BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

IMPROVING THE EFFICIENCY OF BULK CARGO UNLOADING BY TREATING RAILWAY GONDOLA CAR BODIES WITH ANTI-ICING LIQUIDS

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Abstract. The article examines the problem of bulk cargo freezing to the bodies of railway gondola cars during the winter period, which leads to a decrease in the efficiency of mechanized unloading, increased wagon idle time, and higher operating costs. An analysis of existing approaches to preventing coal from freezing to the side walls and floors of gondola cars was carried out, and the necessity of applying preventive technological solutions at the stage of wagon preparation before loading was substantiated. A developed installation for treating railway gondola car bodies with anti-icing liquids before loading is presented, and its design features and operating principle are described.

Keywords: railway transport, gondola cars, bulk cargo, cargo freezing, anti-icing liquids, loading and unloading operations, unloading mechanization, unloading efficiency, coal transportation, winter operation, industrial transport, wagon body treatment, cargo operations, transport logistics.

Introduction. Mechanized technical means used for unloading railway gondola cars make it possible to significantly reduce the duration of cargo operations and decrease the share of manual labor. However, the efficiency of their application largely depends on the condition of wagon bodies after the previous transportation cycle [1]. During the transportation of bulk cargoes, especially in winter conditions, one of the major limiting factors is the freezing of cargo residues to the side walls and floors of gondola cars, which necessitates additional cleaning operations and consequently increases wagon idle time.

An analysis of scientific studies [2], [3], [4] showed that the modern development of railway transport requires the implementation of effective organizational and technical solutions aimed at improving the safety, reliability, and efficiency of freight operations. The studies address issues related to the improvement of transport processes under globalization conditions, increasing the productivity of loading and unloading operations, as well as the development of specialized devices and technological schemes for handling railway gondola cars. The authors note that the use of modern technical equipment and the modernization of technological processes make it possible to reduce labor intensity, decrease operating costs, and improve the overall efficiency of transport and cargo complexes.

Operational practice shows that even with the availability of modern mechanized unloading equipment, the presence of frozen cargo significantly reduces productivity and requires additional resources. In this context, improving the efficiency of loading and unloading operations should be

considered not only from the standpoint of improving unloading processes, but also from the perspective of preventing technological difficulties at earlier stages of the transportation cycle.

In this regard, the implementation of preventive technological solutions aimed at preventing bulk cargo from freezing to railway gondola car bodies before loading becomes particularly relevant. One such solution is the treatment of gondola car bodies with anti-icing liquids, which reduce cargo adhesion to metal surfaces and ensure more complete and faster unloading.

Main Part. Currently, at coal mining enterprises in Kazakhstan, coal freezing to the bodies (side walls and floors) of railway gondola cars occurs during transportation in winter conditions. After unloading, additional cleaning operations must be carried out on the gondola cars, which consequently leads to increased financial costs. Therefore, the development of measures to prevent coal from freezing to the bodies of railway gondola cars is an urgent applied task. To date, various developments have been proposed in this scientific field aimed at preventing coal from freezing to gondola car bodies through the use of different devices, methods, and cleaning technologies. A preliminary analysis conducted in the Republic of Kazakhstan and abroad revealed the absence of an effective method for combating coal freezing to railway gondola car bodies. Therefore, in 2022, specialists of the Scientific and Technical Center “Industrial Transport” (Department of “Industrial Transport named after Professor A.N. Daniyarov,” Karaganda Technical University named after A. Saginov) together with LLP “MINING RESEARCH GROUP” developed an installation for treating railway gondola car bodies with anti-icing liquids before loading [5].

The operation of the developed installation for treating railway gondola car bodies with anti-icing liquids before loading is carried out as follows (Figure 3.3) [5]:

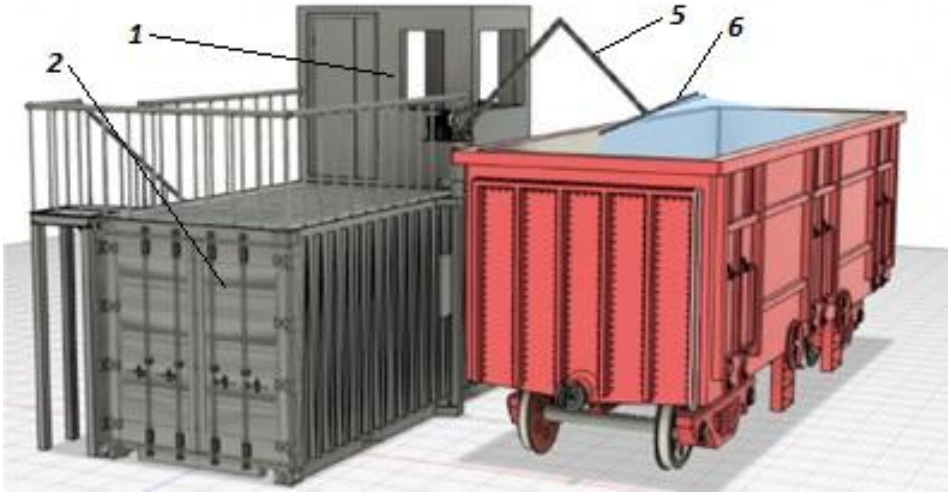
the installation (Figure 1a) is located near the railway track before the loading point (not shown in the figure);

in the operator room 1 (Figure 1a), from where the operation of the installation can be visually monitored, there is a control panel (not shown in the figure) that allows automatic and efficient treatment of gondola cars under operator supervision by tracking train movement with sensors;

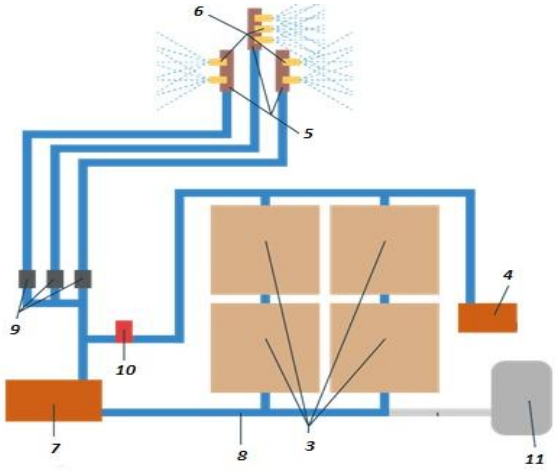
all technical equipment of the installation is located in the technical compartment 2 (Figure 1a);

four tanks 3 (Figure 1b) can be filled with up to four different anti-icing liquids using pump 4 designed for filling the tanks;

a)



b)



operator room 1, technical compartment 2, tanks 3,

pump for filling the tanks 4, bar 5 with nozzles 6,

high-pressure pump 7, pipelines 8, electric valves (taps) 9, pressure relief valve 10, compressor 11

Figure 1. Installation for treating railway gondola car bodies with anti-icing liquids before loading

after receiving a signal from the operator room 1 (Figure 1a) indicating the start of operations, a shunting locomotive (not shown in the figure) pushes empty gondola cars along the railway track so that the gondola car is positioned under the bar 5 with nozzles 6;

the anti-icing liquid, under pressure generated by the high-pressure pump 7 (Figure 1b), is supplied through pipelines 8 to the nozzles 6; the liquid supply is regulated by electric valves (taps) 9, while excess pressure is released using the pressure relief valve 10; from the nozzles, the anti-icing liquid is sprayed onto the floors and walls of the gondola car body; the liquid consumption for one gondola car is approximately 10–15 liters;

when replacing one anti-icing liquid with another, the pipelines are purged from the residues of the previous liquid using compressor 11 (Figure 1b);

depending on the number of gondola cars in the train consist, the above-mentioned operations are performed for each empty gondola car;

after all gondola cars of the train consist have been treated, a signal indicating the completion of operations is sent from the operator room, and the shunting locomotive removes the train consist with the treated gondola cars for further loading with bulk cargoes.

The installation for treating railway gondola car bodies with anti-icing liquids before loading (hereinafter referred to as the installation) was selected as the object of experimental studies. The installation was mounted by LLP “MINING RESEARCH GROUP” on the territory of a coal mine (Figure 2) [6].



Figure 2. Installation for treating the sides and floors of railway gondola cars with anti-icing liquid under coal mine conditions

Conclusion. Thus, the developed installation for treating railway gondola car bodies with anti-icing liquids before loading makes it possible to improve the efficiency of organizing loading and unloading operations during the transportation of bulk cargoes under low ambient temperature conditions. The application of the installation helps reduce the degree of coal and other bulk materials freezing to the side walls and floors of gondola cars, thereby ensuring more complete cargo unloading and reducing the need for additional cleaning operations.

The use of anti-icing liquids makes it possible to reduce wagon idle time during unloading, decrease the labor intensity of manual body cleaning, and minimize operational and financial costs of enterprises associated with wagon flow processing during the winter period. An additional advantage is the increased productivity of mechanized unloading equipment and the improvement of the technological stability of transport and cargo complexes.

The results of pilot industrial tests confirmed the operability of the installation under real production conditions at a coal mine, the compliance of its technical parameters with established requirements, and the effectiveness of using anti-icing liquids when treating railway gondola cars. The obtained results indicate the prospects for further implementation of this technology at industrial railway transport enterprises and in bulk cargo transportation systems on the railways of the Republic of Kazakhstan and other countries with severe climatic conditions.

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