Analysis of the state and prospects of the development of the freight wagon fleet of the Republic of Uzbekistan

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As is known, the economic indicators of any metallurgical process, especially in non-ferrous metallurgy, depend primarily on transportation costs. Transport costs include the delivery of ore from the quarry to the mining and processing plant, and then the delivery of metals to the metallurgical enterprises for the production of semi-finished or finished products. Naturally, the reduction of transportation costs is an important task, which depends on the fleet of wagons of railway companies. The current state and structure of the railway wagons fleet of Uzbekistan, which are currently experiencing a deficit of a serviceable fleet of freight wagons, are analyzed. To replenish the fleet of freight wagons, the wagon-building plants of the Republic of Uzbekistan every year increase their production capacities and also master and launch in mass production new types of freight wagons with an axle load of 23.5 tons. To determine the directions of the wagon fleet development of the Republic of Uzbekistan, the analysis of the existing Russian and foreign freight rolling stock has been carried out. Comparative characteristics of technical and economic parameters of domestic freight wagons and foreign production showed that freight wagons produced by domestic wagon building plants with an axle load of 23.5 tons are inferior in technical and economic parameters to wagons of foreign production, the metal structure of which is made with the use of high-strength steels and aluminum alloys and the load from the axis of the wheel set to the rails is 32–35 tons. Formulated the main proposals on the development and introduction of perspective freight wagons with increased axial load are developed with the use of modern construction materials on the railways of Uzbekistan, the implementation of which will significantly increase the throughput and carrying capacity of railways, reduce maintenance costs and specific fuel and energy resources consumption for traction trains, as well as increase the level of localization of products.

Key words: JSC "Uzbekiston temir yo'llari", freight wagons, wagon fleet, technical and economic parameters, axle load, wagon building, high-strength steels, aluminum alloys, prospective wagon, railway transport infrastructure.

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Introduction

In non-ferrous metallurgy — a large branch of the economy of Uzbekistan — the indicators of production efficiency depend, first of all, on the degree of introduction of innovations in the production cycle [1–3]. Equally important for increasing the efficiency of non-ferrous metallurgy is the transport infrastructure, since ore extraction, processing for the production of non-ferrous metals, further delivery of non-ferrous metals for the production of semi-finished products or finished products are related to transportation. In this regard, the main tasks set for the railway transport of Uzbekistan require a significant improvement in the technical and economic indicators of the railway industry as a whole for the further socio-economic development of the country [4].

The construction of new railways and the electrification of railway sections, in accordance with the decrees and decrees of the President of the Republic of Uzbekistan [5–7], led to an increase in the total length of the main railways and the volume of freight traffic, which required the corresponding development of the freight wagon fleet.

However, due to unsatisfactory condition and shortage of rolling stock on the railways of Uzbekistan, the fleet of freight wagons is not in a position to fully provide for an increasing volume of freight traffic [8].

The main factor leading to the critical condition of the inventory fleet of freight wagons is the annual cancellation of wagons without replenishment in sufficient quantities by freight wagons of modern designs, with modernized and upgraded units.

Analysis of the fleet of freight wagons

Analysis of the fleet of freight wagons and the volume of freight transportation by rail in the Republic of Uzbekistan allowed to determine the forecasted parameters of the freight wagon fleet up to 2021 (Fig. 1).

It can be seen from the diagram (Fig. 1) that since 2017 the railways of Uzbekistan have been in short supply with an efficient fleet of freight wagons and if not to take appropriate measures to replenish the fleet of wagons, the deficit of freight wagons in 2021 will increase more than 3 times as against 2017.

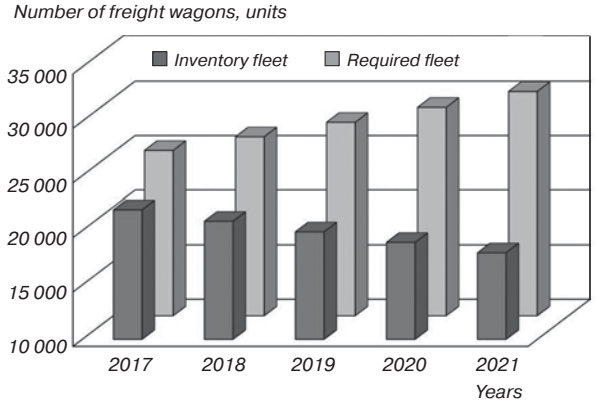

Fig. 1. Balance of the fleet of freight wagons of JSC "Uzbekiston temir yo'llari" for the period 2017–2021

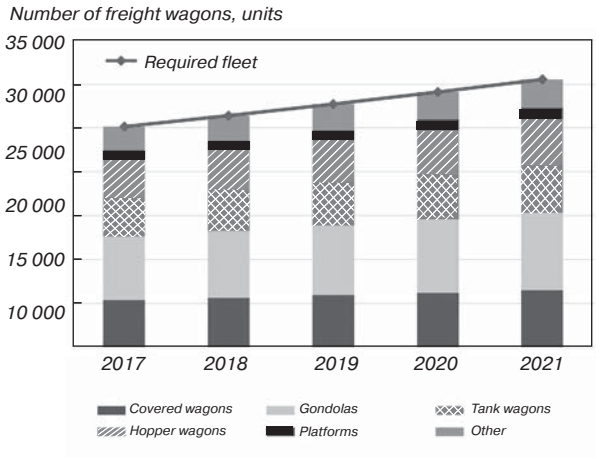

Fig. 2. The required fleet of freight wagons of JSC "Uzbekiston temir yo'llari" for the period 2017–2021 by types of wagons

Structural analysis of the required fleet of freight wagons of JSC "Uzbekiston temir yo'llari" for the period 2017–2021 by types of wagons (Fig. 2) showed that in 2021 the required fleet of wagons should be approximately 31 thousand units of rolling stock, 29% of the open wagons, 21% — covered wagons, 18% — tank wagons, 17% — hoppers (including cement carriers — 9%, grain carriers — 5% and mineral carriers — 3%), 4% — platforms, 11% — other wagons [8].

To replenish the fleet of freight wagons wagon-building plants of the Republic of Uzbekistan, the SC "Foundry-mechanical plant" (SC "FMP") and the SC "Andijan Mechanical Plant" (SC "AMP") every year increase production capacity, and also master and launch in mass production new types of freight wagons, replenishing the model range of produced wagons. The freight wagons produced by domestic wagon building plants have an axial load of 23.5 tons and for their construction, mainly are using steel grades 10G2BD, 09G2SD, 09G2S, 10HNDP with a strength class of 345 MPa [9–11]. The basic models of freight wagons produced by the wagon-building plants of the Republic of Uzbekistan and their technical and economic parameters are given in Table 1.

However, the production capacities of these plants do not allow to fully update and restore the forecasted required fleet of freight wagons of the Republic of Uzbekistan.

Besides, at present the required fleet of rolling stock of metallurgical plants of the country of the State Enterprise "Navoi Mining and Metallurgical Combine" and JSC "Almalyk Mining and Metallurgical Combine" accounts for approximately two thousand freight wagons (of which more than 80% are dump wagons and tank wagons) and this quantity is increasing every year with the providence in the Republic of Uzbekistan of large-scale reforms aimed at developing an innovative economy, introducing modern high technology and scientific

Table 1

Basic technical and economic parameters of freight wagons produced by the Republic of Uzbekistan

Name of parameters	Covered wagon model 11-9923	Gondola model 12-9922	Hopper model 19-9596	Gondola model 12-9768-01	Tank model 15-9724	Tank model 15-9721
Manufacturer	SC "FMP"			SC "AMP"		
Carrying capacity, *t*	65	70	72.5	70		66
Tare of the wagon, *t*	28.5	23.5	21.3	24		28
Coefficient of tare	0.44	0.34	0.29	0.34		0.42
Load from the axle of the wheel pair on the rails, kN (tf)	230 (23.375)		230 (23.45)	230.5 (23.5)		
Body volume, m^3	158	92	61.6	92	36	72.4
Specific volume, m^3/t	2.43	1.31	0.85	1.31	0.51	1.1
Load load, tf/m	4.95	6.72	7.8	6.75	7.82	
Length of the wagon along the axes of the coupler coupling, mm	18900	13920	12020	13920	12020	
Dimension	1-VM		1-T	1-VM	02-VM	
Service life, years	32	22	26	22	18	32

Table 2
The main technical and economic parameters of freight wagons of Russian production

Name of parameters	Covered wagon model 11-6874	Gondola model 12-9548-01	Hopper model 19-9549-03	Tank wagon model 15-6880	Hopper model 19-5167	Tank wagon model 15-5157-04	Gondola model 12-9828
Manufacturer	PC "RPC UCC"				JSC "RPC "Ural-wagon-factory"		JSC "Roslavl WRP"
Carrying capacity, t	73	83	76	73	74	73	83
Tare of the wagon, t	27	25	23.5	27	26	27	25
Coefficient of tare	0.37	0.3	0.31	0.37	0.35	0.37	0.3
Load from the axle of the wheel pair on the rails, kN (tf)	245.25 (25)	264.6 (27)	245.25 (25.0)	245.25 (25)	245.25 (25.0)	245.25 (25)	264.6 (27)
Body volume, m^3	175	92	120	88	125	76.3	98
Specific volume, m^3/t	2.4	1.11	1,58	1.21	1.69	1.05	1.18
Linear load, tf /m	5.21	7.76	6.76	8.32	6.17	8.32	8.93
Length of the wagon along the axes of the coupler coupling, mm	19200	13920	14720	12020	16220	12020	12100
Dimension	1-T	1-VM	1-T	1-T	1-T	1-VM	Tpr
Service life, years	32	40	32	32	32	32	22

Table 3
The main technical and economic parameters of freight wagons of foreign production

Name of parameters	37' MILL GONDOLA	GONDOLA-MILL	Hybrid Gon	Beth Gon II
Manufacturer, country	American Railcar Industries, USA	National Steel Car, Canada	Freight Car America, USA	
Carrying capacity, t	105	116	108	110.8
Tare of wagon, t	24.7	24.3	21.8	18.9
Load from the wheel pair axis to the rails, tf	32	35	32.5	32.5
Body volume, m^3	70.8	76	117	128
Coefficient of tare	0.24	0.21	0.20	0.17

and technical projects into the company's activities. Also increasing the length of railways contributes to an increase in the number of rolling stock. For example, only in the Navoi region the length of railways has been extended to geographically deeper areas of the cities of Zarafshan and Uchkuduk, which requires the carriage of cargo, for example, in the form of ore for the production of non-ferrous metals, for increased distances more far than 270 km. Similarly, the AMMC began to extract zinc, copper, lead-tin ore in remote areas of Angren, Almalyk, which increased the length of railways for more than 120 km to transport raw materials to metallurgical enterprises.

Analysis of foreign freight rolling stock

In order to find new directions for solving this problem — the development of the freight wagon fleet of the Republic of Uzbekistan, a review and analysis of the existing foreign freight rolling stock was carried out.

The analysis shows that on the railways of the Russian Federation for more than 10 years, freight wagons with axle loads of 25 tons have been operated, and research and development for the development of a new line — an axle load of 27 tons (Table 2) [12–14] is being intensively pursued. The use of steels with increased strength of grades 16G2AF, 30HGSA, 35HGSA, 30H9N8M4G2S2 and 25N25M4G1 in the construction of wagons of the new generation has made it possible to reduce the coefficient of tare of Russian freight wagons to 0.29 ... 0.37 [15–17].

On the railways of North America, Australia and South Africa, tens of thousands of freight wagons with loading from the axle of the wheelset to the rails of 32–35 tons and a tare coefficient of 0.17 to 0.24 (Table 3) are in operation [18–20]. It was the use of aluminum alloys in the construction of cargo wagon bodies, along with other measures, that allowed to reduce the tare weight of wagons to 17.5–18.9 tons and increase the carrying capacity to 112.5–116 tons [17–19, 21–23].

Comparative characteristics of technical and economic parameters of domestic freight wagons (Table 1) and foreign production (Tables 2, 3) showed that freight wagons produced by domestic wagon-building plants are inferior to wagons of foreign production by technical and economic parameters.

Consequently, for the development of the railway industry in Uzbekistan, it is necessary to conduct complex scientific research and technical developments to develop the construction of perspective freight wagons with increased axial load at the wagon-building plants of Uzbekistan and their implementation on the country's railways [24].

The development of such prospective freight wagons and putting them into operation will save money for maintaining the rolling stock fleet, thanks to the numerical optimization of the fleet, carrying out the average monthly volume of traffic in a smaller number of axles.

Materials used in freight wagon building

When developing perspective freight wagons by domestic wagon-building plants, one of the main directions of improving their design should be the improvement of their technical and economic parameters by reducing the material consumption with the use of high-strength steels and aluminum alloys. The quality of construction materials used in wagon building significantly affects the reliability, durability and other technical and economic characteristics of wagons [15, 18].

Analysis of the characteristics of materials applied in the wagon building industry of the Republic of Uzbekistan and used by Russian and foreign manufacturers of freight wagons allows us to conclude that currently used in domestic wagon building steel is significantly inferior in mechanical properties of foreign analogues.

The use of high-strength steels with a yield strength of over 800 ... 900 MPa (for example, steel grade 30HGSA, widely used in Russian freight wagons of new generation and the grade Optim 960 QC, widely used in wagon building in Finland) in the construction of freight wagons makes it possible to reduce their weight to 5 ... 15% and increase the carrying capacity [16–17, 23]. The use of high-strength aluminum alloys for the load-bearing structures of freight wagon bodies will reduce tare of the wagon to 50%, because the specific gravity of aluminum alloys is three times less than steel [25]. Also, aluminum alloys have high corrosion resistance, which allows to not applying protective coatings or painting the body of the wagon, which saves paint and varnish materials during repair work, and their high price is justified by a longer service life [25].

In this connection, taking into account the cumulative experience of Russian and foreign wagon building companies, the wagon-building plants of Uzbekistan together with the advanced metallurgical plants of the country, the State Enterprise Navoi Mining and Metallurgical Combine" and the JSC "Almalyk Mining and Metallurgical Combine", which are the largest in the world in terms of production of non-ferrous metals (copper, zinc, tin, lead, precious metals, rare earth elements), it is necessary to develop new promising materials for wagon building, which will improve the technical and economic parameters of domestic structures of freight wagons, in particular, to reduce their weight. This requires close, mutually beneficial cooperation with one of the world's largest aluminum producers United Company RUSAL. In Uzbekistan, UC "Rusal" is present indirectly. The company did not enter the Uzbek market, although the market for it is large. JSC "Uzbekiston temir yo'llari", which has its own industrial enterprises, is already repairing old wagons and producing new types of light wagons in repair and production areas. At the moment, to reduce the weight of rolling stock (by replacing heavy cast iron and steel structures of wagons, diesel locomotives with lightweight high-strength aluminum alloys, producing power lines, components for wagons, diesel locomotives and electric locomotives), the demand for aluminum and its alloys increases year by year, as Uzbekistan does not have its own raw materials and, accordingly, aluminum production. Uzbekistan's long-term demand for high-quality aluminum alloys is more than 140 thousand tons per year with an annual increase of 10% on average. Aluminum alloys are planned to produce cable products for power lines of railways, carpenters, hull parts such as brake bays, pumps and others [26].

Prospects for the development of a fleet of freight wagons

Analysis of scientific and technical achievements and best practices of foreign countries allows us to formulate the following basic proposals for the development and introduction of new generation wagons with increased axial load on the railways of Uzbekistan:

– conduct research on the interaction of wagons with the infrastructure of railways;

– modernization of the infrastructure of general and non-general railways to increase the permissible loads;

– prepare a locomotive fleet with increased traction power;

– develop a comprehensive methodology for selecting the parameters and structure of the wagon fleet;

– select the permissible running and axle loads for traffic safety conditions;

– to choose new technical solutions and technical and economic parameters of prospective wagons taking into account the possibility of introducing enlarged dimensions;

– reduce metal consumption of carload structures and apply high-strength steels and aluminum alloys.

Conclusions

Thus, the implementation of the proposed works and the creation of perspective freight wagons of a new generation with increased axial load with the use of modern structural materials will allow raising the technical and economic parameters of freight wagons produced in the Republic of Uzbekistan to a new level, significantly increasing the throughput and carrying capacity of railways, for the maintenance and repair of wagons and the specific consumption of fuel and energy resources for the traction of trains, and level of localization of output products in order to create a faster development of the railway industry, which is the key to stability of the most important sector of the country's economy.

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