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ANALYSIS OF DUST GASES FORMATION AND DISPERSE COMPOSITION IN SUPERPHOSPHATE PRODUCTION PROCESS

Nargizakhon Rajabova
Doctoral Student, Fergana Polytechnic Institute, Fergana Uzbekistan
Email: n.rajabova@ferpi.uz
Oybek Soliyev
Assistant, Fergana Polytechnic Institute, Fergana Uzbekistan

Abstract
The article presents the results of the research on the development of the methodology for calculating the hydraulic resistance of the dispersion composition analysis of the selected dust samples to determine the cleaning efficiency of the combined scrubber.
The error of laboratory analysis between sieve and microscopy method was 5.4%. In the experimental studies conducted to determine the efficiency of cleaning in the scrubber, the average median size of crushed particles for superphosphate dust was taken as d_{50}=9.3 µm.
Keywords: combined scrubber, superphosphate dust, sieve analysis, microscopic analysis, mixing reactor.

Introduction
In order to determine the cleaning efficiency of the combined sieve plate scrubber and to determine the acceptable values, chemical analysis was carried out for the compatibility of DS with samples of dust generated during the production processes of AS-72M superphosphate mineral fertilizer of "Fargonazot" JSC, which is one of the major chemical industry enterprises in our Republic, and A two-stage (using a sieve and a microscope) laboratory analysis of the dispersed composition of dust was conducted [1-4].
First of all, the structural scheme of the zones of formation of dust gases in the production processes of the enterprise was drawn up (Fig. 1 shows the view of the structural scheme) and the compatibility of dust with sanitary norms was analyzed.

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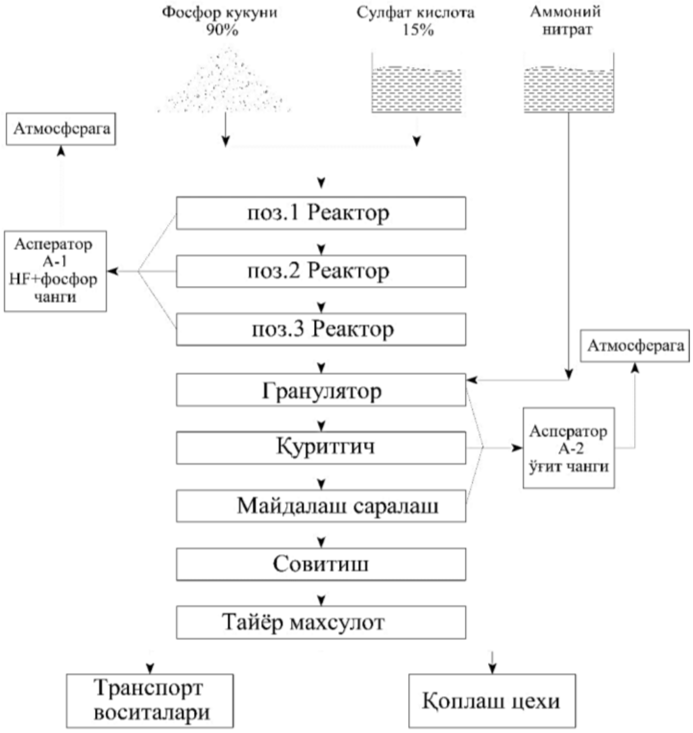

Figure 1. Structural scheme of dust gas generation zones during superphosphate production

When conducting researchthe permissible limit amount of dust in the air in mg/m3 according to GOST 12.1.005-38, that is, the method of determining the mass of dust or the number of particles per unit volume of dust was used. A special analytical aerosol aspirator of the AFA type (Aspirator M-822) was used as a research device, perchlorvinyl fabric of FPP brand as a filter material (the fabric was mounted on a protective ring with paper) and a plastic conical tube was used as a filter mounting cartridge [5-11].
The results were obtained by installing the aspirator M-822 on the inlet and outlet pipes of the dust cleaning device, and the current situation was analyzed. Table 1 shows the results obtained.

Table 1

Dust extraction zone	Dust cleaning device	PDK standard at device access,mg/m3	The amount of dust at the entrance to the device,mg/m3	The amount of dust at the exit of the device,mg/m3
Mixing reactors (Aspirator A-1)	Scrubber S-1	333.7	≈ 2697.9	377.7

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Drum granulator-dryer (Aspirator A-2)	Cyclone	258.8	≈ 908.7	679.78
	Scrubber S-2		≈ 679.78	216.71

Table 1 shows the amount of dust in all dust exit zonesmore than sanitary (PDK) norms andThe condition of asperator A-1 and asperator A-4 is also unsatisfactory. In order to improve the condition of Asperator A-1, the enterprise changed the cleaning method in 2020. That is, a new absorbent was selected for the working fluid, and it was observed that the cleaning level of the device increased somewhat. In addition, the installation of a pre-cooling system of the dust gas stream or changing the hydrodynamic regimes in the scrubber used will further increase the level of cleaning. But the situation in asperator A-2 is relatively complicated. The reason is that the fertilizer is not fully reacted during the drying process and the moisture content is in the range of 18%, and the speed of the heat agent is required for drying. This, in turn, increases the discharge of fertilizer dust along with the flow. There are two ways to correct the process. The first is to find a way to ensure the drying intensity even at a low flow rate of the heat agent in the drum dryer used in the drying process. In this case, the amount of dust particles coming out with the flow decreases and the high load on the asperator decreases. This, in turn, increases the cleaning level of the device. The second is to redesign the asperation shop by determining the average median size of the dust particles that escape with the heat agent flow. Based on the above, the dispersion composition of dust formed during fertilizer drying was analyzed in two ways (sieving and microscopy) [12-19]. In this case, the amount of dust particles coming out with the flow decreases and the high load on the asperator decreases. This, in turn, increases the cleaning level of the device. The second is to redesign the asperation shop by determining the average median size of the dust particles that escape with the heat agent flow. Based on the above, the dispersion composition of dust formed during fertilizer drying was analyzed in two ways (sieving and microscopy) []. In this case, the amount of dust particles coming out with the flow decreases and the high load on the asperator decreases. This, in turn, increases the cleaning level of the device. The second is to redesign the asperation shop by determining the average median size of the dust particles that escape with the heat agent flow. Based on the above, the dispersion composition of dust formed during fertilizer drying was analyzed in two ways (sieving and microscopy) [20-28].

In the first method, the powders were sieved for 5 minutes in the laboratory model of the LM-2E sieving device (begun) and underwent 5-stage sorting for 5 minutes in the laboratory model of the RETSCHDIN-ISO 3310/1 sorting sieve device. The size of sieve meshes was selected up to 5, 20, 40, 63,100 μm. Based on the obtained results, the powders were divided into fractions based on percentages. Below are the chemical properties of dust samples selected as model material, indicators of production conditions and laboratory analysis results [29-37].

The results of the laboratory analysis showed that the superphosphate dust was 1÷5 μm. up to 12%, 5÷20 μm. up to 45%, up to 20÷40 μm 10%, up to 40÷63 μm 23%, 63÷100 μm. up to

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10%. Table 2 shows the amount of superphosphate dust by fractions and the efficiency of the installed dust treatment device.

Table 2. The amount of superphosphate dust by fractions and the efficiency of the installed dust treatment device

The size of the fraction, μm	Fraction share, %	Scrubber %
1-5	12	65
5-20	45	82
20-40	10	98.7
40-63	23	100
63-100	10	100

The second method used an optical microscope to determine the dispersed composition of dust (Such analysis of particles in a biological microscope gives a relative error of ±1.5%. The average value of the measurements gives a relative error of ±3.4%).
Photomicrographs of each mineral dust sample are taken using optical microscopy. A hair fiber is used to determine the size of dispersed dust and it is divided into fractions in percentages. (The average median hair fiber size was assumed to be 40 μm) [38-41].
The powders selected for the sample were not mixed with water due to their solubility in liquid media. Photography was carried out with a DSM-310 camera and a SM001-CYANS biological microscope LANGDORPSSESTENGER-1603201. Photo processing was done in EHM. At 400 times the magnification of the microscope, the percentages of 1÷100 μm dust particles were counted compared to the size of a hair fiber (Figure 2).

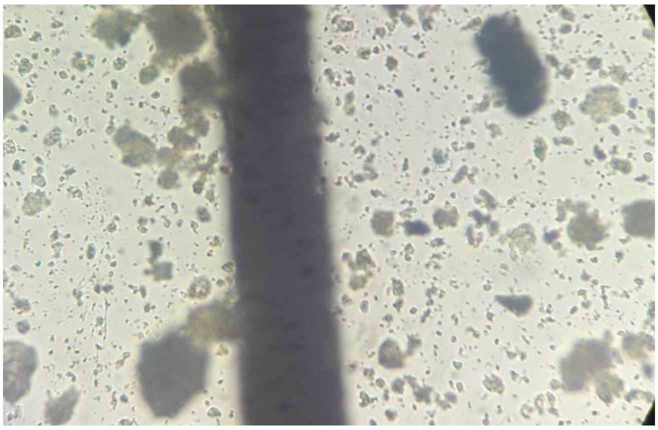

Fig. 2 The appearance of the dust selected as a sample under the SM001-SYANS microscope at a magnification of 400 times

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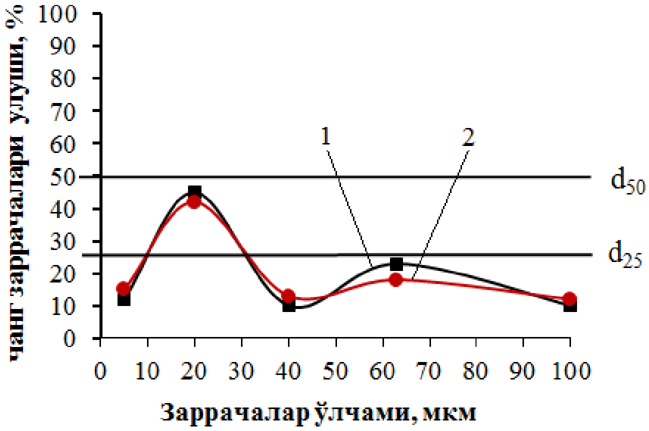
According to it, superphosphate dust is 1÷5 µm. up to 15%, 5÷20 µm. up to 42%, up to 20÷40 µm 13%, up to 40÷63 µm 18%, 63÷100 µm. up to 12%.

Based on the results of the laboratory analysis determined by the method of sieving and microscopy, a graph of the comparison of the dispersed composition of dust was constructed (Fig. 3) and the average median size of the selected dust sample was determined.



1 – sieve analysis; 2 – microscopic analysis.

Figure 3. Comparison graph of the dispersed composition of superphosphate dust

Figure 3 shows the relationship using the method of least squaresempirical formulas were obtained.

$y = -0.0023x2- 0.1705x + 35.257R^2 = 0.9879(1)$

$y = -0.0023x2- 0.1705x + 35.257R^2 = 0.2589(2)$

The error of laboratory analysis between sieve and microscopy method was 5.4%. Therefore, in the experimental studies conducted to determine the cleaning efficiency of the scrubber, the average median size of crushed particles for superphosphate dust can be taken as d_{50}=9.3 µm. It can be seen from the results of sieve and microscopy analysisThe percentage of dust particles between 5÷20 µm is high. In addition, the share of dust particles in the range of 40÷100 µm is significantly higher. It can be concluded that the cyclone device can be used for the primary cleaning of dust particles up to 40÷100 µm in order to reduce the load on the dust cleaning device.[5]. This, in turn, reduces the amount of dust particles in the air entering the scrubber by an average of 20% and ensures the entry of dust particles up to 1÷40 µm into the scrubber and increases the cleaning level of the device.

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