

Analysis of the State and Development of Vehicles Working in the Quarry

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Annotation: This article provides information about cars operating in a quarry, which is the main traffic flow of industrial vehicles. An analysis is also given of opinions on the serious development of road transport, due to its criteria and advantages, in comparison with rail transport and conveyor modes of transport.

Keywords: mining equipment, road transport, CIS countries, dump truck, vehicle fleet.

Introduction

The main flow of transportation by industrial transport (up to 65%) is accounted for by cars working in a quarry. Road transport, due to its criteria and advantages, has received significant development compared to rail transport and conveyor modes of transport. A significant change in mountain conditions during mining creates a need for further development of the design of dump trucks operating in a quarry [1].

Research Analysis

All models and modifications of dump trucks produced by ICHB "BelAZ" are mainly used in quarries in the CIS countries. Mining transport equipment of foreign firms is also used in quarries in limited quantities. Table 1 shows the structure of the dump truck fleet in the CIS countries [2].

Table 1. Structural composition as of 01/08/2020 of the BelAZ vehicle fleet in the CIS countries

CIS countries	Load Capacity									
	30	42	45	55	80	110	120	130	180	200
Russia	3840	2749	316	323	64	42	548	320	83	77
Ukraine	1247	774	32	1	-	26	168	18	-	-
Kazakhstan	242	459	33	25	34	22	56	2	-	-
Uzbekistan	139	157	10	-	34	22	56	2	-	-
Georgia	31	65	-	-	-	-	-	-	-	-
Armenia	42	113	10	6	-	5	-	-	-	-
Azerbaijan	23	45	-	-	-	8	-	-	-	-
Tajikistan	18	7	3	-	-	-	-	-	-	-
Belarus	87	84	2	-	-	-	-	-	-	-
Total:	5669	4453	406	355	129	107	775	344	83	77

Today, there are many mining machines on the market, both in terms of carrying capacity and other operational characteristics. For any mining enterprise, it is possible to choose the most rational machine model that is fully compatible with the relevant operating conditions.

Table 2 shows that only four companies in the world: BelAZ, Komatsu, Caterpillar, Ebtlid-Hitachi produce trucks capable of carrying cargo from 35 to 380 tons.

Mining dump trucks manufactured by various companies in the world have two design schemes: the first is the traditional scheme, in which all units and systems of the dump truck are installed on a single frame; the second is a

hinged frame scheme. More than 65% of the world's mining dump trucks have a 4x2 wheel arrangement and are designed according to the first scheme.

Table 2. Classification of trucks of the world's leading companies by carrying capacity

Manufacturing company	Load Capacity, t								
	30-50	51-70	75-113	120-136	140-170	170-197	200-238	270-290	300 and more
	7528 7540 7548 75473	7555A	7549	7512 7514 75131		75215	75303	75501	75600
BelAZ	HD325-6 HD405	210M HD465-5 5HD605-5	330M HD785-5 HD985	HD1200-1 HD1200-ID HD1200M	530MHD1600M	63 OE 685E 730E	830E	930E	-
Komatsu	769D 771D	773D 775D	777D	785B		789B	793C	-	797
Caterpillar	R32, R36, R40, R50	R65	R85	R130	R150	R170, R190, R220	R260	-	-
Euclid	-	-	MT 3000	MT3300	MT3600B	MT 3700B	MT 4400	MT 4800	MT 5500
Unit Rig		-	-	-	-	T252	T262	T272	T262

The advantages of the traditional 4x2 layout are as follows: the structure is simple; the working radius is small. Disadvantage: the loads are distributed unevenly along the axes. According to the second scheme, dump trucks of smaller (up to 35-45 tons) or very large (up to 275-420 tons) carrying capacity are produced. The articulated chassis of the dump truck has a 4x2 wheel arrangement. These machines are completely autonomous. They can also be operated with the wheel formula 6x2, 6x4.

The maneuverability of machines in the hinged scheme is much higher than in the conventional scheme, which is its advantage (the turning radius can be reduced to 6-7 m).

Due to the complexity of the design, maintenance costs are also high. The articulated joint with two degrees of freedom not only increases the cross-country ability of the machines, but also increases their maneuverability. When driving, the body holds the metal well even in off-road areas.

Currently, dump trucks are equipped with tubeless tires, which allows you to safely operate dump trucks. In tubed tires, a catastrophic situation can arise if the tube is punctured, a large section of the tube can suddenly fail, and the air pressure drops almost sharply. The same thing happens when there is a crack in the weld. Such a crack imperceptibly increases with the movement of the wheel until it fails.

A particularly dangerous situation can arise if this happens on the front wheel at high speeds. In the tubeless version, in both cases, the air leaves the tire slowly. The pressure drops slowly and there is no emergency. The working conditions of the tires are improved due to a significant reduction in the generated heat, which increases their mobility by 7-9%.

Until recently, the main factor limiting the use of modern diesel-electric dump trucks in deep quarries was considered to be overheating of the electric motors of traction generators and wheel motors [4]. This problem was completely solved in subsequent years due to a significant improvement in hauling of mining trucks. The latest models of BelAZ dump trucks are capable of operating without overheating with traction motors at a rock lifting height of 350 m or more.

Usually, at the present stage of development of mining equipment, diesel engines with a capacity of up to 1100 kW are used as power units of the HMP (hydromechanical transmission), along with dump trucks with a carrying capacity of up to 120-150 tons, diesel engines of high power - EMT with a carrying capacity of more than 190 tons in dump trucks (used in conjunction with an electronic-mechanical transmission).

Considering the general trends in increasing labor productivity, we can expect a slight increase in the power plants of mining dump trucks to increase the lifting speed to the height of most machines up to 17 km/h.

At present, road transport with a carrying capacity of 210 tons or more can provide any productivity of the quarry - 190 million tons per year. up to tons or more [3, 5, 6].

However, road transport, as a quarry transport, often suffers from the complexity of mountain conditions associated with the depth of excavation.

As the quarries deepen, it becomes more and more difficult to cut and transport rock from deep horizons, the productivity of mining and transport equipment naturally decreases, and, despite technical progress, the cost of ore extraction increases.

In addition, road transport operating in a quarry is considered a source of negative technogenic impact on the environment in the deep horizons of open pits. It is known that road transport in a quarry is the main source of environmental pollution. At the same time, calculations show that the size of losses from environmental pollution, calculated according to existing criteria, cannot have a significant impact on decisions on investment projects. In order to increase the investment potential of measures to improve the ecological state of quarries, it is correct to use the estimated value of "loss of annual income" due to downtime of mining and transport equipment as a criterion for assessing pollution losses.

This is especially true for very deep (450 m and more) and small planned open pits mining valuable ores, where equipment downtime is 1450 hours per year.

The search continues for new technological schemes, as well as ways to improve and develop it in order to expand the scope of vehicles in deep quarries and increase its efficiency. Electrification is one of the main areas of career vehicles. Diesel transport provides:

- an increase in the speed of walking uphill by 18-28%,
- increase in labor productivity by 9-12%;
- reduce diesel fuel consumption by 45-65%;
- reduce energy costs;
- improvement of sanitary and hygienic conditions in deep quarries;
- reduce operating costs by 12-18%.

Conclusion

Currently, the production of cars with design parameters designed for specific operating conditions is a problem.

The main elements of the dump truck are to increase the carrying capacity. In cooperation with the Navoi Central Research Center, BelAZ and a number of metallurgical plants, comprehensive research and development work was carried out to produce corrosion-resistant, low-alloyed high-strength steel. Such steels are intended for the manufacture of load-bearing elements of the crankcase of the rear and front axles, parts of the guide vanes of the front and rear suspensions, as well as elements of cargo platforms that are subjected to rapid friction during operation.

As a result, a reduction in the mass of dump trucks and an increase in reliability indicators are expected.

All this suggests that investment projects for the long-term formation of transport systems operating in deep pits require improvement and development in the following main areas:

- reducing the cost of mining;
- improving the structure of transport equipment, constantly increasing its carrying capacity, increasing productivity;
- development of automated methods for assessing stresses in nodes and production reserve, as well as express testing methods at the stand and test sites;
- helps to reduce the cost of development and modernization of manufactured equipment;
- to improve and organize the production of new tribological materials in order to increase the overall FIC of machines and facilitate maintenance;
- development of transport electronics (processors, controllers), including those for operation at low temperatures;
- mastering the production of modern thickening and noise-insulating materials, as well as materials for interior trim of cabins in order to create comfortable conditions at the operator's workplace;
- introduction of new developments in the field of nature protection, continuous improvement of environmental and ergonomic qualities of trucks;
- to build a unified information environment that ensures the exchange of information between all parts of the production.

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