. Installation of vibrators is carried out on a specially designed construction. Vibrator mount consists of horizontal and vertical plates (the vibrators are bolted to the plates), metal tube with longitudinal, and transverse stiffening ribs. Flanges are used to mount the unit to the screen.

There is a need to determine the durability of the modernized design of the screen for rationale of efficiency. The screen is a complex welded construction. It is not calculated using standard algorithms and requires additional research.

The purpose of the study is to determine the durability of the modernized design of the screen.

The following assumptions are made during the validation of the computational scheme: dynamics task is transformed into static task; crash box is fixed on the base; the interaction of vibrators with the mount is modeled by a force equal to 12.3 kN, which is determined from the technical characteristics of the vibrator.

The solid model screen is simplified for research to determine its durability. Bolted connections and openings for them are excluded. Computer models of vibrators, sieve and metal angles for its support and mounting are not used. An important step in creating a computational model is modeling the welds of the vibrator mount. Welded seams are created as a solid part, taking into account the geometry of the parts being welded.

Angle-free weld seams are used in the manufacture of the screen. This is the reason for the formation of a low penetration zone, which leads to a decrease in the durability of the welded joint. Requirements for modeling welded structures with lack of

penetration are: the lack of penetration is modeled as a rectangular slot 1 mm thick between the parts to be welded; the optimal size of the element of the finite element mesh is equal to the width of the gap; reducing the size of the grid element from 10 to 1 leads to an increase in stresses, which indicates the singularity of the problem and the need to apply special calculation methods such as the Hot Spot Stress [1].

The method of calculating welded structures with incomplete welding is applied to the calculation of the vibrator mount to the screen. The maximum stresses in the welds occur at the junctions of the middle longitudinal rib with the platform and the pipe.

The HSS method should be used to assess the durability of these joints. As a result of using the HSS method, the stresses arising in the welds are 2.5 MPa. The design of the screen is calculated in the same way. From the analysis of the results, it follows that the maximum stresses arise in the welds in the node of the vibrator's attachment to the rumble.

If the stresses arising in the construction are lower than, the durability of the welded joints exceeds the cycles, and since the maximum stresses in the welds found by the HSS method are 2.5 MPa, the durability of the welded screen structure is not lower than cycles.

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VIBROWAVE PROCESSES IN MACHINE RECYCLING TECHNOLOGIES

The effective solution of technological problems in the disposal of machines is largely associated with the improvement of methods of disassembly, cleaning and washing operations. A promising method for solving such problems is the use of vibration-wave technologies using vibrations of a different spectrum in the form of a vibration effect on the corresponding objects (parts, assembly units, etc.).

In work [1], the factors influencing the efficiency of vibration processing of parts are noted. It is shown that the M&A process is the most effective due to the combination of mechanical and physicochemical factors, namely, the form of many collisions of particles of the processing medium with the surface of the workpiece, the mechanochemical interaction of the processing medium and the material of the workpiece, and the acoustic effect of shock waves.

Vibration exposure is one of the most effective ways to significantly reduce the required force for disconnecting the connection elements is - it allows you to reduce the complexity of disassembly and the operation time.

Disassembly of the joint after vibration wave loading is carried out under conditions of discrete and dynamic interaction of surfaces. Consequently, the actual contact pressures increase or decrease, the frictional forces and the resistance to plastic deformation decrease, which leads to a decrease in the disassembly forces. And although

the actual interference in the joint is reduced, there is no loss of strength. The formation of wear products filling the depressions of the microrelief is accompanied by an increase in the contact area of parts, friction forces, and, ultimately, an increase in the strength of the joint.

The described leads to a decrease in the disassembly torque when applying vibration wave loading to the joints

As you know, the moment required for disassembling a threaded connection is used to overcome the moment in the thread and the moment of friction forces at the end of the nut (screw head) against the fixed surface of the part. The moment of disassembly also depends on the diameter and type of fit of the joint.

The fit of threaded connections is mainly determined by the nature of the connections on the lateral sides of the profile. The relative position of the contacting sides of the profile depends on the actual values or deviations of the average diameters, thread pitches and angles of inclination of the profile.

In the case of a vibration wave impact on the connection, there are two options, depending on the fit:

- joints with a gap are necessary to achieve easy make-up, compensate for temperature deformations of parts during operation, apply protective coatings, etc. The gaps along the thread diameters contribute to a more uniform distribution of the load between the turns and increase the cyclic strength of the joints. With the imposition of vibration, the presence of a gap makes it possible to destroy the communications formed during operation, which contributes to the easy disconnection of the connection. The tensile and compressive effects contribute to collisions between the outer surface of the bolt and the inner surface of the nut;

- threads with interference and transitional fits are used for fasteners operating under vibration, variable temperature conditions and in other cases to ensure the immobility of the threaded connection during operation or centering of parts along the thread. In the case of vibration-wave loading of such joints, disassembly is possible due to a decrease in the fit relative to the initial one.

To confirm the above, a number of experiments were carried out according to the vibration wave loading scheme in the spectrum of harmonic vibrations with a frequency of 15-25 Hz and an amplitude

of 2-7 mm. The processing was carried out "in bulk" in the working chamber of the vibrating unit; the natural abrasive "Baikalit" and the molded abrasive of the PTS type were used as a working one. The processing efficiency was assessed by the tightening torque and the torque corresponding to the beginning of breakout.

After analyzing the results obtained, the following can be noted:

- an increase in the duration of the vibration wave exposure is accompanied by a weakening of the tightening of the threaded connection and a decrease in the torque for its connector. In this case, the influence of the vibration wave effect on the reduction of this parameter is manifested more intensively at the beginning, after which the continuation of such an effect causes relatively small changes in the moment of the connection disassembly;

- the duration of the vibration wave action of the working environment noticeably changes the moment for disconnecting the connection. Moreover, such loading of the connection elements reduces the disassembly torques to a certain minimum value, at which the duration of the process is optimal. Further processing brings only a relatively minor change in torque;

- vibration-wave loading contributes to a rapid decrease in torque in pairs of joints, where the formed bonds are larger;

- a microscopic examination of the surface of disassembled joints without vibration-wave loading shows some difference with respect to the surface of disassembled joints with the imposition of vibration-wave action. In the first case, there are more noticeable traces of surface interaction and relatively large sizes of microchips in the depressions of the threaded surface of the parts. Obviously, this is due to the increase in the disassembly torque and the additional forces that arise between the surfaces of the parts to remove a relatively large microchip.

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S E C T I O N
"ECONOMICS OF NATURAL RESOURCES USE"

UDC 504.062.2

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ORGANIZATION OF RESOURCE SAVING IN LOCAL ECOLOGICAL AND ECONOMIC SYSTEMS

The research of the spatial system structure of nature management revealed the need for the formation of new modern operational units of the territorial organization of the use of natural resources. Based on the analysis of pecularities, theoretical and practical principles of reoginalytics, it is established that their separation should be carried out on the basis of a systematic approach based on the principle of natural economic adaptation. The common features of socio-economic systems are important, such as integrity, interaction, economic structure of society, production relations, the relationship of system elements, the internal organizational structure.

We support the idea than the notion of Socio-conomic System' should be understood as a holistic, complex and dynamic complex of interconnected and interacting social and market institutions and relations for the use of nature, production, distribution, exchange and consumption of goods and services. The local stage of such system is formed at the level of an individual region or their association. Therefore, it is appropriate to admit it to be true that the local socio-economic system of the region is an administrative unit (region, district, settlement) or their association, represented by the territorial socio-economic complex formed in the interaction of natural, labor, physical and monetary resources.

Analysis of research methods for the development of ecological and socio-economic systems has shown the need to identify ecological and economic diagnostics - the basic analytical stage of the process of streamlining nature in the local socio-economic system. It should be considered as an analytical activity aimed at identifying, analyzing, and evaluating environmental problems of development and improving socio-economic and environmental efficiency. The main task of diagnostics in the system of ecological management is to identify the existing positive or negative economic, ecological or social effects.

As a result of ecological and economic diagnostics, resource conservation reserves are identified, taking into account the peculiarities of the needs of the local socio-economic system. In this case, it is necessary to consider such a system not just as an administrative unit but as their union by clustering.

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ORGANIZATIONAL STRUCTURES OF NATURAL RECOURCES RATIONAL USE IN THE REGION

Environmental and economic conflicts have a causal basis, which is a key element of national, global, and local safety in a deteriorating environmental situation. There is a need for effective and balanced policies to minimize the effects of economic activity and use of natural resources. Therefore, it is necessary to create new organizational structures for the regulation of nature management,

which will be able to solve the problem of rational use of natural resources.

Such structure is a multi-purpose ecological complex. It is considered as an integrated, dynamic, complex consisting of institutions, organizations and facilities united to achieve a common goal - to ensure environmental safety of economic activity by performing specific functions inherent in each of the elements of this complex. Its specific feature is the target subordination of each element to the common goal, as well as the presence between the elements of the relevant system-forming links. They are information, technology, economic etc.

The strategy of the multi-purpose ecological complex is the long-term most basic installations and plans of activity of the organizational-technological complex. These are aimed at minimizing the negative impact of economic activity on the environment. They are determined, taking into account the generalized situation in the region as a whole, and are consistent with the characteristics of clusters of local socio-economic systems. The process of complex development includes the formation of activities, a system of long-term goals and the choice of the most effective ways to achieve the final result.

Tactical tasks of functioning of a multipurpose ecological complex are defined by the basic problems of local social and economic systems revealed in the course of ecological and economic diagnostics.

In Ukraine, the main strategic objectives of the multi-purpose environmental complex are to ensure resource conservation by providing assistance in investment support of environmental projects. Supporting activities are related to conducting qualified consultations on a wide range of issues, including investment assessment, choice of strategy for technical and technological development of enterprises, environmental marketing, environmental education, etc.

When creating a multi-purpose ecological complex, it is extremely important to assess its impact on the level of socio-economic development. To do this, based on economic and mathematical forecasting, it is necessary to identify trends that should be expected in the development of leading industries in the region, investment activities, financial self-sufficiency, labor market efficiency, energy efficiency.

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ENERGY EFFICIENCY MANAGEMENT OF THE NATIONAL ECONOMY

The modern mechanism for the development of resource-saving technologies is energy efficiency management. It is considered as a set of actions aimed at optimizing the use of fuel and energy resources, and choosing the optimal combination of these resources (taking into account volume, unit costs, cost, innovation, etc.).

We believe that the management of energy efficiency of the national economy is a process of adaptation of the country to both favorable opportunities and threats posed by the consequences of the use of energy resources; identification of appropriate options for the optimal combination of fuel-and-energy resources (FER).

Energy efficiency management of the national economy is aimed at improving the object of management, which involves optimizing the use of fuel and energy potential, the need to take into account the relationship of all its structural elements, and reducing energy costs and maximizing the effect of their use.

In some regions of Ukraine relevant institutions have been set up under the regional state administrations to perform energy efficiency management functions. For example, in the Department of Housing and Communal Infrastructure of the Kyiv State Administration.

Despite the rich world experience in implementing mechanisms to improve the energy efficiency of national economies, the management of this process in modern reality is characterized by fragmentation and lack of coordination. It should be noted that today there is no single fundamental theoretical and methodological basis for energy efficiency management, the development and

implementation of which will contribute to energy security in the country.

Improving energy efficiency management is an important task that can be solved through the introduction of an energy efficiency management model. A change (decrease or increase) in energy efficiency is the result of energy efficiency management. We consider the main purpose of this management to increase energy efficiency. The means to achieve this goal is to reduce the energy intensity of products.

Thus, given the complexity of the object of energy efficiency management, the implementation of this process requires a systematic analysis of energy efficiency of the national economy. Systematic representation of the national economy as an object of management actions to translate it into a state of energy efficiency requires monitoring of interrelated internal and external factors of influence.

Energy efficiency management of the national economy is a complex process that ensures the achievement and/or increase of the overall level of energy efficiency of the economy due to a number of measures in various sectors through the application of program-target method and public-private partnership in energy consumption. It is the process of implementing interrelated management decisions to reduce the energy intensity of products and ensure the energy safety of the state.

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CONCEPT OF "BLUE" ECONOMY WITHIN LAND RELATIONS REGULATION

The dirigisme model describes methodological grounds for land relations regulations which are based on the sustainable development. These grounds take into account an anticipatory environment protection. They were introduced by Pashencev O.I. [1] and combined by him into three groups: principles of the

management of the natural environment protection (publicity, devolution, accounting, coordination, organization); principles of the natural environment stability (harmony, communicativity, symmetry, ecological efficiency, integrity); principles of the parity based development of the subject, who operates, and natural environment (differentiation, integration, scientific grounding, hierarchy compliance, emergency).

The concept of the land resources sustainable development should be used in order to develop a new economic model which combines rich natural decisions that evolved during a long period of time; components of "blue" economy, introduced by H. Pauli, must be applied as well because he puts a human being into the center of the system; this encourages humanization of economic thinking.

Moreover, "blue" economy proposes very simple and cheap decisions under the conditions of limited resources. Its purpose is to find innovative solutions which are safe for the environment and society [2]. According to the scientific postulate of Gunter Pauli, "nature has nothing redundant", that is why a rational usage of resources at each stage of the human economic activity turns into an obligatory condition for the competitive economy. The scientist is convinced that a restoration of the ecological balance and economic development must turn into a unified process [2]. Is it even possible to disagree with such a statement? Hence, it is directly connected with the land resources usage within the context of the sustainable development.

The determination of the "blue" economy ideas includes a combination of the orientation of business structures, authority and public sector with a maximized efficiency of the usage of territorial resources and a creation of conditions to compensate ecological losses and also a formation of the profitable share in order to recreate an integrity of the system according to the territorial space.

Herewith, the necessity to widely implement innovative strategies arises; such that are capable to generate income and financial flows in order to create new jobs. Innovations appear to be a core of the "blue" economy. Nevertheless, there is a need to reconsider available principles of the land resources usage specifically in a direction of the welfare increase of local communities. In turn, it requires to pay attention to the scale effect, which opens opportunities for the new

generation of entrepreneurs who have an orientation to fulfill ecological needs of local citizens.

As noted by representatives of the Roman Club, the "blue" economy becomes a basis where a creative partnership of the business, authority and public sector are united under the background of upfront innovations towards the protection of natural systems, an enforcement of favorable terms of living, and growth of the spiritual and cultural level of the nation.

In general, a direction, which is oriented towards the "blue" economy, reflects the evolutionary path of the nature development which is related to categories of complexity, variety, sustainability, and flexibility.

The "blue" economy is defined as one that is based on the energy wastes reduction and enforcement of the variety at the expense of innovations which are implemented by entrepreneurs who manage to consider principles of the sustainable development and take responsibility for business risks moving from deficit to surplus.

Due to this aspect, a moral obligation turns into a social capital, and external costs turn into opportunities to make a difference on the market.

Thus, we can affirm that the basic postulate of the "blue" economy is reflected in the innovative aspect, which is highlighted by Humarova H.I. as one that solves ecological problems defying principles of ecologically clean production [3] which are the following: of the scientific anticipatory approach; of preventional remedies; minimization of the creation as well as recycling of waste, prevention of ecological losses; of the caution presumption; principle of the integrity; of the democratic transparency.

Therefore, a spectrum of principles of ecologically clean manufacturing will become a basis for the safety approach during the forming of the economic and ecological concept of land relations regulation considering risks and dangers of the land relations development.

Objective picture, which we have, testifies that principles of the sustainable development are not fundamental yet when it comes to the activity of main players on the global arena. Moreover, a systematic financial and economic crisis, which the global economy

is facing, demonstrates an effort to solve its own problems based on existing economic models which are oriented on an increasing consumption of natural resources. The above determines an increase of geopolitical problems that are caused by the battle for resources on a global scale. Consequently, this threatens to reduce the influence of those international organizations which are aimed to provide solutions to global problems of various types on behalf of the entire humanity [4].

To conclude, we can state that modern conditions of economic development are determined by norms of the "brown" economy as well as growing postulates of the "green" economy, and also an implementation of the "blue" economy components have already started. Moreover, "colored" economies are related and integrated into each other within a system of economic relations.

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ECOLOGICAL COMPONENT OF RURAL DEVELOPMENT DIVERSIFICATION IN CONDITIONS OF DECENTRALIZATION

Diversification of rural development should be considered as a process aimed at diversifying agricultural production, non-agricultural activities, the transformation of organizational and legal forms of governance, expanding sources of funding for rural development programs and projects to increase incomes and employment of the rural population [1].

The implementation of decentralization of power and the formation of united territorial communities is a factor in stimulating the diversification of rural development. An important aspect in improving the quality, accessibility of administrative social, and other services; improving the efficiency of budget funds at all levels of government; opportunities to dispose of agricultural land; attracting funds to finance environmental projects through grant funding is the decentralization of relevant powers, their delegation to local governments.

From the point of view of the structural approach to the formation of the integral concept “rural territories”, it is expedient to define their basic constituent parts – structure, set, elements which have various functional components [2]. They are social, economic, financial, environmental, institutional components.

In our opinion, the ecological component of diversification of rural development should include land, including agricultural and

forestry purposes; reservoirs; flora and fauna; minerals; atmosphere. Therefore, to analyse the environmental component of the diversification of their development, it is advisable to use indicators of air pollution, the volume of freshwater intake by agricultural enterprises; fertilization of land areas with mineral and organic fertilizers; forest reproduction; volumes of capital, and current investments in environmental protection.

In Ukraine, in recent years we have seen an increase in the share of pollutant emissions into the atmosphere from stationary sources of pollution of agriculture, forestry, and fisheries in their overall structure from 2.4% in 2014 to 3.1 in 2018 [3].

The profitability of agricultural production and, accordingly, soil fertility depends on the amount of mineral and organic fertilizers. During 2000-2018, there was a tendency to increase the number of mineral deposits, although it was not possible to reach the level of 1990. According to statistics, during 2000-2018, the volume of applied organic fertilizers, on the contrary, decreased from 28.4 million tons to 10.6 million tons.

In recent decades, we have seen the deterioration of soils. Therefore, in our opinion, in order to reduce these degradation processes, it is necessary to promote the development of organic production as one of the areas of diversification of agricultural activities. The development of organic agriculture is important because it provides an opportunity to produce and grow environmentally friendly food.

Researchers believe that the rapid and steady growth of international trade in organic products, local demand for healthy and safe food, and the price surcharge for organic production provide a good opportunity for Ukraine to improve the economic situation of rural people through the development of the organic sector in the country [4, c. 4].

Ukraine ranks first in Europe in terms of agricultural land and arable land. The agricultural sector occupies one of the leading

positions in the national economy of Ukraine. The area of agricultural lands of Ukraine as of January 1, 2019, amounted to 42.7 million hectares, or 70% of the total land fund, of which 381.2 thousand hectares are agricultural lands with organic status. In general, about 19% of agricultural lands in Ukraine are suitable for the development of organic farming.

However, very few farms in Ukraine are at risk of developing organic production. The reason for this, according to O. Shulha, is the low level of real incomes in the country. Food costs account for a significant share of household expenditures, so for most citizens, the transition to organic products at higher purchase prices on the national market is virtually impossible [5].

Therefore, the development of organic production is one of the priority types of agricultural activity in today's conditions, which contributes to improving the environmental situation in rural areas.

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INTERNATIONAL ASPECTS OF FINANCIAL AND ECONOMIC SECURITY OF NATURAL RESOURCE MANAGEMENT

In the context of geoeconomic transformations resource efficiency is a powerful economic argument with significant potential for reducing public spending, which at the same time leads to increased competitiveness of the economy and financial and economic security. Structural restructuring and greening of the economy as a whole at the state and, accordingly, regional and local levels should be implemented through economic policy and build it on socio-environmental principles.

The economy of the country should focus on maintaining a constant balance between man-made environmental impact and the ability of the environment to self-healing, and the state must create the conditions for the implementation of appropriate strategies.

However, there is a high probability of risks associated with the depletion of natural resources. Thus, according to UNEP estimates, since the 1980s, world production of both abiotic (fossil energy sources, minerals) and biotic (agriculture, forestry and fisheries) resources has been growing steadily. In 2020, resource production is projected at 80 billion tons, which is 200% of the volume for 1980 [1]. While the share of BRICS and other non-OECD countries in world resource production is growing, the share of OECD countries is declining.

EU countries have to import about 21% of their resources to produce products for final consumption, which underscores the EU's dependence on natural resources in other parts of the world. Such dependence cannot be alleviated by domestic production, as natural resources in the EU are limited.

Therefore, Europe's dependence on other countries will increase in cases where resources are strategically important and absent in the EU. This dependence will increase as the share of countries in future world resource production decreases. In addition to the impact on the financial and economic security of countries, the extraction of resources abroad also has environmental risks, as a result of which the burden on the environment is shifted to other regions of the world.

Regression analysis shows that productivity of resource use is a driving force for competitiveness. It should be noted that according to the Federal Statistical Office of Germany, a correlation has been established between the Competitiveness Growth Index and the productivity of resources of the EU economy [2]. The main argument for seeing resource productivity as a competitive advantage is the high potential for cost savings in energy procurement. Improving quality through radical innovation and reducing environmental impact are also associated with competitive advantages through resource productivity [3].

Finally, increased resource productivity contributes to better planning for financial and economic security, which is another factor influencing competitiveness. The EU can realize significant environmental and competitive advantages if it systematically reduces internal disparities in resource efficiency. This entails supporting the existing resource policy of leaders and creating jumping strategies for outsider regions.

In the long run, resource efficiency should be included in a comprehensive vision of sustainable use and management of natural resources, which can be characterized by four pragmatic and complementary perspectives:

- resource-efficient industry based on recycling;
- a society of permanent stocks, where the growth of materials in the economy will be replaced by a dynamic balance between production and disposal;
- solar economy using natural solar energy;
- balanced biological economy based on balanced use of biological resources.

Thus, the main vector for strengthening financial and economic security in the global dimension should be specific measures to

address economic and environmental problems by developing and implementing incentives to improve the efficiency of use of resources and natural assets; increase productivity, reduce waste and energy consumption and maximize resource efficiency; intensifying the introduction of innovations and creating political and framework conditions that promote the innovation activities of all participants in the innovation system and that allow a new approach to solving environmental problems; promoting the development of new markets by stimulating demand for 'green' technologies, goods and services, while creating new employment opportunities.

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THE IMPLEMENTATION OF DYNAMIC GAMES IN THE NATURAL RESOURCE ALLOCATION

The effective allocation of natural resources is the central concern for the economics of both developing and developed countries. The natural deposits are initially the reasons for the rivalry between nations and individuals inside societies. Most natural resources are common sources and not allocated efficiently enough

due to the gaps in the identification of property rights. These gaps contribute to the prodigal exploitation of innate stock. Additionally, they are responsible for the downfall of livestock and extensive pollution across the Earth's biosphere. In the article "Dynamic games in the economics and management of pollution," written in 2009 by Jørgensen, J., Martín-Herrán, G., and Zaccour, G., the authors provide the excessive explanation on the implementation of two types of dynamic games [1-3]. The scholars consider the Pareto-optimal or efficient game and the game with open-loop or Markovian strategies. Besides, other scholars deem dynamic games as powerful instruments in connection with resource allocation problems. The scientific evidence of the effectivity of dynamic games is present in the research "Global environment and dynamic games of environmental policy in an international duopoly" conducted in 2009 by Yanase, A., the researcher of Tohoku University. This study takes the main focus on the cooperation of governments with national policies.

The failures of environmental policies in the identification of property rights lead to the emergence of external effects or externalities. In other words, market failures inducing negative externalities are the deflection from Pareto optimal solution. Negative externalities arise with the environmental damage done by manufacturing enterprises. However, it is not clear whether the manufacturing unit becomes fully responsible for the damage generated to the local or global environments. Therefore, it is necessary to determine the frames of ownership. The dynamic games assist in solving property rights issues by capturing the relationships between environmental policies, manufacturing firms, and governments. According to the research conducted by Jørgensen, J., Martín-Herrán, G., and Zaccour, G., three key factors such as time, interdependence, and strategic behavior are necessary for each dynamic game. First, interdependence is the determinant intimating that the individual cannot change his welfare without influencing the welfare of another agent. Secondly, externalities are time-specific phenomena which require the setting of appropriate time frames. As Jørgensen, J., Martín-Herrán, G., and Zaccour, G., claim, the negative external effects are considered only as of the one-shot

event. At last, strategic behavior is a crucial factor when dealing with conflicts between the agents.

Dynamic games are effective analytical techniques to solve myriad environmental issues. Each dynamic game is a state-space with the innate variables resembling the characteristics of the environment of interest at any time-phase. The inherent variables represent all outcomes of past events over the discrete or continuous-time stage. Therefore, the main advantage of the dynamic games is the ability to perform analysis of not only circular contamination effects but as well as aggregated pollution consequences. Besides, each agent makes the decisions on the pollution emission; thus, another type of variable arise. Control variables are alternating indicators of the choices performed by players. The described factors formulate favorable circumstances for the implication of dynamic game scenarios. The best framework is the Pareto-optimal or efficient solution that leads to maximizing the welfare of each player. Agents are willing to cooperate until the best solution achieved unto them. However, the Pareto-optimality is an ideal-world case and is not achievable when agents cannot reach an agreement. Therefore, another scenario is applicable to solve the environmental problem. This case calls the open-loop or game with Markovian strategies. They imply that the situation is observable over a fixed period without fallacies with the supplied feedback to other agents.

An efficient scenario is not relevant when agents are not able to reach the solution maximizing each one's welfare without worsening the prosperity of others. Hence, it is necessary to imply the Markovian scenario. In the article "Markov-perfect Nash equilibria in a class of resource games," written by Sorger, G., the scholar discussed in details the exploitation of renewable resources undertaking their potency [4-5]. The author assumed that the agents made decisions depending on the current state of a game; however, past events, time phase, or choices of other players are not relevant for the decision-maker.

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ECOLOGICAL COMPLIANCE IN SPECIFIC CRITICAL INFRASTRUCTURE SECTORS

Food security is a significant place in the economy of many countries as a component of the development of critical infrastructure and the consequence of such development. This aspect is particularly relevant for the Economic Community of West African States [1].

While developing countries and the world have made significant progress in reducing poverty, in Africa, the percentage of people living in poverty has increased. This process of divergence of countries in terms of food security increased sharply when economic structural transformations took place on other continents. In this way, poverty and food security in Africa are a major economic growth challenge for many countries. The pace of economic growth in African countries has always been too low to catch up with other countries in the world.

The process of regional integration, expanding market size, stimulates efficient resource allocation, increases human capital and labor mobility, develops research in agriculture, diversifies

production, improves the production sector, increases domestic savings and investments, improves infrastructure and reduces the need for external debt [2].

Regional integration through its impact on agriculture, food prices and macroeconomic policies affects food security. The Food and Agriculture Organization (FAO) states that food security will depend on international trade in general and trade in, in particular, agricultural products. Given the ability of intra-regional trade to promote economic growth and increase prospects for employment and income opportunities for the poor, it will increase access to food. Increased intra-regional agricultural trade can also contribute to food security by increasing domestic food supplies to meet the needs of consumption and reduce overall variability of food. In particular, macroeconomic policy plays an important role in the direct or indirect impact on food security, affecting the poverty, food, prices, foreign currency, employment and wages.

Poverty reduction in countries requires increased food availability at the national level and at the level of households. Integration is the best instrument for addressing food security through the integration of trade and markets, investment in agricultural resources, investment in agricultural and trade infrastructure, improving agricultural technologies, reducing domestic and external political pressures, and saving economies of scale. Integration significantly affects the productivity of the agricultural sector by stabilizing food prices, strengthening the regional market and reducing dependence on the international market, improving the quality and structure of exports, and reducing imports. It affects the distribution of countries' revenues, rural development, job creation and competitiveness of the economy, as well as the development of technologies that provide the opportunity to confront bad harvests or natural disasters. Consequently, all these channels of struggle against malnutrition and hunger create a favorable environment for increasing consumption and improving the well-being of the population, which directly affects the level of poverty. The impact of regional integration on food security goes beyond the food and agriculture dimensions and encompasses general economic development indicators that have different implications for the country's trade policy.

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INNOVATIVE ASPECTS OF THE NATURAL RESOURCE ENSURING OF ECONOMIC DEVELOPMENT

The main way to ensure a sustainable type of economic development is the use of scientific and technological advances with high innovation activity. Scientific and technological progress has an extremely important role in ensuring optimal compliance with economic development and the state of the environment. Innovations provide an opportunity to take a new approach to solving resource and environmental problems.

World practice shows that the best economic indicators are easiest to achieve using so-called "cheap technologies", which do not require significant costs for development, implementation and use. But these technologies lead to the greatest pollution of the natural environment and irrational use, depletion of natural resources.

The natural way to overcome the contradictions between economic growth (in line with the concept of innovative breakthrough) and environmental security (in line with the concept

of environmentally sustainable development) is to create and implement environmental innovations. However, as practice shows, the share of ecological innovations in their total volume is insignificant, which in combination with the low level of innovation activity of the domestic economy does not allow to take advantage of this path of development.

The reasons for this are: lack of proper motivation to create and consume eco-innovations; difficulties in orienting production and sales to meet vaguely defined environmental needs of consumers, especially if they are latent; difficulties in assessing market prospects for environmental innovations; low efficiency of strategies for their promotion on the market, irrational use of communication tools [3].

Ecological innovations include the following processes [2]:

- development, creation and implementation of new technological processes and cycles of development and coordinated development of all functional units of resource extraction, their processing, use of waste and reproduction of these resources;
- development and use of resource-saving equipment, development and implementation of low-waste and non-waste technologies that provide integrated development of natural resources, development of biotechnology;
- development of new territories, as well as the expansion of existing ones, taking into account the environmental safety of the population and production;
- development and production of new environmentally friendly products and the creation of facilities for their production, development of options for the use of new and renewable energy sources;
- introduction of new organizational forms, including improvement of organizational and territorial structure of potentially dangerous productions, for the purpose of reduction of their ecological danger;
- formation of new thinking in the developers of innovations in terms of the need for their greening through the introduction of compulsory environmental education.

It should be noted that there are difficulties that arise during the development of environmental innovations [1]:

- it is difficult to determine how production and products impact on the environment;

- it is hardly possible to predict the framework conditions for future waste disposal;

- the service life of the product is reduced, which is contrary to environmental goals, i.e. the goals of long-term use, resource conservation and environmentally friendly waste disposal.

Thus, one of the most acceptable ways to resolve the contradictions between economic growth and environmental protection should be the focus on innovative environmentally sustainable market development by moving to new principles of performance management, using marketing guidelines for strategic decisions [4].

Ecological innovations, like any other, involve changes in technics, technology, management, legal system, with the only difference that their results are aimed at preventing and reducing the negative impact on the environment.

As a rule, eco-innovations include the development and application of resource-saving technologies, the creation of environmentally friendly products, the introduction of new ways of organizing production (eco-management, eco-marketing) [2].

Innovation in the field of ecology should be based on the development and use of efficient environmentally friendly non-waste and low-waste technologies that help reduce the amount of dispersed waste and consumption of primary natural material resources [3; 5].

In modern conditions, the intensification of the resource-ecological crisis, the importance of scientific, technical and innovative factors is crucial for the further development of society. The main way to ensure sustainable economic development and overcome natural resource constraints is the use of scientific and technological advances, with high innovation activity. At the same time, the current state of both scientific, technical and innovative activities of enterprises in Ukraine is unsatisfactory. Therefore, the formation and implementation of the main guidelines of scientific, technical and innovative activities, which would organically include elements of resource conservation and sustainable use of nature, is quite relevant and urgent.

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EVALUATING THE EFFECTIVENESS OF ENVIRONMENTAL INVESTMENT

Terms of the Agreement on Political Association of Ukraine and the EU provide for the implementation of sustainable economic development and mechanisms of «green» economy, which corresponds to the principles of sustainable development strategy adopted at the UN summit «Rio + 20», and the process of greening the economy has two dimensions new «green sectors» of the economy, which need to intensify investment activities and assess the effectiveness of investment.

Using the methods of semantic analysis, the theoretical foundations of investment management are explored and it is determined that the concept of «investment» is characterized by a prerequisite – investment in certain objects in order to obtain a predetermined result (economic, social and/or environmental effect).

Among the approaches to the interpretation of the economic category of «environmental investment» are two approaches: environmental and preventive. In our opinion, the understanding of the theoretical meaning of the concept of «environmental investment» comes down to the following: first, the target and functional characteristics of environmental investment is multi-vector; second, environmental investment should be seen as an opportunity to prevent eco-destructive impacts. Thus, the effectiveness of environmental investment should be based on a clear identification of investment objectives and targets, which are crucial factors in the selection of performance criteria. The optimal criterion for the effectiveness of environmental investment is the calculation of changes in input and output parameters, that is, the assessment of the effectiveness of environmental investment is reduced to solving the problem of binary classification on the basis of a single criterion for the effectiveness of environmental investment [1-5].

The research of the main directions of investment in environmental activities in Ukraine revealed that the main components of environmental expenditures for environmental protection in Ukraine are capital investment and running costs. Over the last decade, environmental spending in Ukraine has increased, but has not led to a significant improvement in the environment or an increase in natural resource potential. Investment support for environmental protection in Ukraine is low, and insignificant investments in integrated technologies do not contribute to the formation of the resource base for modernization, reconstruction and technical re-equipment of environmental infrastructure and can lead to irreversible negative environmental impacts, because investment costs in integrated technologies are investments that lead to changes or modifications of the production process, and their main purpose is to reduce pollution, while changing production technology and reducing the formation of pollutants. The main sources of financing the costs of environmental protection are the own funds of enterprises; the share of other sources is insignificant due to the lack of a proper institutional basis for attracting private capital to finance environmental activities [1-5].

Environmental solutions in most countries are implemented through environmental taxes, fees and charges, which are used as a means of

influencing the behavior of economic entities, regardless of whether the water belongs to the producers or consumers of certain goods. The most widespread in the EU countries are transport and energy taxes, which are inherently fiscal, and the positive effect on the environment is concomitant. In the EU, the main function of environmental taxation is to regulate the activities of economic operators so that their activities cause less burden on the environment.

The need for cooperation between Ukraine and the EU in the field of environmental policy is indisputable, not only in view of the prospects of integration, but first of all, given the need to preserve the environment in this part of the world. Experience in the implementation of EU environmental policy is good for Ukraine for reasons of expediency and efficiency of modern technology in the field of environmental management.

Since the evaluation of efficiency involves comparing the results obtained after the implementation of certain measures with the costs incurred for their implementation, the main criterion for the effectiveness of environmental investment is the dynamics of reducing environmental pollution, which follows from the essence of «environmental investment» and does not depend from the type of environmental investment. But the criterion of efficiency of ecological investment reflects the ratio of the obtained results to the used resources.

Thus, the evaluation of the effectiveness of environmental investment should be carried out using multi-criteria evaluation, which is based on the method of index comparative evaluation, which will form a set of criteria and indicators for these criteria. This evaluation method involves grouping the main performance indicators according to certain criteria, calculating individual indices of performance indicators and determining on their basis the performance indices by criteria, as well as a consolidated integrated index – the level of efficiency of environmental investment [3].

The advantage of the proposed methodological approach to assessing the effectiveness of environmental investment is the possibility of gradual aggregation of data level by level, which allows you to track the values of indicators at each level using a wide range of methodological and applied tools. The proposed integrated index of environmental investment efficiency, in contrast to others, is

characterized by a reflection of the effectiveness of investment activities in the field of environmental protection.

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IDENTIFICATION OF THE LEVEL OF ECONOMIC AND ECOLOGICAL SUSTAINABILITY OF AGRICULTURAL LAND USE IN DRAINAGE CONDITIONS

Solving the problems of the agricultural sector in terms of economic growth and improvement of natural ecosystems corresponds to the rational use of reclaimed land. This demands the search for and activation of factors to ensure economic and environmental sustainability of land use in conditions of drainage. Ultimately, such stability determines the efficiency of agriculture and creates the preconditions for investment attractiveness of drained lands of Ukraine.

However, in studying the problems of sustainability of agricultural production there is no unambiguous approach to the

formation of a system of indicators of efficiency of agricultural land use [1; 2] and identification of the level of its economic and environmental sustainability taking into account, in particular, the peculiarities of the use of drained lands. This determined the purpose of this study.

In Ukraine are accounted for 5485.3 thousand hectares of reclaimed land, in particular 2178.3 thousand hectares of irrigated and 3307 thousand hectares of drained lands with appropriate reclamation infrastructure [3]. In 2017 less than 500.000 hectares were actually irrigated, and bilateral water regulation was carried out on an area of more than 250.000 hectares. It is less than 20% of the available irrigation area and less than 10% of the available drainage area. In recent years, crop production on these lands has decreased more than threefold while their productivity has fallen almost to the level of rainfed lands. The state of reclamation agriculture in terms of the level of utilization of the available capacities of irrigation and drainage engineering infrastructure can be characterized as a crisis with the threat of deterioration [3]. Reclaimed lands have ceased to perform a stabilizing function in ensuring food security.

Sustainability of land use with regulated water regime depends on a large group of stabilizing and destabilizing factors, namely: reclamation of land, which depends on soil criteria and hydrological criteria. In addition, the sustainability of production on drained lands depends on the technical level of drainage systems, the state of financing the costs of maintenance and repair of systems, fertilizer application, crop structure, the use of special farming systems etc.

In the process of research in order to select and structure the system of indicators we formed models (maps) for assessing the economic and environmental sustainability of agricultural land use in terms of drainage. The economic block should include indicators to describe the state and directions of development of agricultural production and financial and investment component of sustainability namely: gross output, land consumption of production, coefficient of nature, productivity of drained land, labor productivity, profitability of agricultural production, specific investments, costs for repair and reconstruction of reclamation funds [4, p.366].

Indicators of the ecological block are used to assess the stability of natural potential and should include phytoproductivity (yield),

fertility of drained agricultural land (humus content), criterion of water resistance of the structure, the share of ecologically stabilizing lands, the level of plowing, the level of degradation and reclamation of drained lands [4, p.367].

Aggregate (key) performance indicators and an integrated indicator are calculated for each of the selected components of sustainability on the basis of standardized unit indicators that are balanced in accordance with the indicators of weight. A four-point scale is used to interpret the integral index. At a high level of stability (1.0-0.65) - the value of the indicator characterizes a favorable situation for land use, tends to increase; on average (0.65-0.35) - characterizes a favorable situation for land use, there is no tendency to improve the situation; at low (0.35-0.2) - characterizes the unfavorable situation for land use, there is a tendency to improve it; at critical (0.20-0.00) - characterizes the unfavorable situation for land use, there is no tendency to improve it.

Thus, ensuring the economic and environmental sustainability of agricultural use of drained lands involves the transition from an intensive man-made system to an environmentally sustainable system of agriculture, which is dominated by environmental motivation. Assessing the sustainability of land use under drainage on the basis of the proposed models will identify its level, identify key destabilizing factors and find solutions to neutralize them.

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TAKING INTO ACCOUNT GROUNDWATER NATURAL PROTECTION WHEN PLANNING TO PROVIDE THE POPULATION WITH QUALITY POTABLE WATER

Groundwater is a valuable resource used to provide the population with drinking water. Groundwater occupies an important place in the economy, even in areas where water consumption is due to surface water. Unfortunately, the current level of industrial and agricultural development leads to pollution of aquifers (groundwater and pressure interstratal waters).

It has been established that the pollution of aquifers is affected by industrial facilities, unauthorized solid waste landfills, fuel, pesticides and mineral fertilizers, long-term excessive water abstraction from wells located in areas with rapid filtration and migration of substances in closed areas. Unprotected surface aquifers are contaminated by cesspools, as a result of which bacteriological parameters in the water of private wells exceed the maximum allowable concentration [1].

Intensive use of groundwater resources has caused certain problems that significantly affect the conditions of management in different regions of the country. Groundwater pollution is not an isolated, local process caused only by the direct action of a man-made source of pollution (industrial or agricultural facility, waste storage, fuel or pesticides, etc.). It is closely related to environmental pollution in general.

Particularly intense pollution of the environment and groundwater occurs in areas of urban agglomerations [2]. In general, groundwater pollution depends, on the one hand, on the anthropogenic load on the natural environment, and on the other - on the natural

hydrogeological conditions that determine the protection of groundwater.

In addition, the geological environment in many cases prevents the penetration of pollutants from the surface, which determines the natural protection of groundwater. Groundwater protection is a complex indicator of the ability of the upper part of the geological environment to maintain the state of the groundwater hydrosphere. First of all, protection is determined by the overlap of the aquifer with low-permeability deposits that prevent the penetration of pollutants from the earth's surface into groundwater. In this regard, it is important to study the protection of aquifers.

In fact, the assessment of groundwater protection is carried out in two directions:

- qualitative assessment of the territory, which consists in determining the degree of influence of various natural and anthropogenic factors on the vulnerability of aquifers, which allows to compare different parts of the territory in terms of protection of groundwater from pollution;

- quantitative assessment, which consists in calculating the time (speed) of penetration of a particular pollutant into the aquifer, taking into account the natural properties of water-containing and permeable rocks and the migratory properties of the pollutant.

In the first case, the assessment and mapping of the protective properties or vulnerability of groundwater is carried out without taking into account the characteristics of specific pollutants, in the second - taking into account the protective properties of the natural system against a particular pollutant.

It should also be borne in mind that the level of protection is not constant, as the factors that determine it (the intensity of man-made infiltration supply, hydrodynamic pressures, etc.) change over time. Often, as a result of water lowering and water abstraction, the groundwater regime also changes dramatically [2].

It should be noted that until recently, no targeted research and generalization work to assess possible changes in the geological environment under the influence of groundwater exploitation has been carried out.

The results of such studies should be used in the development of strategies for the operation and protection of groundwater in areas

with different natural protection and to justify water protection measures.

In the future, it is advisable to assess the impact of man-made load on the underground hydrosphere as a component of the environment.

It is extremely necessary and appropriate to conduct a qualitative analysis, even with limited data on the economic activities of individual enterprises and facilities.

It is necessary to constantly monitor the quality of artesian water in pumping stations, taking into account the requirements for drinking water quality standards.

This will not only control the quality of drinking groundwater, but also allow in case of pollution to identify sources of pollution, ways of getting pollutants into artesian wells and aquifers and further study the processes of water exchange.

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SUSTAINABLE BRAND MANAGEMENT AND INNOVATIONS: THE GUIDING INSTRUMENTS ON THE MARKET

Sustainable brand management and innovations are closely related to the success of launching a new product. Sustainable brands show their significant importance for the evaluation of products by customers. Modifications on the market are directly dependant on brand development and vice versa. Besides, sustainable brands

alleviate the perception of possible market failures by customers and investors. In the state, when a product exposes weak performance abilities on the trade market, sustainable brands are becoming a rescue tool. According to the research conducted by Brexendorf, T. O., Bayus, B., and Keller, K.L., in 2015, sustainable brands are the inherent resource of management innovations. The main fundamental points of innovations in management are sustainable brand leadership and innovation perfection (Brexendorf, T. O., Bayus, B., & Keller, K.L., 2015) [1].

Therefore, scholars consider three stages of interdependence between sustainable brands and innovations. The analysis of sustainable brand potential revealed the unarguable importance of brand image and actualization. Brexendorf, T. O., Bayus, B., & Keller, K.L., acknowledge that brands are the central tools for the development of innovations. Moreover, sustainable brands become the guiding instruments on the market of innovations. Thus, firm management can adopt its branding directions to the rapid market changes and the emergence of new innovative technologies.

However, innovations do not adhere solely to the branding of sustainable products. Market innovations are closely related to the organizational sustainable development of a firm. The comprehensive research on the correlation between a firm's infrastructure and market innovations was conducted by Steiber., A., and Alänge., S., in 2015. In their article "Organizational innovation: a comprehensive model for catalyzing organizational development and change in a rapidly changing world," scholars attempt to perform the systematic analysis of the creation and infusion of innovations into the firm structure. Furthermore, Steiber, A., and Alänge, S., give the interpretation of the term "organizational innovation" [2].

They specify it as favourable performance for the improvement of working conditions, lessening the costs at each stage of product production and management. Researches consider organizational innovation as the process of creation of a novel tool for facilitating in- and outside-firm trade activities (Steiber, A., & Alänge, S., 2015). Besides, Simao, L. B., Carvalho, L. C., and Madeira, M. J., analyze the model of innovation management creation. The scholars contemplate the administrative innovations incorporate a positive impact on business organizations within a firm. According to the research conducted by Simao, L. B., Carvalho, L. C., and Madeira,

M. J., the fundamental part of the organizational analysis is the search and the identification of poorly performed business cells preventing the implementation of innovations [3]. Overall, the innovations are affected by branding, the firm's hierarchy, and inner infrastructure.

Previously, innovations are dynamic tools closely correlated to the sustainable branding and the enterprise's structure. However, these factors are not the least for the incorporation of innovations. According to the advanced study conducted by Dabic, M., Potocan., V., and Nedelko, Z., in 2014, innovations are in the context of the advent of a "new economy" (p.1243) [4]. The authors deduce the four-stage model of ascertainment of management innovations. The model measures the quality of personnel's knowledge and education. Dabic, M., Potocan., V., and Nedelko, Z., state that there are differences in perception of working performance depending on the entrance stage of an employee into the firm.

In other words, the success and productivity of the worker depend on her or his education, previous and current experience, positioning, gender, firms' size, and industry direction. The success of innovations' implementations is in direct connection with the range of personal characteristics such as creativity, ambitions, and satisfaction from private life. In conclusion, the innovations show a high correlation between personnel value perception, sustainable branding, and organizational infrastructure. The mentioned elements are necessary for the implementation of instruments for catalyzing sustainable development and change in modern economy.

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INNOVATIVE DEVELOPMENT OF RESOURCE-SAVING TECHNOLOGIES AND SUSTAINABLE USE OF NATURAL RESOURCES

BOOK OF ABSTRACTS

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