Problems of a Transport Complex of Mining and Processing Plants

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Abstract. The article considers problems of a transport complex of mining and processing plants. Requirements for quarry transport are presented. The production process and technological operations of the transportation process are considered. The ways of solving the problems of the transportation process are determined. It is established that when creating a rational system for transporting iron ore raw materials, it is possible to reduce material costs and losses during transportation.

1 Introduction

Iron ore is one of the most common minerals used for the production of steel and cast iron. To carry out the process of transporting the extracted raw materials from the quarry to the mining and processing plant, it is necessary to create a transportation system, providing transportation of raw materials with minimal costs: material, labor, financial, temporary. The process of reducing costs is possible if problems of a transport complex of mining and processing plants are solved. Efficiency of resource use and efficiency of the enterprise's activity largely depends on the system of transportation of raw materials, as well as on the number and condition of the operating machinery. Therefore, the study of the transportation process and its improvement is an actual task.

Transportation of iron ore is connected with its production and extraction. Initially, before the implementation of the production and transportation process, production plans and technological operations are established, which determine the sequence and scope of work; the number of working days is considered, a work schedule is drawn up; monthly work plans are prepared, indicating the main indicators that require implementation in a certain period [1]. The plans drawn up include parameters such as the amount of drilling, the arrangement of transport, the determination of the places of extraction of iron ore raw materials, indicators of mined minerals, the terms of the performance of extraction and transportation, the volume of the cargo being transported, the time of transportation, the route of transportation, etc.

Transportation of iron ore raw materials and metal resources depends a lot on the properties and characteristics of the extracted minerals. Requirements for the preparation of marketable products. Extraction of minerals solutions open, open-underground, underground methods.

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The transportation complex of mining and processing plants includes various types of quarry transport: railway transport, road transport, conveyor transport, cable, hydraulic transport, scraping means of delivery, etc. The choice of transport is determined by the type of transportation of the mining segment, weight and volume of cargo, transportation distance from career at the enterprise, delivery time.

The transport complex of mining and processing plants: prefabricated, railway trains, cars, bulldozers, motor graders, compactors, excavators, dump trucks, drilling machines, crushing plants, etc.

To assess the performance of mining and processing plants different indicators are used. So, for example, to evaluate the work of excavators use indicators such as: the volume of extracted raw materials in m^3 and the time of extraction of raw materials in hours. The productivity of the excavator, m^3 / h, is determined by the ratio of the volume of extracted raw materials and production time. To evaluate the performance of cars used indicators such as: the volume of goods carried in tons, the time of carriage of goods in hours, idle time, including due to failures of a particular car system. The car's productivity is defined as the ratio of the volume of transported raw materials to the time of transportation. To assess the work of warehouses use such indicators as: the arrival and consumption of minerals in tons, the amount of change in the volumes stored in a warehouse in tons, the operating time of the warehouse in hours [4].

Statistics operate on the final indicators of work, such as: the production of the enterprise for a certain period, the operating time of the equipment, the number of repairs carried out and the time of their conduct [3].

Requirements for career transport:
• Providing transportation capabilities;
• Ensuring reliability and durability of nodes and aggregates of transport;
• Rationality of the complexity and costs of transportation;
• Ensuring safety in the operation of transport;
• Ensuring environmental friendliness in the operation of transport;
• Delivery of goods in the shortest time;
• Ensuring the safety of cargo [17].

While transporting raw materials on railway quarry transport, the maximum size of transported goods should not exceed 1250 mm. In open-pit trucks it is allowed to be loaded into the body of a quarry and underground dump truck a rock mass with a piece size of up to 600 mm. With the belt conveyor tool, a rock mass of granulometric composition up to 300 mm is allowed for transport on a conveyor belt with a width of up to 2000 mm. In the case of pipeline hydrotransport, the maximum piece size up to 30 mm is permissible by the condition of moving a solid in the liquid flow [7].

2 The main problems of the transportation of iron ore raw materials

To study the problems of a transport complex of mining and processing plants. It is necessary to consider the transportation process of minerals in ore and coal deposits [6].

In closed systems (in ore quarries) iron ore is transported by rail. Rolling stock has several railway carriages of open type. Wagons operate only within the quarry. The main purpose of transportation in closed systems with non-disconnected wagons is to deliver raw materials to the destination.

The transportation process in open systems (in coal mines) differs from closed systems, because the transportation process is performed differently. Wagons before loading with minerals are unhooked into groups, and after loading they are reunited. The main purpose of

transportation in open systems is to build a transportation management system, efficiently distribute wagons, delivered raw materials to the destination.

In mining and processing plants the production process, the extraction of raw materials and their transportation are different. Mainly it depends on the characteristics of the extracted minerals, the quantity and condition of transport equipment, the volume of production, material costs, etc.

The production process of mining and processing enterprises consists of the following main stages:

• Extraction and delivery of ore to averaging and intermediate warehouses;
• Transportation of ore from the averaging and intermediate warehouses to the concentrating factory;
• Enrichment of ore at the concentrating factory [2, 10].
• Technological operations of transportation are divided into:
• Production (extraction and concentration of iron ore);
• Auxiliary (warehousing);
• Serving (transportation of raw materials).

On the example of iron ore the transportation process presented in Figure 1.

All these processes can be represented in the form of elements of production that interact with each other through material, information, and service flows, carrying out an organized, purposeful activity to manage these flows, thus forming a logistical system [8].
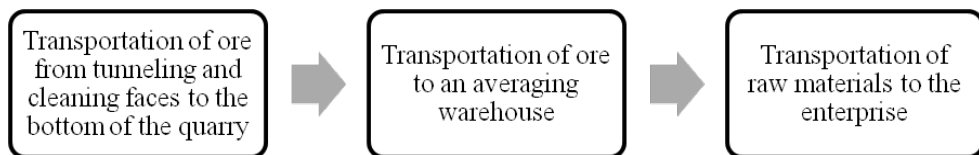

Fig. 1. The process of transporting iron ore.

The main problem in the transportation of minerals in mining and processing plants is the disruption of the interaction of operations performed during the transportation of raw materials from the quarry to the enterprise [18]. The analysis of the efficiency of the transportation process should be carried out not on the basis of the study of individual objects, for example, the efficiency of the functioning of vehicles, the efficiency of maintenance and repair of transport, etc., but on the basis of the study of all elements and objects involved in the transport process [5]. The transportation system should control not one segment during transportation, but the interaction between each segment shown in Figure 2. The study of one particular object of the transport process can lead to congestion or underload of the process at another facility. This leads to a decrease in the efficiency of transportation indicators, which does not allow reducing costs for the delivery of raw materials to the enterprise. In turn, while studying all objects of transportation, it is necessary to take into account dynamic changes in the volume of work. The well-established work between the place of extraction, temporary storage and enterprises, as well as intermediate units will allow to reduce losses during transportation, transportation costs, transportation time, transport downtimes.

Fig. 2. Interaction of the main processes in the extraction of iron ore raw materials.

The main goal of the transportation process is to deliver iron ore raw materials, in the right amount, to the destination, at the right time, with the least losses and costs, excluding malfunctions.

Improvement of the process of transportation of extracted raw materials should be directed not at achieving the maximum volume of production, but at ensuring the uninterrupted operation of production, reducing possible failures, reducing the occurrence of a number of transport failures and other conditions that entail a halt in the transportation process.

The solution to these problems is the creation of operational planning, which consists in the following:
• Regular maintenance of vehicles;
• Continuous monitoring of the transportation process;
• Efficient distribution of transport across work areas;
• Effective distribution of the volume of transported cargo;
• Choosing a rational transportation route;
• Creating a time interval.

When operating a transport that carries iron ore raw materials, it is necessary to ensure the uninterrupted operation of transport systems and units. The technique is used for the transportation of raw materials has already expired often [16]. The use of outdated technologies increases the wear of parts, even with minimal load.

Therefore, mining and processing plants periodically need to update the fleet of vehicles. Replacement of equipment for a new, regular maintenance, with periodic replacement of consumables and parts, carrying out timely maintenance of transport will reduce the occurrence of a number of faults, increase mileage before major repairs of vehicles requiring large investments, and reduce the possibility of downtime of equipment waiting repair.

When mining iron ore, in the quarry should be formed work sites, bases for maintenance and repair of transport, the relevant routes (roads) for transport, storage areas for transport and equipment, temporary storage [13]. Currently, the primary task in quarries is to extract minerals and transport to the destination. The question of the formation of a system of maintenance and repair on the ground near the places of extraction of raw materials remains open [15]. In the event of a transport failure, there may be disruptions in the transport process, which may lead to a slowdown in production, thereby causing a disruption in the overall operation. So, the formation of working areas and service bases will reduce losses during transportation, it will be possible, without stopping the production process, to eliminate possible malfunctions on the ground.

One of the problems of the transport complex of mining and processing plants is the traffic routing. For enterprises, the main task is to develop an optimal route for the transportation of iron ore with the lowest costs. The route is based on such indicators as: the distance from the place of extraction to the quarry, the time of transportation of the cargo, the fuel consumption of transport, the mileage covered by the transport, the speed of transport, the time taken to perform loading and unloading operations. Taking into account these factors, it is possible to construct an optimal transport route with the least losses.

The time of transportation of iron ore raw materials consists of the time of registration of transportation documents, the time spent on traffic, idle time due to various operations, time for maintenance. With a reduction in the timing of the delivery of raw materials from the quarry to the enterprise, it is possible to reduce material costs and increase the volume of the cargo being transported.

Providing non-stop operation of the transport complex is possible with reducing the time for loading and unloading [11]. To exclude the downtime of transport, it is necessary to form a system of supplying equipment to the excavator after a certain time interval. Thus, the reduction of economic losses is achieved due to operational work "dump truck - excavator."

The reasons for idle time of dump trucks in anticipation of loading is the absence of a formed system, which regulates the interval of motion [12]. The downtime of the transport complex is affected by:

• The structure of the fleet of cars;
• Number of vehicles;
• Technical characteristics of transport;
• Priority of feeding the dumper to the excavator;
• Time of submitting the truck to the excavator.
• As a result, there are downtimes of either a dump truck or an excavator. Steady loading of equipment excludes the possibility of delays when entering and leaving the loading and unloading areas.

3 Conclusion

In connection with the huge volumes of transportation of raw materials, many enterprises are just beginning to introduce modern information systems in the transportation process. At many enterprises there is no established relationship between objects of transport through communications. With the increase in production volumes, mining and processing plants need reconstruction of production. To increase the efficiency of all stages of production, including transportation of extracted minerals, it is necessary to build a transport management system using information technology [9]. The automation of the transportation process consists in the active use of fiber-optic cables, radio communication facilities, a permanently operating Internet network, and wireless communications.

In quarries there are no dispatch centers, duty stations, which control the transportation process. The presence of these stations will allow to observe the process of transportation of raw materials in each section with the help of computerized systems, as well as the introduction of the identification of transport, which collects data on the location of machines, would largely solve the transportation problems. To regulate the transportation process throughout the career, a single control center is needed, which will monitor the movement of vehicles on each site in real time [14]. Active use of information systems, provision of communication facilities between objects, will allow to control the movement of vehicles remotely, monitor the state of transport, track the location of objects, ensure traffic safety, adjust the traffic schedule, provide information on delays and failures, etc.

The solution of the problems of a transport complex of mining and processing plants will allow to develop a system of transportation of raw materials from the field to the enterprise with the least losses during transportation, which in turn will reduce the material costs of transportation, will reduce the volumes of iron ore stored in temporary warehouses, and ensure uninterrupted operation of transportation of minerals.

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