

Influence of railway facilities on the environment of the Russian Federation

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(Received 8 May, 2021; Accepted 27 June, 2021)

ABSTRACT

The article discusses the impact of railway transport facilities on the environment of the Russian Federation. The research methods were the analysis of scientific literature on the research topic, analysis of data from open sources. The author points out that railway transport is the least dangerous source of environmental pollution. The sources of environmental pollution by railway transport have been determined. The perspective directions of reducing emissions of pollutants into the environment from mobile and stationary sources are considered on the example of Russian railways (JSC RZD). It was noted that due to the measures taken, the environmental friendliness of railway transport is increased, harmful emissions into the atmosphere, the degree of acoustic impact of railway transport on adjacent residential buildings, and a negative impact on the environment are reduced.

Key words : Environment, Railway transport, Emissions, Atmosphere, Environmental monitoring

Introduction

The issues of environmental pollution and improvement of the ecological situation, which are actively discussed in European countries, have an impact on the development of both the transport sector in general and certain types of vehicles.

Historical factors, economic development, location of settlements, economic and logistic ties have had a great influence on the formation of the railway network in Russia. This type of transport accounts for about half of the passenger and freight traffic of all types of transport in Russia. In this regard, railway transport is one of the most important sectors of the country's economy. Nevertheless, it is only in the last decade that studies have appeared on the environmental monitoring of railway transport, since, along with road and air transport, it is a serious source of environmental pollution.

The main types of impact of any type of transport on the environment are pollution of exhaust gases of transport engines with toxic substances, emissions of harmful substances into the atmosphere from stationary sources, pollution of surface water bodies, waste generation and the impact of traffic noise. One of these types of transport is rail.

According to the representative for the environmental policy of the oil and gas sector WWF in Russia, about 40% of passenger traffic falls on this sector, while railways produce no more than 2% of the total volume of greenhouse gases in the country (US Environmental Protection Agency, 2019). Thus, railway transport, on which passengers and large volumes of cargo are transported in large quantities, is recognized as one of the most environmentally friendly modes of transport in the country. This type of transport has many advantages over other types: low specific fuel consumption per unit of work of a

vehicle leads to a lower coefficient of frictional resistance when a wheelset moves on rails compared to moving car tires along a road, the use of electric traction to reduce the intake of pollutants from rolling stock. Despite the environmental friendliness of this type of transport, railway transport facilities have a negative impact on the environment.

Materials and Methods

The aim of the study is to consider the issues of the impact of railway transport facilities on the environment of the Russian Federation and measures to reduce it using the example of Russian railways.

The research methods were the analysis of scientific literature on the research topic, analysis of data from open sources.

The research material was the data of international agencies, the reporting data of the Russian Railways company on environmental monitoring for 2019-2020.

Results and Discussion

According to Silva *et al.* (2017), Railway transport facilities have less polluting impact than car roads, which is associated with the equipment of trains, for the most part, with electric motors (Silva, 2017). García de la Morena *et al.*, (2017) distinguish the ecology of railways as a separate direction, motivating their position by the fact that environmental monitoring of the impact of this transport covers mobile and stationary objects (García de la Morena, 2017). There are several specific environmental impacts that are unique to rail transport. First, the noise and vibration of a train is much higher than that of a car, but of a shorter duration. Secondly, some types of trains are capable of developing sufficiently high speeds, which requires much more attention to the topic of ecology (Shapiro, 2016).

According to the Eurasian Rail Alliance Index (ERAI), rail transport is the only mode of transport that, along with increased traffic, reduces CO₂ emissions (ERAI, 2020). Direct emissions from this type of transport are almost 5 times less than by sea, 89 times less than by road, 528 times less than by aviation. Despite the fact that railway transport is not the main pollutant of the environment, it is a source of noise and negative impact on the atmosphere and biosphere (García de la Morena, 2017). Accordingly,

railway transport facilities must reduce their impact on soil, air, water, and become safer for people and nature. Moreover, “green technologies” have become a worldwide trend.

In terms of energy efficiency, rail transport facilities consume less energy than other modes of transport.

According to the international energy agency IEA, it accounts for 7% of international freight traffic, but only 3% of the energy used by the global transport industry. In 2019, rail transport used 0.6 million barrels of oil, which is 0.6% of global consumption, and about 280 TWh of electricity, that is, 1.2% of global consumption (IEA, 2020). The direct contribution of railways to carbon dioxide emissions is significantly lower and amounts to only 0.3% of the global (Shapiro, 2016).

According to the IEA, in the long term, the railway industry will be affected not only by electrification, but also by the transition to new types of fuels (IEA, 2020). To date, the only tested alternatives to diesel and electric locomotives are LPG and hydrogen. At the moment, the Russian railways are aimed at the creation of main gas turbine locomotives and gas locomotives operating on liquefied natural gas. This approach will provide reduced CO₂ emissions compared to diesel engines.

Russia is the second largest country with a developed railway network in the world (about 85,000 km) after the United States, about 8% of all railways in the world and only about 51% are electrified (Shapiro, 2016). The maximum density of the railway network is typical for the European part of the country. In the Asian part of Russia, the railway network is poorly developed and oriented towards latitude, but in the European region it is predominantly radial. The average density of the RF railway network is about 9 km per 1,000 km².

Today all extracted, processed and synthesized substances are transported by rail. During operation, hazardous chemicals and materials are used. Most pollutants enter the soil during the transport of goods, as well as during their dispersal or leakage (Brodsky, 2016). All this significantly affects the increase in emissions of harmful substances into the environment of the railway line.

A special role is played by environmental pollution by emissions of electric locomotives, which are formed during the wear of wheelsets, parts and assembly units, contact wires and pantographs (Dontsov, 2017).

The ratio of the adverse effects of the railway industry to the total volume of environmental pollution on a Russian scale 0.72% of atmospheric emissions from stationary sources, 1.00% of emissions from mobile sources, 0.09% when discharging polluted wastewater, 0.08% of waste from production (Katin, 2013).

From the point of view of environmental safety, the greatest risks are associated with the transportation of dangerous goods. 890 items are transported by Russian railways. The number of train accidents and incidents with dangerous goods in Russia is quite large - these are leaks of oil products, poisonous and other substances (Kazantsev, 2014).

Ozone-depleting substances are used in the refrigeration equipment of refrigerated rolling stock, each refrigeration machine (two per car) is filled with 35 kg of freon. Leaks lead to activation of ozone depletion processes. The seriousness of the global environmental problem of the depletion of the ozone layer requires the use of ozone-depleting substances in household refrigeration equipment to be phased out as soon as possible (Makarov, 2014).

There are 35,970 stationary sources of atmospheric emissions in railway transport. Of these, 197 thousand tons of pollutants enter the atmosphere annually, including 53 thousand tons of solid substances, 144 thousand tons of gaseous substances. More than 90% of emissions are from boiler houses and blacksmiths (Serazhutdinov, 2017).

Wastewater discharge at the locomotive depot is 20-400 thousand cubic meters. per year, passenger carriage depot - 30 - 180 thousand cubic meters, freight car depot - 20-150 thousand cubic meters (California Air Resources Board, 2019).

Specific for railway transport are enterprises for the preparation and impregnation of sleepers, crushed stone plants, washing and steaming stations. The main sources of pollutant emissions are the impregnation cylinder when pumping out the antiseptic, pipelines and a vacuum pump, as well as the cooling of sleepers when transporting carts to the warehouse. The processing of sleepers is accompanied by the release of naphthalene, anthracene, acenaphthene, benzene, toluene, xylene, phenol into the air, that is, substances belonging to the 2nd hazard class (Serazhutdinov, 2017).

In the field of railway transport in the Russian Federation, railway transport accounts for 75% of freight turnover and 40% of passenger turnover (Russian Railways company, 2020). Such a volume

of work is associated with a large consumption of natural resources and, consequently, the release of pollutants into the environment. The influence of railway transport on the environmental situation is manifested in air, water and soil pollution during the construction and operation of the railway. There are the following sources of pollution: mobile and stationary (Cristea, 2013).

The average annual emission of pollutants from mobile sources is 1.65 million tons. The main pollution occurs in areas where diesel locomotives with diesel power plants are used as locomotives. Emissions of combustion products into the atmosphere are emitted during the operation of mainline diesel locomotives. Its composition is similar to the exhaust of a diesel car engine. In addition to emissions of fuel combustion products during transportation and reloading of goods from the wagon, about 3.3 million tons of ore, 0.15 million tons of salt and 0.36 million tons of mineral fertilizers are annually emitted into the environment. More than 17% of deployed railway lines carry a significant degree of pollution with dusty cargo (Forslid, 2019). Oil products are lost from tank wagons due to leaks in valves and tank drain devices, not tightly closed hatches. They penetrate the soil cover and pollute the groundwater. Passenger cars pollute the environment with dry waste and sewage. For each kilometer of the track, up to 180-200 cubic meters are poured out, while 60% of transport pollution falls on hauls, the rest - at stations (Sidorov, 2013).

For 2020 in Russia 166 895 units. freight cars of all types, 17 898 units. long-distance passenger cars, more than 20.5 thousand locomotives (Russian Railways company, 2020). Until 2015, the basis of the locomotive fleet was made up of Soviet-made machines: about 98% of DC electric freight locomotives had an outdated design, about 50% of which were shunting diesel locomotives that deliver cars to access tracks, are used to push cars onto marshalling humps, service passenger and marshalling yards. It is shunting diesel locomotives that emit a large amount of various harmful substances and create difficult environmental situations. At the beginning of 2020, the total number of mainline freight locomotives of Russian Railways amounted to 10,570 traction units. on average per day (Russian Railways company, 2020).

Consider the activities carried out on the railways of the Russian Federation in order to reduce environmental risks and improve the state of the envi-

ronment at the end of 2019-2020. on the example of Russian railways (Russian Railways company, 2020).

As part of ensuring environmental safety on the Trans-Baikal Railway, 24 units of control and measuring and educational and laboratory equipment have been put into operation since 2019. Work continues on the installation of noise barriers at the stations, construction of sites for the temporary accumulation of old sleepers. A gradual transfer of heating points from stove to electric heating, boiler rooms - to long-burning equipment or electric heat, replacement of dust and gas cleaning equipment, replacement of outdated shunting diesel locomotives with an electronic fuel supply control system is being carried out.

Thus, at ZabZD, a decrease in pollutant emissions is achieved by connecting facilities to modern modular boiler houses with automated processes - the decrease from stationary sources was 809 tons (7%) compared to 2019. Reduction of discharge of contaminated wastewater into water bodies and onto the terrain occurred by more than 90%, the level of water consumption was reduced by 42.13 thousand m³, which was achieved due to the commissioning of a self-made washing machine for washing parts, increasing the volume of water reuse in the service locomotive depot, cleaning oil traps, reconstruction and modernization local treatment facilities for locomotive depots.

Another way to reduce air emissions is to save the amount of fuel burned during the operation of mobile emission sources. In 2018, stationary sources emitted 7247 tons of harmful substances, while in 2019 - 5499 tons, that is, the volume of emissions decreased by 24%.

The East Siberian Railway (ESSR) is currently the only one where 92.8% of waste is reused: MSW, as well as crushed stone, which is reused for overhaul of the track.

The transfer of heating points from heating furnaces to electric heating continues.

At the Eastern Highways, the problem of recycling wooden sleepers (hazard class 3) is solved by a complex for thermal neutralization of wooden sleepers, work is underway to neutralize reinforced concrete sleepers - reinforced concrete sleepers are crushed or used reinforced concrete sleepers are used for the construction of sites between tracks. Monitoring by waste type in 2019 showed that paper and cardboard make up 42% of the total waste

volume. These types of waste are being collected for reuse.

The priority area in the environmental activities of the ESC is the introduction of resource-saving technologies to reduce the negative impact on the environment. In 2019, emissions of pollutants into the atmosphere from stationary sources decreased by 3% compared to 2018.

On the Sverdlovsk railway, the priority areas are reducing the negative impact on the environment from technological activities, the introduction of modern resource-saving technologies, and the creation of an effective waste management system. So, in 2019, the decrease in emissions of pollutants into the atmosphere from stationary sources was 8.7% compared to 2018. The discharge of insufficiently treated wastewater into water bodies decreased by 7.6%. The Sverdlovsk Mainline has in its arsenal a mobile environmental laboratory, a complex for the processing of reinforced concrete sleepers, 37 units. modern laboratory equipment for large-scale environmental monitoring. The process of reusing paper, cardboard, plastic, glass has been established. Environmental clean-ups, cleaning of territories, planting of trees are held within the boundaries of the railway.

The following activities are being implemented on the Moscow Railway:

- Reconstruction of treatment facilities of the operational locomotive depot;
- Installation of noise protection screens in certain areas;
- Cleaning of the territory, elimination of landfills;
- Planting trees and shrubs.

Thanks to environmental measures in 2019, the decrease in electricity consumption amounted to more than 160 thousand kWh, the consumption of fuel and energy resources - by 33.8 tons, the emissions of pollutants into the atmosphere - by 5.7 tons. Thus, the reduction of emissions of greenhouse gases due to a decrease in electricity consumption in the general railway network will amount to 61.6 thousand tons of CO₂ per year.

In 2019, almost 1.5 million tons of production and consumption waste were generated along the railway network as a whole. Moreover, more than 80% of the waste was neutralized and involved in the secondary economic turnover.

At the stations of the South Ural Railway, a modular laboratory complex was put into operation

to conduct environmental monitoring and determine the toxicity of water and waste.

On the North Caucasian Railway, at one of the stations, a solar power plant with a capacity of 30.7 kW was installed with a direct transfer of the generated electricity to the station's internal power grid for priority consumption.

New protective forest plantations are created annually in the railway right-of-way. During the overhaul of the track, wooden sleepers impregnated with antiseptics are replaced with environmentally friendly reinforced concrete sleepers. Environmental monitoring of emissions from diesel locomotives is carried out. A waste-free technological process of washing the inner surfaces of railway tank cars and washing wheel pairs and other parts, equipment for liquidation of emergency oil spills is put into operation.

In accordance with the environmental policy implemented on the Russian railway, over 17 years, emissions of pollutants decreased by 71%, wastewater discharges - by 85%, and the involvement of waste in secondary circulation increased by 22% (Russian Railways Company, 2020).

Conclusion

Based on the study of the impact of railway transport on the environment, as well as analysis of measures to reduce environmental risks on the railways, it is advisable to draw the following conclusions:

- Railway transport is the least dangerous source of environmental pollution;
- Sources of pollution include: emissions of electric locomotives, transportation of dangerous goods, waste water discharge, the processing of sleepers, accompanied by the release of pollutants into the air, oil spills, emissions of fuel combustion products during transportation and handling of goods, dusty cargo, garbage and landfills, the use of diesel engines, furnace heating in boiler rooms;
- Promising ways to reduce emissions of pollutants into the environment are:
 - (a) mobile sources - conversion of diesel locomotives to electric heat, diesel locomotives to liquefied natural gas, replacement of outdated shunting diesel locomotives with an electronic fuel supply control system;
 - (b) stationary sources - the transition to renewable energy sources, energy and resource-saving

technologies, the installation of noise screens, grinding rails, laying a continuous track, transferring boiler houses to environmentally friendly fuels, heating points to electric heating, neutralization of reinforced concrete sleepers, disposal of wooden sleepers, construction of sites for the temporary accumulation of old sleepers, reconstruction and modernization of local treatment facilities for locomotive depots;

- Carrying out constant environmental monitoring, introduction of mobile laboratory complexes;
- Waste disposal and reuse of waste;
- Replacement of dust and gas cleaning equipment;
- Introduction of a modern waste-free technological process of washing and washing the inner surfaces of railway tanks, wheelsets and other parts.

Thanks to the measures taken, the environmental friendliness of railway transport is increased, harmful emissions into the atmosphere, the degree of acoustic impact of railway transport on adjacent residential buildings, and a negative impact on the environment are reduced.

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