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ПЕРСПЕКТИВЫ РАЗВИТИЯ БОЛЬШЕГРУЗНОГО АВТОМОБИЛЬНОГО ЭЛЕКТРОТРАНСПОРТА

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DEVELOPMENT PROSPECTS OF HEAVY-DUTY AUTOMOBILE ELECTRIC TRANSPORT

Heavy-duty dump trucks take part in the rock formation transport in open-pit mining. Nowadays the most commonly used scheme of electric power installation is the system consisted of diesel generator set and electrical motors of power-wheels feeded from it.

Considering the active evolution of electric transport in the market segments of light vehicles and public transport, and also taking into account that the executive element driving heavy-duty dump trucks is an electric motor, its obvious development is the transformation to an all-electric power installation.

Below we will analyze the state-of-the-art of all-electric heavy-duty dump trucks. The table shows basic technical characteristics of all-electric rock haulers by leading manufacturers.

Table

Technical characteristics of all-electric rock haulers

Rock hauler	Off-highway truck capacity	Power of engine installation	Capacity of a storage battery	Brake energy regeneration
Caterpillar 793 Electric [1]	262 t	2650 h.p.	1 MW·h	+
Liebherr T 264 [2]	240 t	2700 h.p.	1,4 MW·h	+
BelAZ-7558E [3]	90 t	–	675 kW·h	+
Komatsu E-Dumper [4] based on Komatsu HD605-7	110 t	–	600-700 kW·h	+
Hitachi EH4000 AC-3 [5-6]	221 t	2500 h.p.	–	+

793 Electric by Caterpillar is an all-electric autonomous rock hauler. Its characteristics are analogous to the diesel ones, but results of field tests [1] showed, that storage batteries allow realization of some additional loaded trips even after a 1-km route up a 10% grade. It was achieved owing to the brake energy regeneration on descent. The maximum speed is 60 km/h.

T 264 by German engineering company Liebherr on storage batteries by Williams Advanced Engineering has rapid charge and large energy store, and also the opportunity of brake energy regeneration. Charge time in speed mode is 30 minutes, power installation is 3,6x1,6x2,4 m from 8 blocks. Each block is composed of 36 modules with individual cooling and control system [2].

Belarusian Automobile Plant designed BelAZ-7558E [3] on traction batteries, shown in the picture 1, fitted with recovery system. The maximum speed is 64 km/h, there are 15 lithium-ion batteries, charge time is 15-20 minutes.

Electric truck Komatsu E-Dumper by Swiss Kuhn Schweiz AG [4] with 65-ton truck body by means of storage batteries with capacity in 700 kW·h through regenerative braking and on descent restores about 200 kW a day per 10-20 trips «quarry-cement factory». Technical characteristics of analogous Swiss dump truck are [7]: capacity of a storage battery by weight 4,5 t is 600-700 kW·h, dump truck 9,4x4,2x4,4 m weights 45 t, truck body weights 60 t.

Japan company Hitachi produced an electric dump truck-trolleybus [5], shown in the picture 2, on the basis of specialized dump truck Hitachi EH4000 AC-3 [6]. It recharges its storage battery by overhead system voltaged 2,6 kV and equipped with a regenerative braking system, that eliminates stops for recharging and allows simultaneous using of some similar vehicles [8].

Rock haulers on storage batteries reduce operating costs of the vehicles' life cycle and increase the service life, reduce the frequency of necessary maintenance [3].

Fig. 1. Off-highway dump truck BelAZ-7558E of 90 t capacity

Robotized BelAZ-7513R of 136 t capacity moves along the route, by shuttle working, operates on area «loading-road-unloading-repeat» and controlled by the satellite navigation system GPS/Glonass up to 1 cm. Also it can be managed distantly by an operator over a wireless network. Analogues of Caterpillar run by a centralized computer of the mining enterprise, reserving the route with an on-board inertial navigation system. Volvo Construction Equipment designed autonomous electric dump trucks-trolleybuses HX2 for all stages of quarrying [9].

Unmanned «KamAZ» based on prime mower Neo 5490 elaborates with next systems: for driver's aid, for distance control, for automatic pilot mode. Autonomous rock haulers Caterpillar Cat 789D, Cat 793F, Cat 797F of 181, 227, 363 t are provided with constant telemetry. Unmanned rock hauler of China Inner Mongolia North Heavy Industries Group Co., Ltd. of 110 t capacity realizes autonomous loading-unloading and is capable of being operated around the clock [9].

Fig. 2. Off-highway dump truck-trolleybus Hitachi EH4000 AC-3 of 221 t capacity [8]

Heavy-duty automobile transport is necessary to develop to improve freight road transport infrastructure, for reliable supply of equipment, loads and materials to industrial enterprises, construction sites, for reduction of transportation costs, for increasing of labour productivity. For this purpose, it is necessary to improve the technological processes of transshipping with the help of automated vehicle lifecycle management.

Implementation of all-electrical rock haulers is associated with the development of robotic unmanned systems, and for their creation it is necessary to comprehensively work out an automated charging infrastructure, the development prospect of which are wireless charging stations.

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