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ИЗУЧЕНИЕ РАЦИОНАЛЬНОЙ ТЕХНОЛОГИИ РЕКУЛЬТИВАЦИИ ВЫРАБОТАННОГО ПРОСТРАНСТВА КАРЬЕРОВ

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Ключевые слова: рекультивация, выработанное пространство, открытая разработка, карьер, вскрыша, отвал, поверхность.

Аннотация. Показана важность изучения рациональной технологии рекультивации нарушенного выработанного пространства на открытых горных работах в период эксплуатации месторождения. Приведены наиболее целенаправленные способы формирования отработанной площади карьеров в зависимости от климатических условий района разработки месторождения и создания природно-технического ландшафта. Предлагаемые рациональные варианты восстановления карьерного пространства улучшают экологические условия территории эксплуатируемого открытым способом месторождения.

THE STUDY OF RATIONAL TECHNOLOGY OF RECLAMATION OF THE MINE-OUT QUARRY SPACE

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Keywords: reclamation, the mined-out space, open cast mining, quarry, stripping, dump, surface.

Abstract. The importance of studying the rational technology for reclamation of disturbed developed space in open cast mining during the field's operation is shown. The most targeted methods of forming the worked-out area of quarries depending on the climatic conditions of the area of development of the field and the creation of a natural-technical landscape are given. The proposed rational options for the restoration of quarries improve the environmental conditions of the territory of an open-pit mine.

The goal solved to justify the need to restore disturbed lands, taking into account the effectiveness of planned reclamation works and technological and economic feasibility when choosing a rational direction for the rehabilitation of disturbed lands in open mining operations. The improvement of technological schemes for mining operations depends on the conditions of the mined deposits occurrence and the land disturbance intensity in open development. The use of a fully developed quarry space for overburden placement during the field development period allows minimizing land use and the cost of reclamation of pile internal dumps under these conditions. Then the choice of the rational direction of disturbed lands reclamation in opencast mining provides higher technical and economic indicators when using the developed quarry area during the mineral deposit exploitation. In this regard, conducting research to establish an appropriate technology for reclamation of the worked-out space in open cast mining is an important task for the field development.

The option of both quarries reclamation in the environmental direction with the creation of the necessary conditions for self-growth of surfaces in the deep parts of the reservoirs, in the upland parts corresponds to the complete cessation of mining in this field [1]. In the case of the new quarries creation close the ore deposit development, old mines used for the disposal of overburden and tailings with the

reclamation of these quarries in a combined direction. Thus, the design of reclamation works with flooding of the developed space in deep quarries carried out after forecasting the water level in an artificial reservoir using the water balance equation and planning measures for its stabilization and anti-erosion strengthening of the abrasion zone.

Open pit mines used for the disposal of solid household and industrial wastes and wastewater residues to improve the biological properties of the soil during the restoration of disturbed lands [2]. The worked out space of the section filled with overburden rocks, which do not pose a potential danger to groundwater pollution. The filled part separated by a water-resistant clay layer with a thickness of 0.8-1.0m, and then filled with household or industrial waste and a water-resistant clay layer with a thickness of 0.5-0.7m. Further, the slopes of the sides flattened, and then a waterproof clay layer of 0.5-0.7m applied in order to prevent the transfer of waste contaminants to the fertile layer. A fertile soil layer formed in layers on the area of the reclaimed space depending on the type of planned vegetation, the depth of its root system and the processed waste. After that, a fertile or potentially fertile soil layer of 0.3-0.5m applied to the recultivated area with a thickness of 0.15-0.2m, into which briquetted fertilizer from wastewater residues with a flow rate of 100-180g/m² applied to improve fertility. The measures taken to divert groundwater coming from higher-lying areas and the surface of the restored zone at the final stage of the technical stage of reclamation. Land rehabilitation carried out depending on climatic conditions, the degree of purification of the reclaimed object and the state of the surrounding natural and technical landscape at the biological stage.

The concept of creating and promoting a tourist facility in the open ponds of tourist and recreational resources can be used as a scientific and methodological basis for developing a regional tourism development strategy based on flooded quarry dumping complexes [3]. For this, the proposed idea adapts to the conditions of the post-industrial region, the technological features of the production and restoration of disturbed lands and the quality of the recreational and tourist zone. The tourism sustainable development strategy implemented using the surplus property of information flows. The systematic use and promotion of tourism products, the development of infrastructure and new types of tourism as tools for the transition to sustainable socio-economic development of the territory, the creation of excursion areas on the site of landscapes degraded in the process of open mining will be used in the geo-ecological design of the reclamation of mine workings. The development of ecologically safe excursions based on the tourist and recreational potential of career reservoirs, the creation of infrastructure within the worked-out zone allows us to differentiate the offer of tourism companies in the domestic market due to the satisfaction of the demand for affordable outdoor activities in the regions.

The priority trends in the targeted formation of the mined quarry space in the form of mining structures in the short term are [4]: construction of sites, obtaining energy from the mine-out area and using this surface as a fish breeding and capacity, recreation park, botanical garden and museum. Improving the efficiency of mining enterprises, completeness and integrated development of the worked-out

part of the quarry is possible due to the creation of construction of decent entertainment facilities in the future, which will ensure the restoration of the worked-out space in the process of developing the field.

The final stage of mining the quarry field and paying off the mine workings is the final part of the mining and technical restoration of disturbed lands [5]. The measures to prepare favorable conditions for the repayment of spent mine workings and the formation of a given relief of the earth's surface should be carried out during this stage. An important element in the restoration of disturbed lands is reasonably selected technologies for the formation and functioning of internal dumps. Examples of a completed reclamation cycle include recreational areas built in restored quarry areas. The sludge storage facility built on dumps, and one-story houses and a consumer services plant built on a quarry. Reclaimed quarry spaces used for recreation areas.

The reduction of the residual developed space and the increase in the area of the recultivated surface of the dump provided when creating an additional capacity of the internal dump by increasing the resulting angle of its slope [6]. Overburden rocks obtained by ejecting the working board at a steeper slope angle, as well as by lowering its height, used for filling. The accepted slope angle of the internal dump formed by dumping on the distance from the axis of movement of the cantilever spreader, which determined by the location relative to the lower edge of the overhang ledge and increases in direct proportion to the height of the main overburden ledge. The dumping dump-unloading radius decreases from 144 to 107m with an increase in the slope angle of the blade from 13 to 20 degrees, which corresponds to the data of a bucket-wheel excavator. The scientific substantiation of its design parameters provides the largest in area restoration of disturbed lands for mining restoration. Technological schemes for the repayment of the quarry space have been improved, the use of which will significantly reduce the negative impact of open cast mining on the efficiency of land conservation in the operation of horizontal deposits.

The analysis of the directions of use of the developed quarry spaces, taking into account various conditions, indicates that the maximum efficiency coefficient determined by the peculiarity of a combination of factors affecting the choice of the direction of reclamation [7]. At the same time, the construction area of reclamation can increase the efficiency of the use of the developed space several times close to other cities in the vicinity of large cities with developed industrial infrastructure. The placement of technological facilities will significantly save land resources under these conditions. The recreational direction is economically justified in the presence of poorly permeable and weakly dusting rocks that make non-working sides and the bottom of the quarry. Water management direction is feasible only in conditions of flat terrain and requires serious costs to perform works on waterproofing of slopes. The agricultural direction of reclamation provides maximum efficiency in the use of the developed space in areas with favorable climatic conditions and terrain. The proposed method allows you to choose the direction of reclamation, providing higher technical and economic indicators for the subsequent use of the developed spaces.

The special measures are taken to fill quarry voids. When placement of overburden and removed rocks of existing enterprises in a quarry [8]. Then quarry excavations used as a potential resource for waste disposal of any production. All technological schemes for technical reclamation of mineral resources at the last stage should be completed with biological reclamation of the surface. At present, there are no incentive or fiscal tools for timely technical reclamation and restoration of the landscape after the completion of the field development.

Various methods of restoration of used quarries in England, used for reclamation of their developed space, are considered [9]. Methods of rehabilitation of disturbed lands into productive state after mining have been developed. Applied technologies include flattening slopes of ledges and restoring them after blasting. These methods mainly used to prepare the relief of the developed part to preserve vegetation, ensure their safety and adapt to various subsequent situations. At the same time, less traditional methods of natural recovery envisaged and other methods of rehabilitation are discussed. The use of these methods improves the environmental quality of restored lands degraded because of field development.

Local authorities have used an extensive range of rehabilitation solutions to meet the basic needs of the population in order to restore abandoned quarries over several years in various locations, mostly in the wider Athens area [10]. The reclamation of abandoned quarries is a serious problem and should be solved gradually due to the lack of necessary funds and meeting the basic needs of the population. The development of a methodology for the rehabilitation of abandoned quarries is part of a geographical or administrative unit. The use of multicriteria analysis and a geographic information system promotes a quick and cost-effective method of restoring damaged areas. A large number of abandoned quarries are located throughout the country; some of them were used as uncontrolled landfills, which became the main cause of serious environmental pollution. The gradual restoration of abandoned quarries helps to improve the quality of the environment and rational planning of regional development. Adverse environmental impacts and the problem of aggravation in the immediate vicinity of large urban centers are common in many areas. The proposed methodology for selecting suitable quarry sites and determining the most rational rehabilitation solution is a useful intention of the administration.

Quarry pits are located near existing fabricated formations and if they are used, they provide almost ideal conditions for storing waste, taking into account the factor of transportation distance [11]. Filling quarries with waste not only eliminates the threat of deformation processes in the form of landslides, lowering of the territory and its swamping, but also guarantees the technical stage of reclamation of disturbed lands, which minimizes the cost of returning them to economic circulation.

The study of the condition of the open pit space is justified taking into account the existing transport access to the horizons to ensure the front of work during the development of the field [12]. On this basis, methods have been developed to improve the technological and economic efficiency of the technical stage of reclamation by forming receiving containers for the disposal of high-risk

industrial waste. Along with this, the possibility and expediency of placing cinder blocks in the quarry space being developed as part of the technical stage of reclamation of land disturbed by mining have been substantiated. The possibility of building receiving tanks for industrial waste disposal is being considered to increase the economic efficiency of restoration of disturbed territories. The tasks of reducing the volume of waste generation in mining and processing production are being solved as a result, which reduce the load on the environment in the region and increase the level of integrated subsoil development.

The surrounding areas of settlements with the waste space of quarries require a solution to the improvement of the area after the operation of the field by an open method [13, 14]. Rational ways to restore the worked area of open mining include its use for recreational purposes. At the same time, the justification of the best technology that contributes to the preservation of the mining area close to the natural state of the natural environment favors the use of rational methods of reclamation of the quarry space that have been tested in practice.

Conclusions

The higher technical and economic indicators are ensured during the period of exploitation of the deposit with a rational restoration of the developed space of quarries. For this, during the reclamation of the developed space, it is necessary to predict the water level in the artificial reservoir and plan measures to stabilize the watercourse. The task of rational reclamation is achieved by directing their placement when using industrial and household waste to fill the free space of the quarry excavation. The reclamation of disturbed lands during the period of subsurface development increases the efficiency of mining enterprises through the formation of mining facilities. The division of the quarry field into adjacent sections when filling the residual waste space increases the surface area of the dumps for reclamation. The degree of flooding of the developed space depends on the parameters of the created reservoir and the amount of work on the design of the coastline. The use of developed space near large cities with improved infrastructure increases the efficiency of the work performed several times. Timely implementation of technical remediation of disturbed lands contributes to the restoration of the terrain after completion of field development. The preparation of the relief of the mine-out space contributes to the improvement of the ecological qualities of the land and the conservation of vegetation. The restoration of abandoned quarries helps to improve the quality of the environment in the area of subsurface development and can be included in regional development planning. Ensuring the technical stage of reclamation of the worked-out quarry space reduces the cost of restoring disturbed lands. These rational methods of reclamation of the developed space in open mining operations contribute to the preservation of the surrounding area.

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