DEVELOPMENT OF ENVIRONMENTAL PROTECTION TECHNOLOGY FROM THE NEGATIVE IMPACT OF THE PRODUCTION ACTIVITY OF THE ASPHALT CONCRETE PRODUCTION FACTORY

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Relevance of the study is due to the following. Increasing volumes and rates of construction, repair and maintenance of highways cause the development of production of road-building materials in industrial enterprises of various types: asphalt-concrete plants (ACP), cement plants, factories of reinforced concrete structures, etc. The main material used for road construction is asphalt concrete. Asphalt or asphalt concrete is a dense mix for various pavements consisting of bitumen, mineral powder, rubble and sand. ACP are the main industrial enterprises of the road industry and are intended for preparation of various asphalt concrete mixes for construction, reconstruction and repair of layers of asphalt concrete covering. As a result of ACP's production activity, pollutants such as soot, hydrocarbons, carbon monoxide, nitrogen oxides, sulfur oxides, phenol, benz(a)pyrene, resinous substances, vanadium pentoxide, formaldehyde are emitted into the environment. Inorganic dust is the main ingredient contained in the emissions of ACP, as well as stone extraction and processing enterprises. The release of a large amount of harmful substances is due to the high temperature of asphalt concrete preparation. The type of asphalt mix, the type of fuel used, and the technical condition of the equipment at the plant have a significant impact on the composition of ACP emissions. Factors that confirm the relevance of the task of ensuring the ecological safety of ACP, in addition to the toxicity of their emissions into the atmosphere, is the presence of raw materials associated with the recycling of dust mixers ACP and its subsequent use instead of mineral powder, as well as the need to improve the combustion processes in the ACP saving hydrocarbon fuel and reducing environmental damage [1–3].

Purpose of the study is to improve the approach to the developing of environmental protection technologies from the negative impact of the production activity of the plant for the production of asphalt concrete mixtures.

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Results of the research. The study of negative impact of ACP on the atmosphere was performed on the example of Ltd. «DS PROM GROUP», an industrial site of which is located in the city of Brovary (Kiev region).

According to the results of the study, it is detected that all stages of preparation of asphalt concrete mixture (ACM) are accompanied by the release of harmful substances into the atmosphere. At the same time, pollutant emissions are divided into organized and unorganized. Organized emissions are emissions that are discharged from places of discharge by a system of gas outlets (dust catchers with exhaust pipes). Emissions resulting from the leakage of process equipment, gas vents, tanks, open flowering and evaporation sites etc. are unorganized [4].

The unorganized sources of the emissions of harmful substances on the ACP include: a) places of unloading of materials from vehicles [5–7]; b) site of loading (unloading) of materials into the drying drum; c) hot elevators; d) storage places for sand, gravel, mineral powder, etc. [4].

The main sources of pollution entering the atmosphere as a result of the production activity of ACP of various types are presented in Table 1. In the Table 2 shows the volumes of substances that are in the process of circulation of ACP and at the same time are sources of atmospheric pollution.

During the operation of this ACP the following pollutants are released into the atmosphere: inorganic dust, with different content of silicon dioxide; carbon and nitrogen oxides; sulfur dioxide; limit hydrocarbons; polycyclic hydrocarbons: fuel oil ash (in terms of vanadium) when fuel oil is used; benz(a)pyrene and soot as by-products of bitumen combustion; soot – during the operation of transport on diesel fuel; lead and its inorganic compounds – when working transport on leaded gasoline.

As a result of calculations, it was revealed that the total impact of harmful substances is exceeding the limit values, so one of the measures to reduce the negative impact on the environment should be to increase the width of the sanitary protection zone up to 1000 m, since at this distance the concentrations of pollution do not exceed the established, and to increase the amount of green space around the plant, fence or even awning can be installed.

Table 1

Sources of pollutant emission at the ACP

Name of the site	Name of the emission place	Name of the emission source
1. Site of mixing of ACM	1. Place the pouring of stone materials into the unloading box. 2. Place of attachment of the drying drum to the unloading box. 3. Dryer for linen. 4. Drying drum elevator. 5. Sifler. 6. Filling places of fillers in bins. 7. Mixers. 8. Pneumotransport of the filler in silo tanks.	Dust catchers with exhaust pipes
2. Bitumen site	Bituminous boilers (bitumen storage)	Exhaust pipes
3. Stone crashing site	1. Place where the stone is poured into the receiving hopper. 2. Cheek crusher. 3. Cone crusher. 4. Sifler. 5. Place where the ground materials is poured into the conveyor.	Fugitive emissions
4. Sand and crushed piles, loading and unloading sites, vehicles	Sand and crushed piles, loading and unloading sites, vehicles	Fugitive emissions
5. Ground mixing plant	1. Mixer. 2. Cement feed place. 3. Bunker of mineral materials. 4. Place of preparation and dosage of organic binder.	Fugitive emissions
6. Boiler house	Combustion system (boilers)	Exhaust pipe

Table 2

Raw materials, auxiliary materials needed for ACM production

Raw materials, auxiliary materials	Storage conditions	Annual use, tons
Bitumen	Container	10500
Screenings 0,5	Storage	79200
Crushed stone 5–10	Storage	18720
Crushed stone 10–20	Storage	17280
Crushed stone 20–40	Storage	28800
Mineral powder	Silage	10500

To increase the ecological safety of the ACP, it is necessary to provide careful waterproofing of silos for the storage of cement, skip hoists with minimal dust emission to feed inert materials into the concrete mixer, belt conveyors placed in a plastic collapsible casing. Careful sealing of coverings by 80–90% guarantees the elimination of the possibility of dust entering outside the housings. It is also necessary to improve the technological processes that are accompanied by the release of dust, namely: a) installation of accurate tensometric weighing equipment, which ensures a dosage error of inert components of 2%, and the error of dosing of binders and chemical additives – 1%; b) integration of the automation system of the ACP, which allows to control all operations carried out by the equipment, in order to reduce the technogenic burden on the environment; c) providing a system of treatment plants that retain cement dust and sand. This complex of technological solutions allows to minimize the level of dustiness of the atmospheric air and to create favorable conditions for living in relative proximity to the ACP. To ensure the required environmental standards, the site of preparation of rubble mill for the preliminary preparation of components of ACM mixtures must be provided with additional dust collectors. For this purpose the technological scheme shown in Fig. 1, where: A – source of emission – site for the preparation of rubble; B – water-drop curtain system; C – cylindrical cyclone; D – bag filter; E – emission receiver – atmosphere; F – separator/sump/filter; G – ABM mixing shop; H – circulation pump; 1 – aerosol purified from large-grade mineral dust; 2 – aerosol purified from medium-grade mineral dust; 3 – aerosol purified from fine-grade dust; 4 – pulp from water and mineral dust of large-grade fraction; 5 – powder of medium-grade mineral dust; 6 – mineral dust of fine-grade fraction; 7 – industrial water; 8 – powder of large-grade mineral dust.

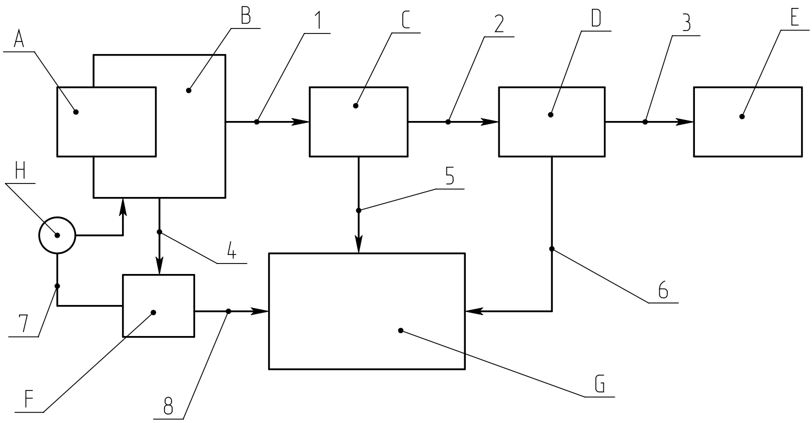

Figure 1. Results of the study – proposed scheme for environmental protection technology

Conclusions. Thus, in the study was proposed and applied approaches to the development of technologies for environmental protection from the negative impact of the production activity of the plant for the production of asphalt-concrete mixtures. On the basis of this approach, a technological scheme of a system for purification of gas emission of the site of preparation of crushed stone from mineral dust with the return of screenings in the technological process was developed.

References:

1. Savenko, V. Ya., Slonivska, O. S., Kaskiv, V. I., & Petrovych, V. V. (2001). Design of asphalt and cement plants for road construction. Tutorial. Kyiv, 218 p.

2. Manihin, V. Ya. (2007). Main problems of environmental safety in the production of asphalt concrete. *Life safety*, no. 5, pp. 37–40.

3. Timofeev, V. A., Vasilyev, A. A., Vasilyev, I. A., & Dekan`, V. A. (1989). Equipment for asphalt plants and emulsion bases. Moscow: Mashinostroyeniye, 256 p.

4. Building code V.2.3-218-186-2004. Flexible type of pavement. Kyiv: Derzhbud Ukrainy, 2004, 55 p.

5. Kondratenko, O. M. (2019). Metrological aspects of complex criteria-based assessment of ecological safety level of exploitation of reciprocating engines of power plants: Monograph. Kharkiv: Style-Izdat, 532 p.

6. Kondratenko, O., Mishchenko, I., Chernobay, G., & Derkach, Yu. at al. (2018). Criteria based assessment of the level of ecological safety of exploitation of electric generating power plant that consumes biofuels. *IEEE 3rd International International Conference on Intelligent Energy and Power Systems (IEPS–2018*), pp. 185–189. doi 10.1109/IEPS.2018.8559570

7. Kondratenko, O. M. (2019). Taking into account the emissions of CO2 as a toxic pollutant and as a greenhouse gas in fuel and ecological complex criteria-based assessment of diesel-generator operation process. *Technogenic and Ecological Safety*, no. 6(2/2019), pp. 12–23. doi: 10.5281/zenodo.3558960