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USE OF EXPRESS CONTAINER TRAIN AS OPTIMIZATION METHOD OF RUBBER EXPORT CARRIAGE

Aim: The article is devoted to the issue of optimizing the export carriage of synthetic rubber produced in Russian, using the service of express container trains.

Methods: The analysis of volumes distribution of synthetic rubber production between the main Russian producers was made and an alternative option was proposed for the delivery of the products of the largest plant for the production of this raw material to foreign countries. To assess the economic efficiency of the carriage variant by express container trains, a comparison was made with the most commonly used method of rubber transportation by transport costs.

Results: Based on the results of the calculations, it was found that when transporting rubber in containers as part of express container trains, significant savings in transportation costs arise.

Practical significance of the work: The relevance of the proposed variant is due to the growth of cars production and the development of container transportations in the world. As a result, the transport component is reduced in the final cost of production, which allows suppliers to be more competitive in the market for the production of this raw material.

Keywords: express container train, synthetic rubber, carriage, container, cargo transshipment.

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ИСПОЛЬЗОВАНИЕ УСКОРЕННЫХ КОНТЕЙНЕРНЫХ ПОЕЗДОВ КАК СПОСОБ ОПТИМИЗАЦИИ ЭКСПОРТА КАУЧУКА

Цель: Описать оптимизацию экспортной поставки синтетического каучука, производимого в России, при помощи сервиса ускоренных контейнерных поездов.

Методы: Проанализировано распределение объемов производства синтетического каучука между основными российскими производителями, предложен альтернативный вариант поставки продукции крупнейшего завода по производству данного сырья в другие страны. Для оценки экономической эффективности сравниваются варианты перевозки в ускоренных контейнерных поездах с наиболее часто используемым способом транспортировки каучука на предмет транспортных издержек.

Результаты: Выявлено, что при перевозке каучука в контейнерах в составе ускоренных контейнерных поездов значительно экономятся денежные средства на транспортировку.

Практическая значимость работы: Благодаря росту производства автомобилей и развитию контейнерных перевозок в мире снижается транспортная составляющая в конечной стоимости продукции, что увеличивает конкурентоспособность поставщиков на рынке производства данного сырья.

***Ключевые слова*:** ускоренный контейнерный поезд, синтетический каучук, транспортировка, контейнер, перетаривание груза.

Introduction

Globalisation, which began in the end of the previous century, is characterised by enhancement of competitiveness, increasing tempo of foreign investments, increase of volumes of intra-firm trade, establishment of transnational corporations in a number of branches, including the automobile industry [1].

The world has an increasing number of produced cars. In 2016, more than 94 million transport means were manufactured, which is 4 million more than in 2015 [2]. The increase of cars manufacture leads to increase of demand in rubber which

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is used for production of tires [3]. Far not all of the automobile concerns and spare parts works are located near rubber suppliers. Consequently, the demand arises to deliver these materials to manufacture sites by means of selecting the material transportation mean, which would be the most optimal for the producer.

Setting the task

Analysis of the world's rubber production volumes

In the production of tires, the natural and synthetic rubbers are used, the greatest part of which is located in Asia [4]. The second place is held by Europe, Middle East and Africa. The third place is held by the Americas (Tables 1 and 2) [5].

Table 1

World's volumes of natural rubber production

Region	Production volume in 2015, 10^6 kg	Production volume in 2016, 10^6 kg
Asia and Oceania	11 340	11 420
Europe, Middle East, Africa	597	645
The Americas	334	336
Total	12 231	12 401

Table 2

World's volumes of silicone rubber production

Region	Production volume in 2015, 10^6 kg	Production volume in 2016, 10^6 kg
Asia and Oceania	7508	7666
Europe, Middle East, Africa	3914	4130
The Americas	3085	3036
Total	14 507	14 831

The world's natural rubber production volume in 2016 made $12{,}4 \cdot 10^9$ kg, synthetic rubber production − $14{,}8 \cdot 10^9$ kg.

Russia with its 8,5 % ($1{,}3 \cdot 10^9$ kg per year) of the world's volume is a big manufacturer of synthetic rubber. The biggest national synthetic production enterprises are represented in the fig. 1 [6].

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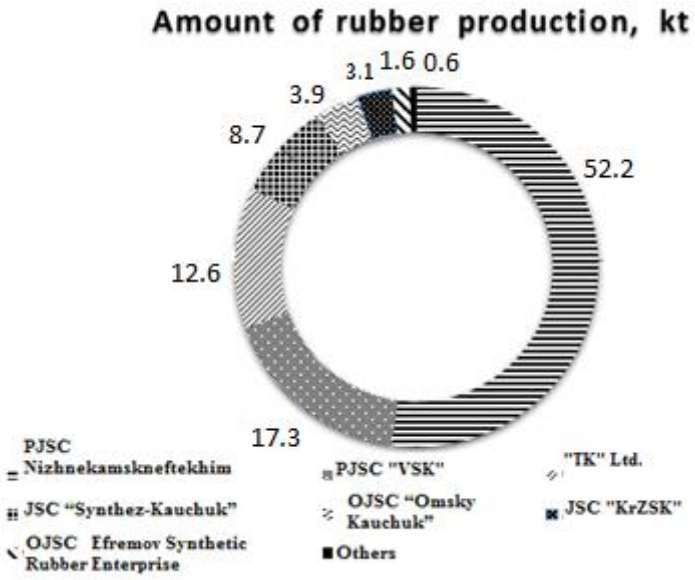

Fig. 1. Distribution of production of rubber in Russia in 2016

The biggest rubber producer in Russia is Public Joint Stock Company "Nizhnekamskneftekhim". The company is one of the top 10 synthetic producers in the world.

In 2016, more than 88 % of synthetic rubber selling operations of the company fell on international markets. 75 % of the volume was sold to big enterprises both in Russia and abroad.

The amount of export of the company for 2016 is distributed as follows (fig. 2) [7]:

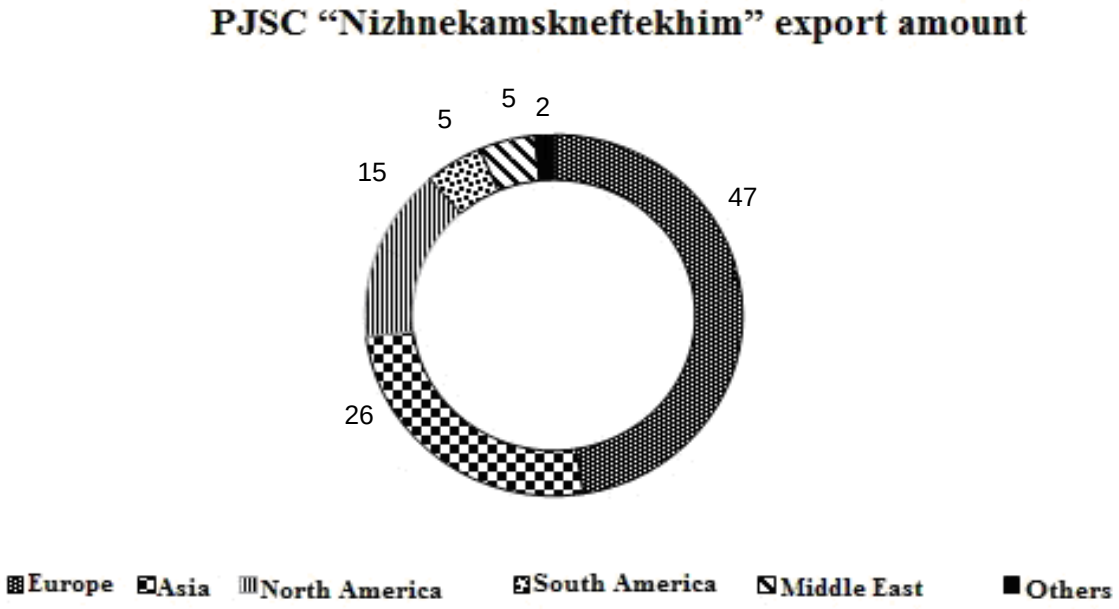

Fig. 2. Amount of Public Joint Stock Company "Nizhnekamskneftekhim" export, %

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It is seen from the diagram that the company exports the largest part of its product to Asia, Europe and North America. These regions are located at a great distance from producers. Moreover, export to some of the regions is possible only by sea.

Analysis of problems related to transportation of rubber as part of export

The city of Nizhnekamsk, where one of the leading rubber factories is located, is significantly remote from Russia's ports (fig. 3). For example, the distance to the port "Saint Petersburg" is approximately 2000 kilometres; to the Far East ports – 8000 kilometres. Another problem is large volumes of the production transported. Hence, the transportation of the production by car is irrelevant.

Fig. 3. Location of the rubber factory

With such long distances and large amounts of product transported, railway transportation is more profitable.

As a rule, rubber is transported in covered wagons. In case of the goods being transported to North America or Asia, there arises the necessity of transshipment leading to the goods being loaded from covered wagon to container for further seaborne transfer [8]. Since the amount of the goods transported is large, the procedure increases transport and time expenditures, which in its turn causes the delivery time to rise.

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When the goods are delivered to Europe, there is a possibility of ground transportation. Yet even in this case transshipment may not be avoided. This is related to different track gauge: 1520 mm in Russia and 1435 mm in Europe.

The problems arising during transportation of goods in covered wagons can be solved by virtue of organisation of transportation of goods in sea containers by railway. This will significantly decrease transport expenditures and delivery time, as there will be no demand in transshipment. This measure will help increase efficiency of such freight transportations [9]. To further reduce the delivery time and transport expenditures, this transportation may be arranged within express container train service.

The container train is a train which is made up from flatcars with containers thereon, running to the destination point without rearranging.

The advantages of express container trains are:

- possibility of transportation of large amounts of goods at one time. One express container train carries up to 150 TEU;
- decrease of delivery time. Absence of necessity of shunting works of containers at technical stations;
- fixed transit time during the journey;
- possibility of organisation of heavy containers delivery (loading to the carrying capacity of containers).

During transportation by express container trains there are two main drawbacks:

- dense arrival at the destination station. The difficulty of organisation of one-time export by car transport from the station.
- lack of empty containers in the regions of loading.

Options of solving the set tasks

Delivery of rubber to Europe, America and Asia is feasible on condition that the intermodal transportation is organised, which means application of several modes of transport.

Below the possible options of production delivery to a client's warehouse in terms of door-to-door shipping with the use of express container trains service is seen (Table 3).

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Table 3

Options of rubber transportation with the use of express container trains service

Route	Modes of transport in use	Tine of transportation by express container train, days	Technology of transportation
Export to Europe			
DOOR PJSC "Nizhnekamskneftekhim" ↓ Nizhnekamsk railway station (freight forwarder) ↓ Avtovo railway station (freight forwarder) ↓ the seaport “Saint Petersburg” ↓ a port of Europe ↓ DOOR a client’s warehouse in Europe	Car Railway Sea	3	1. Empty container picking; 2. Delivering container for further loading to PJSC "Nizhnekamskneftekhim"; 3. Delivering the container with freight to Nizhnekamsk railway station; 4. Transportation by express container train by route Nizhnekamsk railway station − Avtovo railway station (freight forwarder); 5. Carrying the container to non-public railway of one of the seaport terminals with further stationing in the terminal; 6. Loading the container on a ship; 7. Seaborne transportation to a European port; 8. Stationing the container in the seaport terminal; 9. Loading the container on a car and carborne delivery to a client’s warehouse
DOOR PJSC "Nizhnekamskneftekhim" ↓ Nizhnekamsk railway station (freight forwarder) ↓ Russia − Europe railway border station ↓ DOOR a client’s warehouse in Europe	Car Railway	3 (to the border transit)	1. Empty container picking 2. Delivering container for further loading to PJSC "Nizhnekamskneftekhim"; 3. Delivering the container with freight to Nizhnekamsk railway station; 4. Transportation by express container train by route Nizhnekamsk railway station – border station; 5. Transloading to car transport and delivery to a client’s warehouse, or loading the freight on standard-gauge railway, transportation to a European station and delivery to a client’s warehouse

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Export to America			
DOOR PJSC "Nizhnekamskneftekhim" ↓ Nizhnekamsk railway station (freight forwarder) ↓ Vladivostok railway station (freight forwarder) / Cape Churkin station (freight forwarder) / Nakhodka – Vostochnaya station (freight forwarder) ↓ Commercial Port of Vladivostok Vladivostok Sea Fishing Port Vostochny Port ↓ DOOR a client's warehouse in America	Car Railway Sea	12	1. Empty container picking 2. Delivering container for further loading to PJSC "Nizhnekamskneftekhim" 3. Delivering the container with freight to Nizhnekamsk railway station 4. Transportation of container by express container train by route Nizhnekamsk railway station – Vladivostok railway station (freight forwarder) / Cape Churkin station (freight forwarder)/Nakhodka – Vostochnaya station (freight forwarder) 5. Carrying the container to non-public railway line of one of the terminals in the seaport and stationing in the terminal 6. Loading the container on a ship 7. Seaborne transportation to a port in America 8. Stationing the container in the seaport terminal 9. Loading the container on a car and delivery by car to client's warehouse
Export to Asia			
DOOR PJSC "Nizhnekamskneftekhim" ↓ Nizhnekamsk railway station (freight forwarder) ↓ Vladivostok railway station (freight forwarder) / Cape Churkin station (freight forwarder)/Nakhodka – Vostochnaya station (freight forwarder) ↓ Commercial Port of Vladivostok Vladivostok Sea Fishing Port Vostochny Port ↓	Car Railway Sea	12	1. Empty container picking; 2. Delivering container for further loading to PJSC "Nizhnekamskneftekhim"; 3. Delivering the container with freight to Nizhnekamsk railway station; 4. Transportation of container by express container train by route Nizhnekamsk railway station – Vladivostok railway station (freight forwarder) / Cape Churkin station (freight forwarder) / Nakhodka – Vostochnaya station (freight forwarder); 5. Carrying the container to non-public railway line of one of the terminals in the seaport and stationing in the terminal; 6. Loading the container on a ship; 7. Seaborne transportation to a

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DOOR a client's warehouse in Asia			port in America; 8. Stationing the container in the seaport terminal; 9. Loading the container on a car and delivery by car to client's warehouse
DOOR PJSC "Nizhnekamskneftekhim" ↓ Nizhnekamsk railway station (freight forwarder) ↓ Russia-China border station ↓ railway stations near China's ports ↓ China's ports ↓ Asia's ports ↓ DOOR a client's warehouse in Asia	Car Railway Sea	16–22	1. Empty container picking; 2. Delivering container for further loading to PJSC "Nizhnekamskneftekhim"; 3. Delivering the container with freight to Nizhnekamsk railway station; 4. Transportation of container by express container train by route Nizhnekamsk railway station – Russia – China border station; 5. Loading the containers on standard-gauge railway; 6. Transportation of containers by express container train from Russia – China border station to stations near ports in China; 7. Delivery of the container to a seaport terminal; 8. Loading the container on a ship; 9. Seaborne transportation to an Asia's port; 10. Stationing the container in the seaport terminal 11. Loading the container on a car and carborne delivery to a client's warehouse

Results of the studies

One of the factors of increase of freight transportation efficiency is tariff setting which is based on the prime cost of transportation [10, 11]. To compare options of transportation of rubber in covered wagons and in express container trains, the transport expenditures were calculated for one tonne of freight [12].

For calculations the today's most widespread transport pack for carrying rubber has been chosen, i.e. corrugated box placed on a pallet. During transportation in covered wagons, the wagon type 11-280 with the volume 138 cubic metres was used, by express container train – 40DC sea container [13].

All data concerning the freight, wagon and container necessary for calculations are given in the Tables 4 and 5.

According to the results of the calculations of the amount of freight in the wagon and in container, the optimal number of pallets in the transport mode was chosen, using the scheme of arrangement and carrying capacity [14].

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The authors have calculated the costs of transportation by the route DOOR PJSC "Nizhnekamskneftekhim" – Avtovo railway station (freight forwarder) with delivery by covered wagons and in containers on express container train for further forwarding to Europe (Tables 6 and 7). Since the cost of transportation by sea and, consequently, further transportation by car or in containers by railway through Europe will be the same, the comparison of carborne transportation cost [15] from PJSC "Nizhnekamskneftekhim" to the departure station (Nizhnekamsk station) and of railway transportation by the route Nizhnekamsk station – Avtovo station (freight forwarder) is made.

Table 4

Determination of the amount of freight in covered wagon

138 cubic metres covered wagon		
Parameter	Unit of measurement	Value
Size of the box	mm	1200 × 800 × 1200
Size of the pallet	mm	1200 × 800 × 145
Freight density	kg/m^3	950 000
Freight weight	kg	1095
Freight weight including the pallet	kg	1107
Inside dimensions of the wagon body	mm	15 724 × 2764 × 2800
Wagon doors dimensions	mm	3802 × 2334
Carrying capacity of the wagon	kg	68
Number of pallets according to carrying capacity of the wagon	pieces	61
Number of pallets according to arrangement of freight inside the wagon	pieces	66
Net weight of the freight without pack in one wagon	kg	66 795
Gross weight of the freight without pack in one wagon	kg	67 527

Table 5

Determination of the amount of freight in container and on a wagon

40DC container on a 25 metres long platform		
Parameter	Unit of measurement	Value
Size of the box	mm	1200 × 800 × 1200
Size of the pallet	mm	1200 × 800 × 145
Freight density	kg/m^3	950 000
Freight weight	kg	1095
Freight weight including the pallet	kg	1,107
Inside dimensions of the container	mm	12 022 × 2352 × 2395
Carrying capacity of the container	kg	26 580
Number of pallets according to carrying capacity of the container	pieces	24

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40DC container on a 25 metres long platform		
Parameter	Unit of measurement	Value
Number of pallets according to arrangement of freight inside the container	pieces	25
Net weight of the freight without pack in one container	kg	26 280
Gross weight of the freight without pack in one container	kg	26 568
Net weight of the freight without pack on one wagon	kg	52 560
Gross weight of the freight without pack on one wagon	kg	53 136

Table 6

Calculation of transport expenditures per one tonne of freight transported in covered wagons, rur

Parameter	Value
Supply of car to PJSC "Nizhnekamskneftekhim" and transportation by car from the factory to Nizhnekamsk station (three runs)	20 000
Loading and unloading of the freight from the car to the covered wagon	26 000
Fastening materials	6000
Lock and seal devices, 2 pieces	600
Additional expenditures (Loading scheme, weighing, document procedures)	1300
Supply of the covered wagon to the route	40 000
Railway tariff of the route Nizhnekamsk station−Avtovo station (freight forwarder)	94 932
Loading of the freight from the covered wagon to sea company owned container	26 000
Total cost of the freight transportation in covered wagon	**214 832**
Total cost of transportation of 1000 kg of the freight	**3181,42**

Table 7

Calculation of transport expenditures per 1000 kg of the freight transported by express container train

Parameter	Value
Supply of two sea company owned 40DC containers	12 000
Picking of the two empty containers from the line, supply of the containers for loading to PJSC "Nizhnekamskneftekhim", delivery by car from the factory to Nizhnekamsk station	22 000
Lock and seal devices for two containers	600
Additional expenditures (Loading scheme, weighing, document procedures)	1300
Supply of the 80 feet platform for the route	20 000
Railway tariff of the route Nizhnekamsk station−Avtovo station	48 014

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Parameter	Value
(freight forwarder)	
Total cost of transportation in two 40DC containers with a 25 metres long platform	**103 914**
Total cost of transportation of 1000 kg of the freight	**1977,05**

Discussion of the results

The results of the studies have shown that with transportation of rubber from Nizhnekamsk to Europe by express container train service, transport expenditures per 1000 kg of the freight decrease by more than 1200 rubles.

Provided that one container train can carry up to 74 40DC containers, the savings will make more than 2,3 million rubles as compared to transportation of rubber in covered wagons.

Conclusion

To conclude, it needs to pointed out that the development of express container trains allows significant reduction of transport expenditures in the final cost of the product, increase of safety of the transported freight and, consequently, enhancement of competitiveness of railway transport.

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