

The analysis of mining conditions influence to operating time of dump trucks traction drive components

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Abstract

Based on the analysis of downtime of dump trucks BelAZ-75131, used in the transportation of the rock mass in iron ore pits at the Kryvyi Rih region and coal mines in the region of the Kuznetsk Basin, it was found that downtimes happen 43% more often on the iron ore pits because of technical influences on truck electromechanical equipment. The results of crack detection analysis of elements of traction electric machines of those pit trucks show that the number of cases of breakdowns and deterioration of winding insulation, the failure of the brushes, tipping of an arc on engine manifold in comparison with the same defects of traction machines, which are equipped with a similar coal pits trucks, increases by 33.2%. To find the cause of this problem the mining conditions of the given model of truck were analyzed at the deposits of the two fields. It was established that the mining conditions does not significantly influence the occurrence of the identified differences in the number of faults of the mentioned nature.

Keywords: DUMP TRUCK, ACDC DRIVE, MINING CONDITIONS, COAL MINE, IRON OPEN PIT, DOWNTIME, BREAKDOWN, TRACTION ELECTRIC MACHINE

Up-today development of innovations all over the world is characterized by production increase of open pits due to the rate increase of their deepening. It requires providing of maximum indices of machines complexes usage which are used in mining [1]. This issue concerns those

vehicles that transport the most amount of natural resources mined in Kryvyi Rih region. They comprise dump trucks BelAZ 7513 series which are equipped with AC-DC drive. But meeting the demand as for pit-run dump trucks productivity increase is complicated by down-time of this

equipment, most of which has organization-technical principle. Moreover, from the financial point of view exactly that down-time is rather essential for electromechanical transmission dump-trucks which is caused by failures of traction of electrical machines as a result of great balance cost of them.

Thus, taking into account traction electrical machines down-time a research has been carried out as for their elements malfunction following the information which was provided by plant-manufacture of mined equipment BelAZ on the base of the agreement from 20.01.2010 No600-10242 "About collaboration in effectiveness increase of BelAZ exploiting and preparation of qualified personnel in Ukraine" between Kryvyi Rih Technical University (at present state high educational institution "Kryvyi Rih National University"), open joint stock company Belorussian automobile plant (at present holding company "BelaAZ HOLDING") and open joint stock company "BelAZ Service Ukraine" (at present LLC "Service Trade Logistics Centre BelAZ Ukraine").

In the result of obtained data analysis it has been established that for pit-run dump tracks BelAZ-75131 there is increase of electrical machines failures number in comparison with dump tracks of the same model which carry out transportations under similar mine technical conditions in coal mines of Kuznetsk basin.

Complimented by it an actual question arises as for causes revealing of electrical traction machines of dump-tracks elements failures increase that work in the mines of Kryvyi Rih

region for organization of technical down-time reduction and expenses for the repairing of traction equipment that is directed to natural recourses transportation prime cost decrease.

Compared analysis of down time percentage correlation caused by necessity of technical service and main components of electrical transmission repairing has been carried out for pit-run dump tracks BelAZ-75131 which are involved in mined rock transportation in Kryvyi Rih iron-ore mines of CC "Kuzbasrozvugilya".

On the basis of technical documentation data analysis in the form cards of automobile car park service in Kryvbas mines and Kuzbas coal ones for a period from 01.01.2012 till 01.06.2013 obtained in accordance with the agreement and time indices of dump-racks down time due to service maintenance, preventive and restoration repairing of transmission components [2, 3] has been done selection of approximately the same dump-tracks as for bring service startup running.

Compared histogram of down time which is caused by technical influence on electromechanical transmission elements of dump-tracks of Kuznetsk and Kryvyi Rih basins has been represented on the picture 1. In accordance with down time histogram we can see that the traction electrical machines (traction generator and electro engine) repairing or change take 62 % out of the total down time of traction equipment or dump-tracks in Kryvyi Rih region and 54 % in Kuzbas. Down time cases connected with towing generator repairing take place in Kryvyi Rih mines 24 % more often, and electrical engine 14 %.

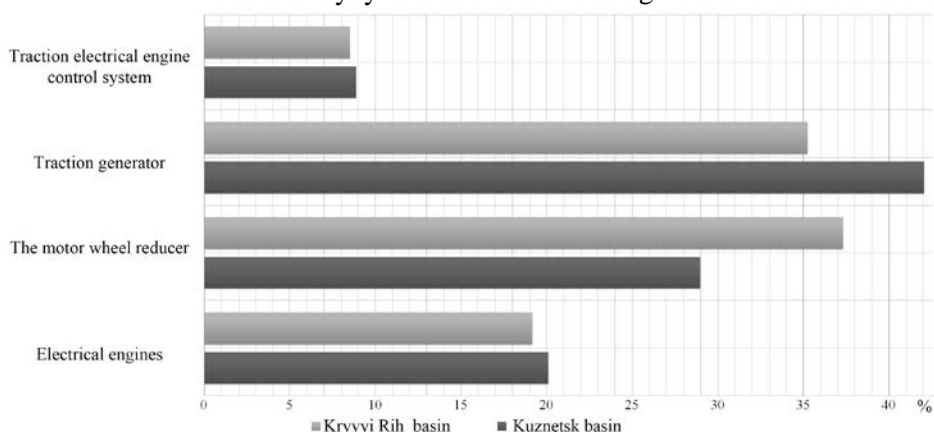


Figure1. Histogram of down time due to technical influence on the electromechanical transmission components of BelAZ-75131.

At the same time a number of mechanical transmission failures prevail in coal open-pit mines. In 2008 Kedrovsk open-pit mine lost 18286.7 motor hours (26.05 % out of total down time), Mohovsk – 5855.7 motor hours (45.63 %),

Bachatsk – 23100.8 motor hours (29.86 %), Kaltansk open-pit mine – 10977.4 motor hours (31.83 %) due to motor wheel reducer failure. On the whole six mentioned above "Kuzbasrozrizvugilya" open-pit mines lost

80699.7 motor hours due to reducer failure (that is 23 % out of total technological auto transport down time) [4].

The main reasons that cause generator and traction electrical engine efficiency problems is reduced insulation resistance of the windings, the breakdown of winding insulation in the body, excessive sparking under the brushes, unsoldering of the stator winding or its findings in the frontal part, conclusions coils of rotor poles or jumpers burnout, burnout or breakage of the connecting tire between the winding and slip rings, inter-turn circuit in the windings, the electric arc transfer by collector, breakdown and unwinding armature winding glass rim. In addition, the performance of the traction electric machines is characterized by elevated heating of contact rings and bearings [5]. The distribution of these causes that results in resources degradation and the probability increase of traction generator and an electric motor engine failure have been established on the results of testing (figure 2).

Traction electric machines dump trucks BelAZ-75131 that work on Kryvyi Rih mines are

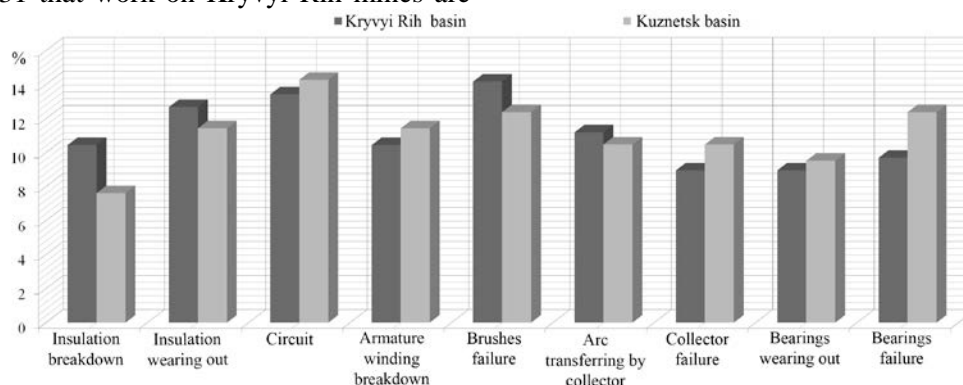


Figure 2. Causes distribution of traction generator and electrical engine efficiency troubles according to flaw detection results.

The increase in the number of breakdowns and intensity of winding insulation deterioration, brushes failure and the arc transferring by the traction electric machines collector that has been established by flaw detection method, may occur due to traction electric machines intense heating [5]. In this regard, the traction electrical engines temperature mode assessment becomes necessary; it depends on the specific mining conditions of the truck.

To establish the degree of Kryvyi Rih basin pits and Kuznetsk coal mines mining conditions influence on the traction electric machines heating, it has been performed their comparison. Kryvyi Rih iron ore mines are characterized by a deep productive seams of deposits, significant depth of mine workings,

characterized by breakdown and deterioration of the winding insulation, brushes failures, the arc transfer by collector. In comparison with Kuzbas generators and motors trucks, the amount of these failures is 42.0 %, 29.4 %, 31.5 %, 26.6 % more respectively, and in average is 32.3 %, which is a significant feature.

To eliminate most of these malfunctions unit disassembly and its constituent parts replacement or repairing is required, which presupposes a considerable time investment and it leads to trucks down time increase [6]. According to the above mentioned service cards, it has been established that 13.1 % out of the total mine vehicles downtime are accounted for electrical part of the traction drive troubleshooting. In general terms, regardless of the climate zone and type of minerals that are transported, the main amount of mine trucks downtime is caused by technical reasons. It reaches 88 % out of the total number of trucks downtime in the Kryvyi Rih iron-ore pits and 94 % in coal mines in the Kuznetsk basin [2].

small size of working area in lower part [3]. Productive deposits of Kuznetsk pits comprise a group of layers with shallow groundwater wings [7]. In spite of the significant difference in the depth of mining working, the average distance of rock mass transportation by road is 3.0 and 2.9 km for Kryvyi Rih and Kuznetsk basins, respectively. Long distance transportations in mines are characterized by their considerable depths, and in the open pits – by their length. Thus, Mokhsivsk operational stations are located with a distance from 5 to 25 km [7]. With the average difference of the fields depth of compared basins in 153 m, the average weighted longitudinal slope of tracks in iron ore mines is 6 %, and in coal mines – 5 % [2].

Thus, the considered above basins fields are very close in mining conditions and

parameters, namely, the transportation distance, the longitudinal bias lines, the usage coefficient of dump trucks, which characterizes the traction electrical engines work in approximately identical ranges of loadings. On this basis, and after carrying out calculations concerning traction electrical engines heating under the existing method [8], it has been established that for trucks used in two basins, the engines will have almost the same rate of heating, which is close to the maximum one, but will not exceed it.

Thus, the mining conditions of mining vehicles exploiting can not create a significant difference in the number of individual elements of the traction electric machines failures. So, based on the analysis of service cards of dump trucks BelAZ-75131, which work in Kryvyi Rih mines, it has been established that there is an increase in their downtime due to maintenance and repairing of electro-mechanical equipment in comparison with coal mines trucks by 43 %, as a result, before all, the breakdown and deterioration of the winding insulation, brushes failure, arc transferring by traction generators and motors collector. These faults occur at an average 32.3 % more frequently in Kryvyi Rih region trucks in comparison with electric machines trucks of Kuznetsk basin, which is a significant indicator.

Kryvyi Rih iron ore and Kuznetsk coal basin open-pit mines analysis has allowed us to establish that the deposits are close in terms of rock mass transportation such as the average distance of transportation, the longitudinal slope of trails and utilization-duty trucks carrying capacity coefficient, which causes the operation of the traction motors in close loading ranges that are close to the maximum parameters, which causes almost the same rate of engines heating and can not significantly affect the resulting difference fault of its elements.

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