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Mini Review

The Return of Lands Disturbed by Mining Production to a New Economic Turnover – As the Final Stage of Mining Production (On the Example of Open-Pit Mining)

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Abstract

Intensive development of mining production inevitably leads to depletion of natural resources, disruption of natural processes and pollution of the natural environment, which entails negative consequences for the socio-economic development of the region after the end of mining. During the extraction of minerals, the integrity of the subsoil is violated, the lithosphere is polluted, wastewater is discharged into the hydrosphere, and dust and harmful gases are released into the air. Mining production can be attributed to natural-technical (technological) systems. The main technological process is associated with the extraction of minerals from the bowels, i.e. the impact on the bowels of the Earth with the help of various technical means and technologies. The subsoil, atmosphere, hydrosphere, soil are elements of the natural system. The complex of technologies and technical means is a technical (technological) system, the choice of which is determined by the properties of the field.

Mining production has its own life cycle, which begins with the justification of the feasibility of mining, and ends with the liquidation of mining production and the transfer of disturbed lands to a new economic turnover. In order to return the disturbed lands to a new economic turnover, it is necessary to recultivate (restore) the lands disturbed by mining production. The study examines the conditions for the return of lands disturbed by mining production to a new economic turnover – as the final stage of mining (on the example of open-pit mining), taking into account the life cycle of mining production.

Introduction

Mining is necessary for the development of many branches of human economic activity, is the basis for the development of civilization. However, despite the high financial performance of mining companies, investor and consumer confidence in the industry is falling. Individual events in the industry, such as security and environmental incidents, contributed to the formation of this opinion [1,2]. The mining industry of recent decades has been characterized by a continuous increase in the labor intensity and cost of extraction of most types of mineral raw materials, increased consumption of all types of resources. We are witnessing the depletion of reserves of rich deposits. This leads to the need to develop deep horizons of exploited deposits with a lower content of useful components, as well as poor deposits with more complex production conditions. The volume of mineral extraction is increasing, new tasks are being set before the enrichment complex, new equipment and methods of enrichment are being introduced. At the same time, emissions of pollutants into the atmospheric air, changes and discharges into the aquatic environment, and violation of the subsoil are increasing.

Mining Production as a Natural-Technical (Technological) System

Mining production is a natural-technical (technological) system. The main technological process is associated with the extraction of minerals from the bowels, i.e. the impact on the bowels of the Earth with the help of various technical means and technologies. The subsoil, atmosphere, hydrosphere, soil are elements of the natural system, and the complex of technologies and technical means is a technical system. During the extraction of minerals, there is an interaction and mutual influence of natural and technical systems. This statement is clearly shown in Figure 1. The technical (technological) system of mining production includes a complex of interrelated and purposeful elements designed to achieve certain goals: extraction, processing and supply of mining products to the consumer. The natural system determines the choice of technologies and equipment for mining, the technical system is the basis of the mining process, but this process negatively affects the environment.

When mining production is functioning at the upper level (the "Mining Production" system), the following main functions must be performed:

a. Technological – determination of mineral reserves and conditions, organization and execution of mining operations, opening, development systems, technology and mechanization of work, organization of quality formation system and dispatching system, organization and maintenance of the necessary productivity of the enterprise;
b. Compliance with the technological regulations for the enrichment of minerals, the complexity of the processing of mineral raw materials;
c. Environmental, including calculation and monitoring of the complex environmental impact (all components of the biosphere);
d. Implementation and control of engineering methods of environmental protection;
e. Economic;
f. Energy;
g. Social, etc.

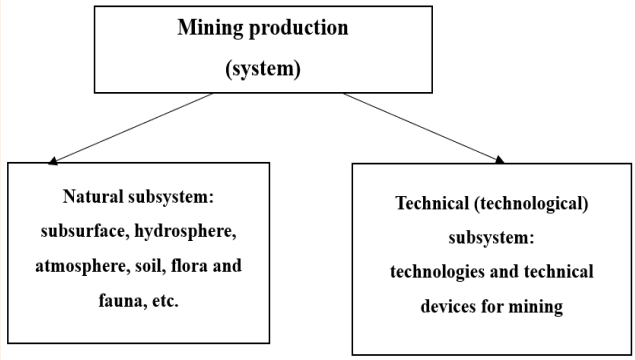

Figure 1: Mining production – as a complex natural and technical system.

In order to maintain a balance between the technogenic and natural environment, it is necessary to establish control and develop effective mechanisms for regulating the level of production impact on the environment. These measures are aimed at reducing environmental risks and reducing negative consequences.

The Life Cycle of Mining Production

Currently, it has been established that enterprises extracting minerals have their own life cycle, i.e. the time from the beginning of activity to the completion of their activities [3]. This time can be calculated based on the geometric dimensions (volume) of the mineral, the volume of annual production and other parameters.
The life cycle includes the following stages:

a. Search and exploration justification of mining;

b. Projects of preparation, opening and mining of the deposit, environmental protection, including reclamation (restoration) and transfer of lands disturbed after mining to a new economic turnover;

c. Preparatory work, which is carried out in accordance with the project of preparation for the opening of the deposit. The project should include issues of safety, environmental impact, taking into account the further implementation of reclamation (restoration) works or in parallel with the extraction of minerals or at the stage of liquidation of mining production to return the disturbed lands to a new economic turnover [4];

d. Carrying out mining and capital works. These include mining operations for the removal of overburden rocks covering and containing the deposit, the creation of capital and traveling trenches, pits and other works that allow you to start systematic overburden and mining operations in accordance with the adopted project. Mining and capital works are also carried out in accordance with the project, in which the choice of sites for the placement of overburden and host rock dumps takes into account the work that relates to the reclamation of lands disturbed by mining production and their return to a new economic turnover during the liquidation of mining production [4];

e. Operational mining operations are divided into stripping operations – excavation and transfer of waste rock to dumps with preparation for the development and opening of mineral reserves and mining operations – excavation and delivery of extracted minerals to transshipment points, warehouses or to the consumer [4].

f. The complex of technological operations includes:

g. Preparation of rocks for excavation, which means the separation of rocks from the massif and their loosening. In the case of rocks, the separation of rocks is carried out with the help of drilling and blasting operations;

h. Loading of rock mass into vehicles, which is carried out using various lifting and transport mechanisms: excavators, loaders, rotary complexes, etc.;

i. Transportation of rock mass, for which various types of transport are used: railway, automobile and conveyor, as well as skip lifts, hydraulic transport and suspended cable cars;

j. Dump formation - placement of waste rocks in dumps, planning of dumps, their reclamation. Dumps can be placed on specially designated lands (external dumps) and inside a quarry (internal dumping).

All these processes should be organizationally and quantitatively linked together in such a way as to allow the formation of cargo flows. As one of the main parameters, the productivity of the quarry is selected, depending on various technological and natural factors. The final stage of field development associated with the depletion of reserves is the period of damping (repayment) of mining operations [3]. The end of the life cycle of mining production is the return of disturbed lands to new economic turnover [5].

Basics of Recultivation and Technology of Recultivation Works

"Recultivation is understood as a set of measures for ecological and economic restoration and/or rehabilitation of lands disturbed as a result of mining operations, and the purpose of recultivation should be the return/involvement of the site in the economic turnover of the region. Restoration of disturbed lands is the creation of new post-mining landscapes and the return of these lands for further use in economic activities" [3]. During open-pit mining operations, a quarry is subject to reclamation, within which mineral extraction is carried out with calculated side spacing, a zone of protection from the harmful effects of mining, zones of rock movement, etc., territories allocated for dumps and other technological facilities necessary for mining (for example, processing plants, storage of enrichment tailings, etc.). By parallel reclamation, we will understand such an organization of mining, in which external dumps will be minimal. This can be achieved with external dumping, without storing rocks in the worked-out space of the quarry when using overburden rocks as materials for the construction of infrastructure facilities in the area, including recreation areas and other popular facilities [4-6].

Parallel recultivation using the developed space of the quarry/section is divided into the possibility of filling it with current overburden rocks or products of processing of minerals, man-made raw materials, i.e. with internal dumping. Open-pit mining technologies can be different [4-6]. As the worked-out space of the quarry/section is filled in and the original relief mark is restored, it is possible to increase the height of the embankment with the provision of a slope angle corresponding to the chosen direction of further use of land in new economic activity. A prerequisite for the implementation of this approach is mandatory long-term planning. The reclamation plan and, accordingly, the choice of the direction of reclamation should be developed even before the start of mining operations (at the stage of justification of mining), in accordance with the needs of the region, and then consistently implemented. Since it is practically impossible for most mining enterprises extracting minerals, including open-pit coal, to obtain a reliable cross-section of data on the state of the environment before the start of mining operations, in view of the fact that these works have been carried out for several decades, and also because this enterprise at the time of the launch of the coal mine could legally if it simply does not exist, then it is necessary to determine a certain "cut-off" or "starting" point/the "reference" time exponent with which environmental indicators will be compared after reclamation.

Currently, all extractive industries can be divided into three groups (Figure 2) in accordance with the stage of the production life cycle at which this production is currently located. The approach to choosing the technology of reclamation of disturbed lands in these cases should be different. For enterprises planning to extract minerals, the most expedient is parallel reclamation with internal dumping, if the geological conditions of the mineral occurrence allow it. Parallel reclamation with external dumping can be applied for enterprises that are in the field operation stage. For already liquidated or in the final stage of mining, it is necessary to create and develop a market for reclamation services [7]. One of the important issues in the development of criteria for the evaluation of reclamation services is the definition of a reference point. Under the reference point we will understand the state of the environment before the start of mining. Ideally, such a starting point should be the moment of the start of mining operations. Thus, we can observe the dynamics of changes in environmental characteristics in the mining area (water, air, soil, etc.) in three time projections: indicators before the start of mining operations (at the stage of justification of mining), any point during mining operations, indicators after reclamation works.

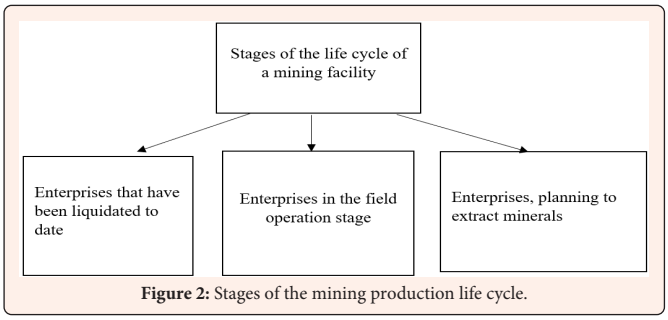

Figure 2: Stages of the mining production life cycle.

A prerequisite for the implementation of this approach is mandatory long-term planning. The reclamation plan and, accordingly, the choice of the direction of reclamation should be developed even before the start of mining operations – at the stage of justification of mining, in accordance with the needs of the region, and then consistently implemented. The purpose of reclamation works is to return the lands disturbed by mining production to a new economic turnover.

Conclusion

It is established that mining is a natural-technical (technological) system in which technological processes and technical equipment interact with the subsoil, soil, atmosphere, hydrosphere, animal and plant life, which negatively affects the environmental characteristics of the environment. Mining production has its own life cycle, which begins with the exploration of minerals and the justification of their extraction, and ends with the liquidation of mining production and the return of disturbed lands to a new economic turnover. Reclamation is the restoration of disturbed lands for their further use.

Parallel reclamation involves restoration work at the stages of preparatory work and mining. With this approach, the areas occupied by external dumps can be minimal. Recultivation ensures the return of disturbed lands to new economic activity. The direction of reclamation is chosen taking into account the further development of the region. Recommend that indicators on the reclamation of disturbed lands, including indicators on the reclamation of quarries, be included in reports on the sustainable development of mining production.

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