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Effective mining and transport complexes in mining of technogenic accumulations

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The development of modern society leads to high rate of growth in the consumption of mineral resources, primarily natural ones. The exploitation of deposits of mineral raw materials results in significant volumes of extracted rock mass. Production wastes in relation to the deposit are overburden rocks, host rocks, internal overburden rocks or substandard raw materials unsuitable for involvement in the national economy in terms of their capacity or percentage of the useful component content. These rocks are usually found in surface technogenic formations. At the same time, the current state of the mining industries is characterized by increasing involvement in the mining of deposits with a low content of useful components. As a result, in order to obtain high-quality commercial products, the mined mineral is subjected to beneficiation, which contributes to the additional generation of beneficiation waste (tailings). The beneficiation waste is inherently a poor mineral raw material, which is formed as a result of imperfect beneficiation technologies, excessive economic costs for extracting the component to the full or lack the ability to technically implement advanced beneficiation methods.

Technogenic formations of overburden rocks, substandard raw materials and previously formed beneficiation wastes are currently under special attention among scientists and producers as potential sources of additional attraction of useful components [1].

The prospects for mining of technogenic accumulations depend mainly on the availability of technological beneficiation schemes, the possibility of industrial production of equipment and the economic feasibility of repeated beneficiation of raw materials. Given the current level of science, technology, beneficiation technologies and taking into account the possible further use of the obtained raw materials, they usually operate with the concepts of conditions for mineral raw materials, indicators

and parameters of conditions as a set of ultimate requirements for the quality and quantity of mineral raw materials, mining-geological conditions of occurrence, mining-technical and other conditions for mining the productive deposits. These design conditions ensure the most complete and cost-effective mining and utilization of existing mineral reserves and resources [2].

An important influence on the feasibility of re-attracting previously processed raw materials is the right choice of mining and transport complexes in mining of technogenic deposits.

In recent years, a surprisingly difficult situation has developed in the field of extraction of carbonaceous raw materials as the main energy carrier. Therefore, an extremely urgent scientific and practical problem is the creation of scientific foundations for the substantiation of effective mining and transport complexes for mining of technogenic accumulations.

The combination of technologies for mining-loading and transport operations, as well as the technical means for their implementation is usually considered as a single technological complex. The elements of the technological complex are the technologies for mining-loading and transport operations, as well as mining-loading and transport machines.

The efficient technological complexes of mining operations are selected on the basis of full compliance with the technical, technological characteristics of mining-loading and transport equipment, taking into account the specific mining-geological characteristics of dump accumulations of carbonaceous raw materials, mining-technical conditions of occurrence, which should correspond to the peculiarities of mining technology [3].

The theoretical and practical foundations for attracting additional mineral resources are considered from the point of view of exploiting existing technogenic deposits, since their shape and the granulometry of the raw materials contained in them contribute to their mining and extraction of valuable components, as well as to obtaining a sufficient profit [1]. But usually the research results are of a general nature and concern technogenic accumulations that are more homogeneous in their genesis and physical-chemical characteristics than technogenic accumulations of carbonaceous raw materials. A promising technological solution in the field of extraction of carbonaceous raw materials is the involvement of solid ash-and-slag waste from coal-fired thermal power plants [4, 5]. The implementation of the proposed technologies is not possible for all accumulations due to various parameters of the modulus of particle size, from which they are formed: in ash-and-slag waste, the particle size modulus does not exceed 6 mm, and in waste heaps – <0.063-40 mm at a maximum of 400 mm, which is a limiting factor for the technological solutions proposed in [4, 5] (excess is by 6.67 and 66.7 times, respectively).

Therefore, given the insufficient degree of research into the specifics of processing, the purpose of this study is to substantiate rational mining and transport complexes as a guarantee of efficient and high-performance re-attraction of stockpiled carbonaceous raw materials.

The sequence of technological decision-making on the choice of an effective mining and transport complex is as follows:

- analysis of technogenic accumulation parameters and properties of carbonaceous raw materials;
- the choice of the mining method;
- the choice of complex mechanization methods;
- proper selection of efficient technological complexes.

When analyzing, particular attention is paid to the average useful component content in the accumulation, the peculiarities of its localization within the technogenic deposit, the hydrogeological and mining-technical characteristics of the formation, the granulometric composition and its distribution, the physical-mechanical properties of the rocks, the location of the dump and its remoteness from the mobile processing complex, availability and technical condition of transport communications, parameters of existing work sites are studied.

In the vast majority of cases, dump accumulations of carbonaceous raw materials are the main waste of underground coal mining – waste rock dumps (waste heaps). They are a combination of preliminary crushed rocks and fractions of coal. In terms of their physical-mechanical, hydrogeological and mining-technical characteristics, the rocks of technogenic accumulations are suitable for surface mining using modern methods of complex mechanization.

According to the number of constituent components, technological complexes are divided into (Table 1) one-component, two-component and three-component (two types of transport) and are called by the name of the machines involved in the processes.

Table 1.

Classification of technological complexes

By the number of components	Name of technological complexes
One-component	Excavator Bulldozer Scraper Hydromechanized With loaders
Two-component	Excavator-rail Excavator-autotruck Excavator-conveyor Excavator-cantilever-belt Excavator-dumping-bridge
Three-component	Excavator-autotruck-rail Excavator-autotruck-conveyor Excavator-autotruck-skip Excavator-autotruck-cage Excavator-various type-autotruck

The final choice of the technological complex is performed in accordance with the specific conditions for the location of technogenic accumulation based on the above

sequence of technological decision-making selection. Usually, plants for the useful component extraction are located as close as possible to the accumulation, and therefore one-component complexes using front-wheel loaders at a transportation distance of 0.7-0.9 km occasionally become widespread. The most effective mining and transport complex in mining of technogenic accumulations is a two-component excavator-autotruck complex (Fig. 1), combining high performance, mobility, maneuverability and complex mechanization.

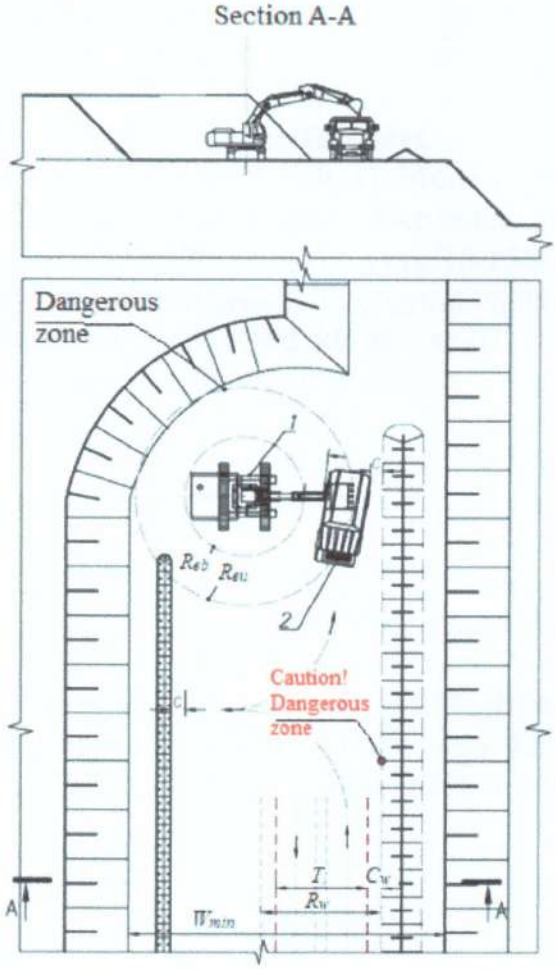

Figure 1 – Schematic diagram of the two-component excavator-autotruck complex operation: 1 – hydraulic excavator; 2 – career dump truck; C – distance from the dump truck to bund wall at maneuvering, m; W_{min} – minimal width of working area, m; R_{eb} – the radius of turning of excavator body, m; R_{eu}– the radius of the excavator unloading, m; T_l– width of the transport lane, m; C_w– the width of the shoulder along the carriageway of the road, m; R_w – road width, m.

Conclusions. Mining of coal deposits under conditions of shortage of raw materials and energy resources should be based on a systematic approach to increase the resource potential of production by attracting previously stockpiled carbonaceous raw materials. The determination of effective mining and transport complexes with the repeated involvement of raw materials into production is a multi-criteria analysis of the specific conditions for a useful component occurrence based on a comparison of laboratory, field, desktop research and modern requirements to the final product

quality. This contributes to the creation of scientific foundations for the substantiation of rational mining and transport complexes as a guarantee of efficient and high-performance re-attraction of stockpiled carbonaceous raw materials.

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