Analysis of the Impact of Emissions from the Blagoveshchensk Asphalt Concrete Plant “Nikko Cbd-100”Jsc“Asphalt”on the Atmospheric Air and Measures to Protect it

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Keywords: Asphalt concrete plant, Emissions of pollutants, Sanitary protection zone, Noise·Air protection, Environmental measures.

Abstract: Air pollution is caused by the release of gaseous, liquid and solid substances in quantities that damage the environment, adversely affecting flora and fauna, water, soil and human health. The main air pollutants are nitrogen compounds (NO, NO2), carbon compounds (CO, CO2), sulfur dioxide (SO2), heavy metals (mercury, nickel, lead, arsenic, cadmium), hydrocarbons and their derivatives, as well as PM 10, PM 2.5 and PM 1.0. Solid pollutants negatively affect human health both directly, penetrating the body, causing allergies and lung diseases, and indirectly, acting as a carrier of heavy metals, microorganisms and bacteria. It is widely believed that large industrial plants, power plants and combined heat and power plants are the main sources of point emissions, affecting both local and global air quality. Strong corporate environmental and sustainability commitments are based on reliable assessments of corporate impacts and realistic mitigation plans. The purpose of this study was to analyze the emissions of pollutants into the atmosphere from the asphalt concrete plant (ABP) “NIKKO CBD-100” (Blagoveshchensk, Amur region, Russia). The results show that the gases emitted by each type of material can influence design criteria from an environmental point of view. From the results obtained, it can be concluded that at the production stage, emissions of methane, carbon dioxide and carbon monoxide increase and decrease depending on the materials used in the operation of the asphalt concrete plant.

1 INTRODUCTION

The infrastructure construction industry, which has been continuously developing in recent years around the world for both construction and maintenance, requires a corresponding consumption of precious materials with enormous consequences for the natural ecosystem (Burlak, Belaya, 2020). These environmental concerns are also associated with the sheer volume of sidewalk construction and the required mining and production technologies for materials that traditionally have high impacts.

Asphalt is one of the oldest building materials. The advent of polymers for asphalt modification has had a major impact on the development of pavement technology.

Over the past five years, total asphalt production in the United States, Japan and 30 European countries has reached 5485.3 million tonnes. Asphalt production in the world exceeds the above figures. These data show that the production of asphalt material worldwide is enormous, and therefore analyzing the environmental impact of producing this amount of asphalt is important for the preservation of the environment.

Asphalt concrete plants (hereinafter - ABZ) are the main production enterprises of the road sector. They are part of the automobile and road complex and are designed for the production of asphalt concrete mixtures. The result of the activity of the ABZ is the release of pollutants into the environment: hydrocarbons, soot, phenol, nitrogen and carbon

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oxides, formaldehyde, etc. (Moore, Lopes, 1999; Burlak, Belaya, 2020).

One of the significant environmental problems of ABZ technologies is the lack of special devices for cleaning emissions from harmful gases under conditions of an increasing environmental load on the atmosphere. In this regard, the selected research topic is of particular relevance and practical importance.

Asphalt concrete plant NIKKO KBD-100 for the production of asphalt concrete mixture is located west of Blagoveshchensk and north of the village Verkhneblagoveshchenskoe. The nearest building is located at a distance of 1200 m from the ABZ. The plant's productivity is 100 t/h of commercial asphalt.

The process of preparing an asphalt concrete mixture includes four main stages:

- Preparation of mineral materials (feeding by a loader of mineral materials from a warehouse to a mixer; feeding sand and gravel into a drying drum; drying and heating mineral materials; separating them into fractions; precise final dosing of gravel, sand, powder);
- Preparation of bitumen (supply from a warehouse to a bitumen plant, heating to operating temperature, dosing of heated bitumen);
- Mixing mineral materials with bitumen;
- Inloading the finished asphalt concrete mixture into a bunker or a car.

Most of the previous studies (Butt, Mirzadeh, Toller, 2014; Sisi, Zhijuan, Minrui, 2019) have focused on the effects of air pollution. Mediation analysis is a statistical technique commonly used to study the relationship between independent, mediating and dependent variables in order to obtain direct and indirect effects of the independent variable on the dependent variable.

The construction and maintenance of roads has a large impact on the environment due to the enormous amount of resources involved. Consequently, existing manufacturing procedures and technologies must be properly investigated to identify and quantify the environmental impacts produced during the life cycle.

2 MATERIALS AND METHODS

In the presented work, the purpose of the study is to analyze the emissions of pollutants into the atmosphere from the asphalt concrete plant “NIKKO CBD-100”, and also proposed measures to reduce emissions. To achieve this goal, the following tasks have been identified:

1) analyze the sources of impact on the atmosphere;

2) analyze the calculation of surface concentrations of pollutants;

3) to identify the main share of gross emissions;

4) to propose an action to reduce emissions into the air.

The research methodology is based on comparative analytical methods, methods of generalization and formalization, coefficient analysis. To write the article, we used normative **legal acts (**Atamaleki, Zarandi, Fakhri, 2019; Standartinform, 2014**)**, periodicals (Atamaleki , Zarandi , Fakhri, 2019; Hamidi, Bahman , 2020; Santero, Masanet, Horvath , 2011; Tumminia, Guarino, Longo, 2018), local documents of the organization.

The calculation of ground-level concentrations of the main pollutants was carried out at the PVEM using the ERAv 2.0 software package (PC), developed by the Novosibirsk enterprise LOGOS-PLUS LLC.

3 RESULTS

At the Blagoveshchensk ABZ, 51 sources of pollutant emissions have been identified, of which 12 are organized sources and 39 are unorganized sources. During the operation of the ABZ, 24 types of pollutants are emitted into the atmosphere. Some of these substances form 5 summation groups. The gross emission of pollutants is 29.064 t/year. Sources of emission of pollutants at the plant are technological units that are part of the installation, etc., emitting pollutants during operation (Table 1). Sources of pollutant emissions are a chimney, aeration lantern, a bunker, a ventilation shaft, a hatch, and other devices through which pollutants are released into the atmosphere (Huang , Bird, Bell, 2009).

Table 1: Sources of emission and emissions of harmful substances at the NIKKO CBD-100 plant.

Site name	**Selection sources**	**Sources of emissions**
Cold section	Inclined belt conveyor	Fugitive emissions

Drying section	Dryer drum	Chimney
Dust collection section	Dust feed rotor, chimney	
Mixing section	Hot hopper	
Inert feed section	Horizontal belt conveyor	Fugitive emissions
Road transport	Engine	Exhaust pipe

Source: Compiled by the authors.

The list of harmful substances that are released into the atmosphere during the operation of the ABZ, their qualitative and quantitative characteristics are presented in Table 2. Analysis of calculations of surface concentrations revealed that ABZ is a source of impact on the environment for nitrogen dioxide (0301), sulfur dioxide (0330), limit hydrocarbons C12-19 (2754), inorganic dust (2908), 31 and 41 groups of summation, whose contribution in atmospheric air pollution at the border of the nearest residential development exceeds 1,0 maximum permissible concentration (MPC).

Also, according to the analysis of the obtained calculations, there is an excess of the MPC in the territory of the Blagoveshchensk Asphalt concrete plant ABP for nitrogen dioxide, xylene, methylbenzene, butyl alcohol, butyl acetate, saturated hydrocarbons C12-19, inorganic dust (70% -20% silicon dioxide), 31 and 41 groups of summation.

Table 2: Short cut keys for the template.

Code	Na-me impurities	Concentration of contaminants in the surface layer in fractions of maximum permissible concentration			
		Background concentration (MPC)	Max. concentration	Max. Concentration at the border of the residential area	Contribution of sources to pollution at the border of residential area
123	Iron oxide	0,20	0,352	0,204	0,004
301	Nitrogen dioxide	0,40	1,628	0,790	0,390
304	Nitrogen oxide	0,20	0,299	0,213	0,013
328	Soot	0,20	0,529	0.262	0,062
330	Sulfur dioxide	0,022	0,359	0,188	0,166
337	Carbon monoxide	0,58	0,656	0,621	0,041
616	Xylene	0,20	1,425	0,211	0,011
621	Methyl benzene	0,20	1,411	0,211	0,011
042	Butyl alcohol	0,20	2,376	0,219	0,019
119	Ethyl cellosolve	0,20	0,365	0,201	0,001
210	Butyl acetate	0,20	1,651	0,213	0,013
401	Acetone	0,20	0,490	0,202	0,002
732	Kerosene	0,20	0,250	0,208	0,008
752	White Spirit	0,20	0,445	0,202	0,002
754	Hydrocarbons, pr. S12-19	0,20	13,864	0,472	0,272
902	Suspended substances	0,20	0,606	0,201	0,001
908	The dust is inorganic. 70-20%	0,20	4,087	0,356	0,156
1 гр.	Nitrogen dioxide + Sulfur dioxide	0,40	1,235	0,733	0,333
1 гр.	Carbon monoxide + Inorganic dust 70-20%	0,58	4,499	0,778	0,198

Source: Compiled by the authors.

Distances from the production sites of the Blagoveshchensk ABZ to the nearest residential area with. Verkhneblagoveshchenskoe are:

- Intermediate storage of sand and gravel mixture - 400 m;
- Area with warehouses for sand and gravel mixture, crushed stone, sand - 400 m;

- The site of the ABZ - 700 m;
- Garage - 800 m;
- BRU site - 880 m.

Table 3: Short cut keys for the template.

Pollutant		Hazard Class	MPCs.s, MPCmax *, OBUV **, mg / m3	Total release of matter	
Code	Name			g /s	t / year
123	Iron oxide	3	0,04	0,0127	0,0263
301	Nitrogen dioxide	3	0,04	1,5403	6,4840
304	Nitrogen oxide	3	0,06	0,2502	1,0536
328	Soot	3	0,05	0,1027	0,9953
0330	Sulfur dioxide	3	0,05	1,6381	2,7077
337	Carbon monoxide	4	3,00	4,0197	9,5905
616	Xylene	3	0,2*	0,0104	0,0675
621	Methylbenzene	3	0,6*	0,0309	0,2500
042	Butyl alcohol	3	0,1*	0,0093	0,075
119	Ethyl cellosolve	-	0,7**	0,0049	0,0400
210	Butyl acetate	4	0,1*	0,0062	0,0500
401	Acetone	4	0,35*	0,0043	0,0350
732	Kerosene	-	1,2**	0,2195	1,3879
752	White Spirit	-	1**	0,0104	0,0675
754	Hydrocarbons, pr. S12-19	4	1*	1,3976	5,2397
902	Suspended substances	3	0,15	0,0061	0,0198
908	The dust is inorganic. 70-20%	3	0,10	0,4129	0,9238
123	Iron oxide	3	0,04	0,0127	0,0263
301	Nitrogen dioxide	3	0,04	1,5403	6,4840
Total substances: 17				**9,677**	**29,064**
of which solid: 4				0,535	2,016
liquid / gaseous: 13				9,142	27,048

Source: Compiled by the authors.

Estimated concentrations of pollutants in 1 MPC outside the territory of the Blagoveshchensk ABZ spread over distances:

1) Nitrogen dioxide - 75-185 m;
2) Xylene - does not go beyond the boundaries of the enterprise;
3) Methylbenzene - does not go beyond the boundaries of the enterprise;
4) Butyl alcohol - 0-35 m;
5) Butyl acetate - 0-20 m;
6) Saturated hydrocarbons C12-19 - 30-280 m;
7) Inorganic dust (70% -20% silicon dioxide) - 0-95 m;
8) 31 summation groups - 0-100 m;
9) 41 summation group - 0-210 m.

At the same time, the excess of maximum permissible concentration for all substances and groups of summation in residential buildings with Verkhneblagoveshchenskoe is notobserved.

The estimated SPZ for the factor of chemical pollution of atmospheric air is determined by the combined isoline of 1 MPC from various substances and is:

- In the north direction - 150 m;
- Eastward - 250 m;
- Southward - 200 m;
- In the western direction - 300 m.

The distance between the boundaries of the territory of the Blagoveshchensky ABZ and residential buildings with. Verkhneblagoveshchenskoe, 400 m away, ensures the observance of the hygienic indicators of the quality of atmospheric air in the standardized territories.

In addition to the chemical impact, 22 sources of noise impact on the atmospheric air have been installed on the territory of the industrial site of the enterprise. According to the results of the calculations, it was found that during the operation of the facility in the mode of main production, the maximum sound levels at the border of the design SPZ and outside it do not exceed the maximum permissible concentration.

To protect the environment from pollution at the plant, organizational, technological, engineering and technical environmental protection measures are envisaged, which allow preventing or minimizing the negative impact on the natural environment.

The NIKKO CBD-100 monitoring system of the Blagoveshchensk ABZ includes control over the quality of atmospheric air at the border of the SPZ and the nearest residential development, on the territory of an industrial site, and also includes monitoring of emissions from pollution sources. The concentration of the following pollutants is subject to control: nitrogen dioxide, xylene, sulfur dioxide, methylbenzene, butyl alcohol, butyl acetate, a mixture of saturated hydrocarbons C12-19, inorganic dust (70% -20% silicon dioxide), 31 and 41 groups of summation.

The facility carries out an inventory of emissions of harmful pollutants into the air every 5 years, and there is also a Schedule for monitoring compliance with the MPE standards. The main activities carried out for the protection of atmospheric air at the NIKKO CBD-100 ABZ: control over the technical condition of equipment, timely technical inspection and its repair; non-admission of idle operation of engines of machines during their parking and mechanisms with internal combustion engines; prohibition of washing machines and mechanisms, draining of fuels and lubricants on the territory of the facility; corrosion protection of technological equipment by applying anti-corrosion coatings; equipping equipment with instrumentation and automation systems to prevent emergencies, as well as to reduce emissions of pollutants into the atmosphere due to the exact observance of the specified technological parameters; during the period of repair work - the use of shut-off and control valves and technological equipment corresponding to the parameters of the working process and corrosiveness of the environment.

According to the analysis, the NIKKO CBD-100 ABZ is a source of air pollution with various harmful substances. The emissions from the plant are in many ways similar to those from the energy sector - concentrations of nitrogenous and sulfur compounds prevail, and large amounts of dust are emitted (from vibrating screens) (Kota, Zhang, Chen, 2014).

To reduce the negative impact of the ABZ in the atmospheric air, the following measures can be proposed:

- To apply reinforcement with shields made of fine-mesh construction non-metallic mesh along the perimeter of small-sized fugitive dust sources and completely cover the stored sources of fugitive emissions;
- To reduce organized emissions of pollutants, use a device for wet cleaning of exhaust gases and dusty air - a Venturi scrubber in combination with droplet separators (Nikkko, 2019).

At present, at the ABZ, the emission purification system is represented by a dry dust collector and a bag filter chamber. The cleaning factor is 91%.

The Venturi scrubber allows to provide cleaning efficiency up to 98-99% on dusts with an average particle size of 1-2 microns at an initial dust concentration of up to 100 g / m3. Specific water consumption for irrigation with a composition of 0.4-0.6 l / m3. The calculation of the Venturi scrubber was carried out according to the methodology given in the interstate standard GOST 31826-2012.

Modernization of the treatment facilities system will increase the efficiency of cleaning pollutant emissions from 91% to 99.8%.

It is also recommended to use water reuse (circulating water supply) for the Venturi pipe in order to reduce the amount of polluted water released into the environment and avoid paying fines for violation of environmental legislation.

According to the calculations obtained, the total costs of upgrading the emission treatment system at the plant will amount to 268,000 rubles. The economic effect of the measure is to reduce the company's expenses for payments for negative environmental impact. According to the results of calculations, the installation of an additional treatment facility - a Venturi scrubber - will lead to a reduction in payments for negative impact on the environment by 88% and will amount to 327 rubles per year.

4 DISCUSSION

All data collected is real data obtained at the production site, in a real operating asphalt plant. Comparisons of different inventory analyzes among different studies available in the literature are not immediate, especially when they relate to different regions. The raw data collected for the environmental audit of the plant can also be used to provide a preliminary discussion of current generally accepted practice. To improve air quality, action must be taken to reduce the amount of pollutants emitted from all sources. Despite some positive results, the main problem with such studies is that the relevant case studies are based on specially optimized models that cannot be easily applied to other countries and scenarios (Santero, Masanet, Horvath, 2011) or immediately compared (Hamidi, Bahman, 2020). Future parallel results will increase the reliability and accuracy of the linked dataset and can also be used for statistical analysis and analysis, as has already been done for other geographic and industrial contexts.

5 CONCLUSIONS

An experimental study of the effect of emissions from an asphalt concrete plant was carried out. ABZ NIKKO CBD-100 is designed and built taking into accountsanitary and hygienic requirements and has established boundaries of the sanitary protection zone. The ABZ has a two-level emission purification system: a dry dust collector and a bag filter. The cleaning factor is 91%. The results of the analysis show that the analyzed enterprise is a source of environmental impact. To reduce the negative impact of the ABZ on the atmospheric air, measures are proposed to reduce organized and fugitive emissions of pollutants. Based on the results of calculations, a Venturi scrubber of type SV 210 / 120-1200 with a capacity of 7-2 thousand m^3/h was selected. This will increase the efficiency of cleaning emissions from the NIKKO CBD-100 plant to 99.8%: the volume of pollutant emissions will decrease from 29.01 tons up to 6.45 tons. A recommendation was made to use recycled water (recycled water supply) for the Venturi pipe in order to reduce the volumetric discharge of polluted water into the environment and avoid paying fines for violation of the law.

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