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Dust Discharge Profile as a Tool to Improve the Objectivity of Atmospheric air Monitoring in Areas Affected by Industrial Enterprises

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***Abstract* – Methodical approaches to construction of dust discharge profile of industrial enterprise are proposed. The discharge profile is considered to be a parameterized characteristic of the component structure of dust with the selection of specific (indicative) for the technological process elements. On the example of a specific mining and chemical enterprise, complex research of dust discharges was carried out. Methods: spectrometry and electron microscopy. The component structure of dust discharges from sources is described. The priority list of pollutants characterizing the structure of dust discharges of the enterprise is determined. Indicators of the production process are singled out. A typical discharge profile was built. Comparative analysis of the obtained results with dust pollution of atmospheric air at the border of the sanitary protection zone is carried out. It is established that the air samples taken in the zone of influence of the enterprise in terms of the structure of dust particles do not correspond to the discharge profile of the enterprise. The contribution of discharges from the object is estimated at 7-10% at different points. Conclusions about the need to search for the real causes and sources of dust pollution in the area of influence of the object are justified. The enterprise is recommended to implement the production control program taking into account the emission profile, which will allow: to control the level of own anthropogenic load, to introduce targeted air protection measures aimed at specific sources. The approaches presented in this paper contribute to minimization of risks to the environment and public health under the influence of dust factor.**

Keywords – Industrial control; monitoring; component structure; dust profile of discharges; regulation.

I. INTRODUCTION

Russian legislation obliges economic entities to conduct production control, the purpose of which is to constantly monitor the level of their own impact on the natural environment and living conditions of the population [1, 2]. Instrumental research and testing within the framework of production control is one of the tools of production control and, at the same time, makes it possible to justify the necessity, sufficiency and/or effectiveness of environmental protection measures.

Production activities of industrial enterprises in various industries are accompanied by air pollution, including solid dust pollutants. Dust extraction processes are formed at different stages of technological processes, as well as during the storage and transportation of dusty raw materials, finished products or waste storage [3-5].

Current practice shows that industrial enterprises with a high proportion of solid dust discharges in most cases include in the program of the control of total suspended particles (TSP). In the state regulation system, suspended particles are defined as the non-differentiated dust (aerosol) contained in the air of settlements. The level of suspended particles content is often used to assess the risk that the enterprise poses to the population of adjacent areas, to take administrative measures, and to justify the need for environmental protection measures.

At the same time, the conducted studies show that the solid dust discharges of enterprises are a polydisperse, complex in chemical structure multicomponent mixture containing both organic and inorganic impurities, including extremely and highly hazardous ones. [6-10]. In this situation, the control of air pollution over solid particles on the level of TSP in some cases leads to the masking of specific, toxic components released into the air, which consistently leads to underestimation of the risks of harm to the human health [11-15], in some cases - to a reassessment of the impact of the enterprise, when it is not possible to separate the dust of the controlled object from the sum of others.

In addition, sources of dust pollution are often incorrectly identified, which can lead to inefficient expenditures on air protection measures and lack of tangible improvement in the situation.

These problems caused the purpose of the study, which was to develop new approaches to the formation of industrial control programs for dust discharges of industrial enterprises on the basis of component and disperse structure of discharges and the formation of profiles of dust discharges of pollution sources.

II. Methods and materials

The object of the study was the industrial enterprise for extraction and processing of potassium salts. The main sources of dust discharges were identified during the study of the list of emission sources and the survey of the production area. The priority sources of atmospheric air pollution were as follows: warehouses for storage of raw materials and finished products. The processes of intensive dust discharge at these sources are formed during the transportation and reloading of bulk materials.

The calculation method at the border of the sanitary protection zone of the enterprise has determined the points of the expected maximum impact of the sources of the enterprise on the quality of atmospheric air.

During the research, samples of discharges and air were taken at dust extraction sources and control points in the area of influence of the enterprise by active sampling method. Dust concentrations in the samples were determined by gravimetric method and laser analyzer with PM 10 and PM 2.5 fraction identification. Disperse structure of discharges was estimated with the use of the laser analyzer Microtrac S3500 (covered range of particles size from 20 nm to 2000 microns); particle morphology and component structure were established by the method of electron microscopy with the scanning microscope of high resolution (degree of increase is from 5 to 300 000 units) with the X-ray fluorescent attachment S3400N "HITACHI". The chemical structure was identified by X-ray analysis of the samples using XRD-700 "Shimadzu" X-ray diffractometer.

More than 40 one-time discharge samples and 20 atmospheric air samples were taken and analyzed during this research.

III. Results

It is found that the chemical structure of dust discharges from stationary sources of the enterprise is stable in terms of chemical structure and is characterized by a strong predominance of solid particles related to the spectrum of potassium and chlorine. The average potassium chloride concentration from the finished product warehouse was 92.93%, and sodium chloride, aluminium and aluminium oxide with a total contribution of no more than 4% were also found in the discharges. Other chemical components discharges were just over 3%. The analysis of dust discharges from the ore storage also confirmed the predominance of potassium chloride in the discharges, with an average concentration of 88.50%. An example of the samples of component structure of the selected dust from the sources of the enterprise is shown in the Figure 1.

The obtained data made it possible to form an "discharge profile" of the main dust sources of the enterprise. As an example, Figure 2 shows the average profile of dust discharge from the finished product warehouse.

Morphology of dust particles from the selected samples confirmed the identified chemical structure of the enterprise discharges. Most of the microscopied particles had a crystalline form that is typical for salts (Figure 3). The dispersed structure of the dust samples was rather homogeneous and was characterized mainly by particles with the size of 20-50 microns (median of 34 microns). The share of finely dispersed fractions was 18% on average.

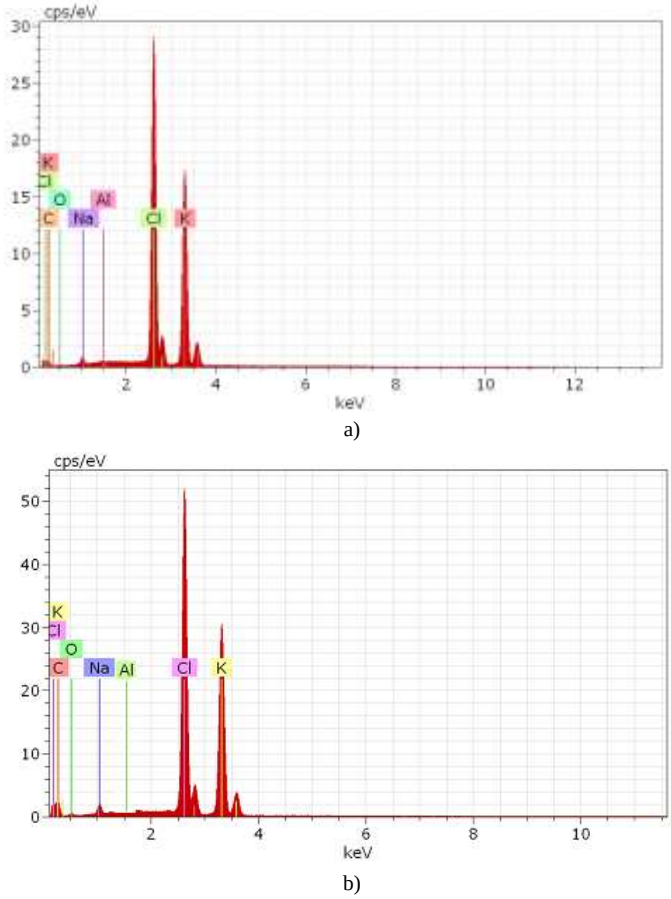


Fig. 1. Spectrogram of the Component Structure of the Dust Discharges of the Enterprise: a) finished product warehouse; b) ore warehouse

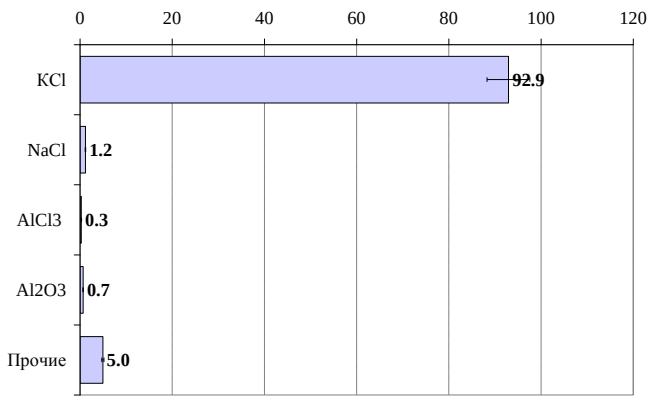
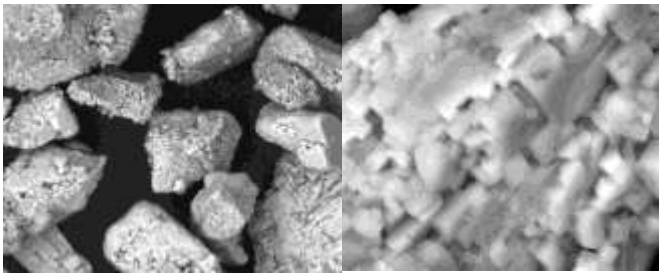


Fig. 2. Average dust discharge profile from the finished product warehouse

Identification of dust pollution of the atmospheric air at the control points on the border of the sanitary protection zone showed the presence of a large number of different chemical components: potassium, sodium, magnesium, chlorine, aluminum, iron, silicon, calcium, etc. The average structure of the solid component of the atmospheric air pollution can be

represented as follows: iron oxide (III) - 30.28%, silicon oxide (IV) - 20.69%, calcium carbonate - 12.81%, potassium chloride - 7.08%, the share of other admixtures - 29.14%. Spectrogram of the component structure of dust pollution at the sanitary protection zone border is shown in Fig. 4, the average profile in Fig. 5.



a) enlargement x 500 b) enlargement x 3000

Fig. 3. The forms of dust particles identified in the discharges of the analyzed enterprise

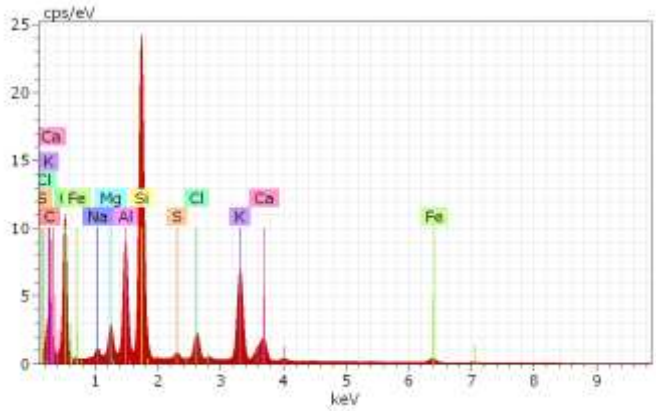


Fig. 4. An example of the component structure of dust pollution at the sanitary protection zone border

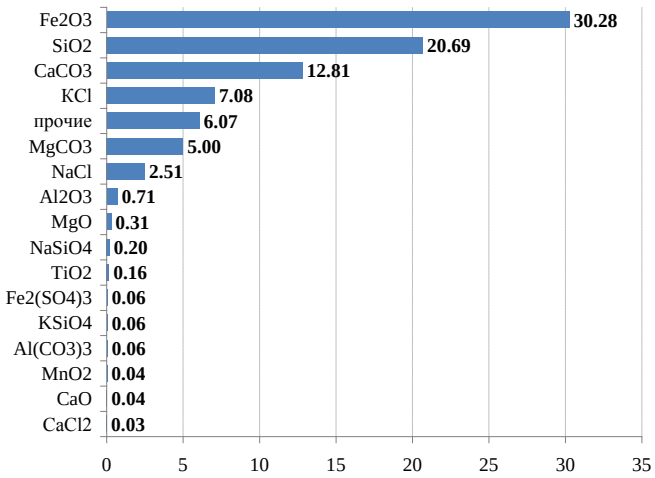


Fig. 5. The average profile of the dust pollution at the sanitary protection zone border

The study of morphological features of the selected dust particles at the sanitary protection zone border allowed us to determine the following forms: crushed, irregular, angular, and compound forms (Fig. 6). The share of fractions with sizes less than 10 microns in all cases exceeded 40%, in some samples reaching 72%.

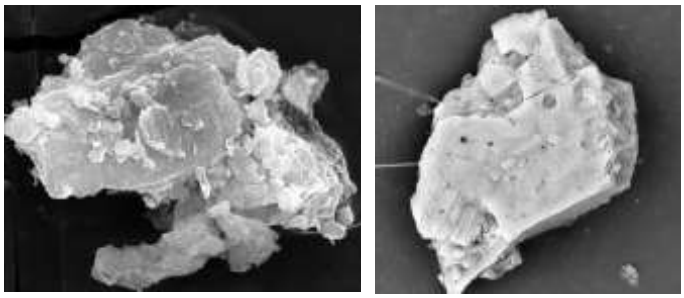


Fig. 6. The forms of the dust particles at the sanitary protection zone border (enlargement x 2000)

As a result, the dust pollution profile established at the sanitary protection zone border of the enterprise was characterized by fundamentally different dispersive parameters, chemical components and differed radically from the emission profile of the enterprise sources. It is established that the contribution of the enterprise sources to the excess of hygienic standards on the border of the sanitary protection zone during the study is not more than 10%. The obtained results made it possible to justify the necessity to include in the production control program of the enterprise not the sum of suspended particles, but the specific pollutants characterizing the enterprise discharges: potassium chloride and sodium chloride.

IV. Conclusion

The methodology of industrial control and air monitoring programs in the areas affected by dust discharges from industrial enterprises should be based on approaches that allow reliable assessment of the level of one' s own environmental impact.

It is found out that for industrial enterprises with a high share of dust particles discharges the formation of a correct production control program should be based on the data of the dust discharge profile. The dust discharge profile is understood as a typical (characteristic and stable) for a particular source dispersed and component structure of the solid phase.

The availability of relevant data on discharge profiles will allow to reliably determine the level of anthropogenic load of the enterprise, to determine the probability of violations of hygienic standards on the border of the control area and to determine the share of contributions of sources of the enterprise in the level of pollution.

The most important task of minimizing the risks to the environment and public health caused by the dust factor is an inventory of dust discharges from industrial objects with an in-depth analysis of the component and disperse structure.

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