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Research Opportunities to Improve Technical and Economic Performance of Freight Car through the Introduction of Lightweight Materials in their Construction

Ramis Zaripov[a], Pavels Gavrilovs[b,*]

[a]*Pavlodar State University, Kazakhstan*
[b]*Riga Technical University, Latvia*

Abstract

The article highlights the problems associated with the design of freight railway cars. In particular, the analysis of possibilities of application of polymeric materials as a structural material of the body of the cars. The relevance of this article is not in doubt, because the improvement of technical and economic parameters of the cars is one of the main tasks of car building at this time. The article describes the basic methods of manufacturing bodies of freight cars with the use of composite material – fiberglass. In the work carried out detailed analysis of the physic-mechanical properties of composite materials and identify their advantage over steel. As the object of research for tank wagon for transportation of petroleum products and a hopper car for transportation of grain. For the production of boiler tank wagon was chosen as the method of winding, characterized by comparative simplicity and adaptability. To create elements for hopper was chosen as method of deposition, are useful when creating components and parts of complex shape. The work identifies and explains such concepts as wet and dry winding, roving, shaping, reinforcement material. The authors in the specific example proves the possibility of application of composite materials in the body structure freight cars of various configurations. Research conducted in this article can be used to create new models of freight cars and their parts.

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Keywords: tank wagon, synthetic materials, spolling, aluminium alloys, winding, fiberglass, steel, open top, side of the wall

* Corresponding author.
E-mail address: pavels.gavrilovs@rtu.lv

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1. Introduction

Cars are one of the main elements of the rail transport system. To achieve the most economical and efficient transportation is necessary to use certain types of cars with appropriate technical and economic parameters, which in turn depend on the parameters of cars and design. Design modern freight car was created over a long period of time and now on the railways of the world have been in circulation for about 5mn. freight cars. Improving freight cars occurred on several fronts. Were taken into account and a higher carrying capacity, and fixture designs of the cars to transport different types of cargo, as well as the creation of better conditions for handling, equipping cars with means of mechanization and automation.

The main indicators for the technical and economic assessment of the design and operational features of cars are the number of axles, load, containers, packaging factor, the specific volume of the body, the specific area of the floor, the pressure of wheel pair on rails, the pressure carriage attributable to 1 m path. With the number of axes connected load of the car – the heaviest load that can be transported on the basis of the structural strength of the car.

Advantages of heavy duty wagons are as follows:

- lower the resistively of the movement, thereby reducing energy consumption and fuel consumed by locomotives;
- large linear load;
- reduction of metal construction unit load capacity of 10...15%;
- reducing the cost of repair and maintenance of cars at 10...20%;
- reduction of costs for shunting work, weighing wagons and formulation of transport documentation.

The amount of the car carrying capacity (net weight) and its packaging is gross weight of the car. Reduction of container wagons, is one of the main tasks of car building, provides an increase in carrying capacity of freight cars and, therefore, increase the carrying capacity of the railways, saving metal required for the construction of cars, electricity and fuel consumed during transportation locomotives, as well as reducing the cost of transportation.

2. Composite materials

Modern load-bearing bodywork of trucks and passenger cars are mostly made out of metallic materials – various steel grades. Despite the difference in mechanical characteristics, these materials have one common characteristic – they are isotropic. However, in recent years in various branches of engineering has considerably increased interest in the use of anisotropic materials. This is due to the emergence of a new class of composite materials with exceptionally high mechanical characteristics. Composite materials formed of two components – fine fibers, providing high strength and stiffness material, and a binder ensuring the cohesion of the material and work together fibers. As these fibers are used in glass, organic, carbon and boron fibers with a diameter from 0.01 to 0.20 mm, a modulus of elasticity from 90 to 400 GPA, a tensile strength of 2.0 to 3.5 GPA and a density of from 1450 to 2500 kg/m. the binder material is applied polymer resin and a metal (generally aluminum) alloys.

The need to update the fleet of tank wagons is inextricably linked with the requirements and needs of industry. Despite the downturn in the development of many industries in the Republic of Kazakhstan the growth of production and consumption of oil, gas and chemical industries, which necessitates the existence of a massive and well-organized deliveries from producers to consumers. While a large role is played by rail transport, as a significant part of the transportation of these goods have on the tank.

Therefore, there is a need for continuous improvement of tank wagons, improving their technical-economic indicators to ensure the safe delivery of product and traffic safety. On the railway network of Kazakhstan operated a large number of different types of specialized tanks intended for the carriage of a variety of acids, alkalis and other aggressive chemicals used in the economic complex of the country and exploitive required abroad. The goods to be transported are placed in the boiler, which is a specific body shape. Universal tanks are classified into tanks for transportation of light (gasoline, kerosene, naphtha, etc.) and dark (oil, mineral oil, etc.) of liquid cargoes.

Among the numerous synthetic materials (fillers, plasticizers, lubricants, dyes, etc.) fiberglass are the most promising. Raw material for fiberglass is glass fiber and articles thereof, as well as polyester, epoxy and other resins