ANALYSIS OF THE DISPERSION COMPOSITION OF DUST PARTICLES

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АННОТАЦИЯ

В статье представлен лабораторный анализ для определения дисперсного состава и процентное содержание пыли в воздухе и газов, выбрасываемых в атмосферу предприятиями, производящими химические и строительные материалы, а также определены медианные размеры пыли, присутствующей на выбранных предприятиях.

Ключевый слова: запыленный газ, мокрый способ, жидкость, циклон, гидроциклон, скруббер, дисперсия, процентное содержание.

The article presents a laboratory analysis to determine the dispersed composition and the percentage of dust in the air and gases emitted into the atmosphere by enterprises producing chemical and building materials, and also determines the median sizes of dust present at individual enterprises.

Keywords: dusty gas, wet process, liquid, cyclone, hydrocyclone, scrubber, dispersion, percentage.

Introduction:

The composition of dust particles in the air and gas released into the atmosphere from industrial enterprises is polydisperse, that is, it contains particles of different sizes. Monodimer powders, that is, the content containing particles of the same size, are almost never found. Thus, for the analysis of polydisperse aerosols and dust, it is necessary to have information about the size distribution or the total fraction of particles, the ratio of particles of individual sizes, and the average size of particles (median size). Because the cleaning efficiency of dust cleaning devices is determined depending on these indicators. Dust dispersion is a series of fractions or fractional composition,

Research object:

Determining the dust dispersion composition is important in determining the cleaning efficiency of the wet dust cleaning drum device and determining optimal values [7,8,10,11]. For this purpose, dust samples from workshops of large chemical and building materials production enterprises in our republic were analyzed according to dispersion composition. Dust of nitrate and urea mineral fertilizers of «Farg'onaazot» JSC and ammofos fertilizer of "AMMOFOS-MAXAM" JSC, Quartz sand and dolomite dust of «QUVASOYKVARTS» JSC, soil and cement dust of "TURON ECO SEMENT GROUP" LLC were analyzed. This distribution of powders in terms of dispersion composition and size was carried out in two stages: 1. using a sieve and 2. a laboratory analysis was carried out by the microscopy method[1,2].

Results obtained:

Dust in the first stage It was sifted for 5 minutes in the laboratory model of the LM-2E brand sifting device (begun) and 7-stage sorting was carried out for 5 minutes in the laboratory model of the RETSCH-DIN-ISO 3310/1 brand sorting sieve device. The size of the sieves was selected up to 1, 3, 5, 10, 20, 40, 60 mkm. Based on the obtained results, the powders were divided into fractions based on percentages. Below are the chemical properties of dust samples selected as models, as well as the results of laboratory analysis.

Ammonium nitrate, known as ammonium nitrate solution, has high explosive properties at 169.6°C, and is an explosive and flammable substance. [3] It is classified as a medium-level substance of the 3rd hazard class in terms of the level of impact on human health. Diluted ammonia (70%) and nitrate salt (30%) are used as main raw materials in the production of ammonium nitrate. Due to the fact that the mode in the process is carried out at high temperature, the technological condition is dangerous. Saltpeter dust from the production process is generated in the granulation tower. Currently, a film scrubber mounted at the top of the tower is used to clean the dust.

Laboratory analyzes showed that the amount of saltpetre dust 0<1 mkm 5%, 1÷3 mkm 9%, 3÷5 mkm 11%, 5÷10 mkm 25%, 10÷20 mkm 35%, 20÷40 mkm 15%, 40-60 mkm accounted for 6%, greater than 60 mkm accounted for 0% (Table 1).

Due to the hygroscopic properties of ammonium nitrate dust, it is necessary to use a liquid with a 20% nitric acid solution for complete absorption in liquid.

Urea mineral fertilizer [3]. NH3 (liquid) and SO2 (gas) are used as the main raw materials of urea. Fertilizer extraction takes place in 2 stages in exothermic and endothermic reaction environment at 1830C and 13.4÷14.4 MPa pressure. Urea is classified as a highly hazardous substance of the 2nd hazard class in terms of the level of impact on human health. To make the fertilizer in the form of granules, it is carried out in a granulation tower of the 9-602 brand. The main source of dust is generated during the granulation process. Currently, a film scrubber installed at the top of the tower is used to clean the dust.

The results of the laboratory analysis showed that 0<1 mkm 10%, 1÷3 mkm 15%, 3÷5 mkm 20%, 5÷10 mkm 21%, 10÷20 mkm 30%, 20÷40 mkm 4% Greater than 40 mkm was 0% (Table 1).

According to the hygroscopic nature of urea dust, it is completely absorbed in liquid (water).

Ammophos fertilizer [3]. Ammonium phosphate, used as a fertilizer, is produced according to DST 18918-85, grades A and B. The chemical composition of the fertilizer is 20÷30% P_2O_5. Fertilizer production is carried out in several consecutive processes. The main source of dust is generated in the granulating device and the drying drum. At present, a cyclone and nozzle scrubber and drum dryer are installed for dust treatment.

According to the analysis results, felt amphos dust 0<1 mkm 3%, 1÷3 mkm 5%, 3÷5 mkm 13%, 5÷10 mkm 13%, 10÷20 mkm 13%, 20÷40 mkm 37%, 40÷ 60 mkm accounted for 16%, and greater than 60% accounted for 0% (Table 1).According to the hygroscopic nature of Ammofos powder, it is completely absorbed in liquid (water).

Dolomite [4,5] is used as a by-product (GOST 23672–79) in the production process of building glass and glassware. The total share of the product is 139÷247 kg per 1 ton, depending on the type of product. The main source of dust is formed during the grinding and drying process of dolomite before it is added to the slag. Currently, cyclone and hydrocyclone are used in the raw material workshop for dust removal.

Based on the results of laboratory analysis, dolomite dust 0<1 mkm 7%, 1÷3 mkm, 8%, 3÷5 mkm, 13%, 5÷10 mkm 26% 10÷20 mkm 34%, 20÷40 mkm 10% was 40÷60 mkm, 2% was more than 60%, and 0% (Table 1). Due to the hygroscopic nature of dolomite dust, it is completely absorbed in liquid (water).

Quartz sand (GOST 22551-77) is used as the main product in the production process of building glass and glassware. The total share of the product is 845÷882 kg per 1 ton, depending on the type of product. The granulometric composition should not exceed 0.05÷0.10 mm. The main source of dust is formed in the process of drying quartz sand and loading it into silos. When analyzing the dispersed composition of quartz sand dust, 0<1 mkm 1%, 1÷3 mkm, 2%, 3÷5 mkm, 7%, 5÷10 mkm 80%, 10÷20 mkm 7%, 20 ÷40 mkm accounted for 1%, 40÷60 mkm for 2%, greater than 60% accounted for 0% (Table 1). Currently, cyclone and scrubber devices are used for dust cleaning.

Due to the hygroscopic nature of quartz sand dust, it is completely absorbed in liquid (water).

Soil [6] is used as a by-product in the Portland cement production process and makes up 20-25% of the raw materials. The total share of soil is 200-250 kg per 1 ton, depending on the type of portland cement. The main source of dust is generated during the compaction process before the soil is added to the limestone. The analysis of the dispersed composition of soil dust showed that 0<1 mkm 13%, 1÷3 mkm 35%, 3÷5 mkm 25%, 5÷10 mkm 17%, 10÷20 mkm 8%, 20÷60 mkm 2% of 60 mkm greater than was 0% (Table 1). Currently, the enterprise uses a hydrocyclone to clean soil dust. Due to the hygroscopic nature of soil dust, it is completely absorbed in liquid (water).

The cement production process is carried out at a high temperature in a cyclone decarbonizer and rotating pet complex. The temperature in the debonizer is 700-7500 C and in the cooking zone of the rotary oven is 1450-15000 C. The main source of dust is the cement dust mixed with the hot air coming out of the decarbonizer and the dust generated during the clinker feeding process in the ball mill. The analysis of the dispersed composition of cement dust is as follows: 0<1 mkm 11%, 1÷3 mkm 12%, 3÷5 mkm 14%, 5÷10 mkm 24%, 10÷20 mkm 25%, 20÷40 mkm 12% 40÷60 mkm accounted for 8% and those greater than 60 mkm accounted for 0% (Table 1).

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Table 1

Size distribution and percentage of dust by fractional intervals

Ammonium nitrate dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	5	3	10	24	34	14	5	0
Urea mineral fertilizer dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	10	15	20	21	30	4	0	0
Ammofos mineral fertilizer dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	3	5	13	13	13	37	16	0
Dolomite dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	7	3	13	26	34	10	2	0
Quartz sand dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	1	2	7	30	7	1	2	0
Soil dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-60	60<	
Percentage share, %	13	35	25	17	18	2	0	
Cement dust								
Dust size, d_p mkm	0<1	1-3	3-5	5-10	10-20	20-40	40-60	60<
Percentage share, %	11	12	14	24	19	12	3	

Currently, the enterprise uses a hydrocyclone to clean cement dust. Due to the hygroscopic nature of cement dust, it is completely absorbed in liquid (water). The efficiency of dust cleaning in the film and nozzle scrubber, cyclone and hydrocyclone devices used for dust cleaning in the above-mentioned production enterprises is 90-96% [9,12].

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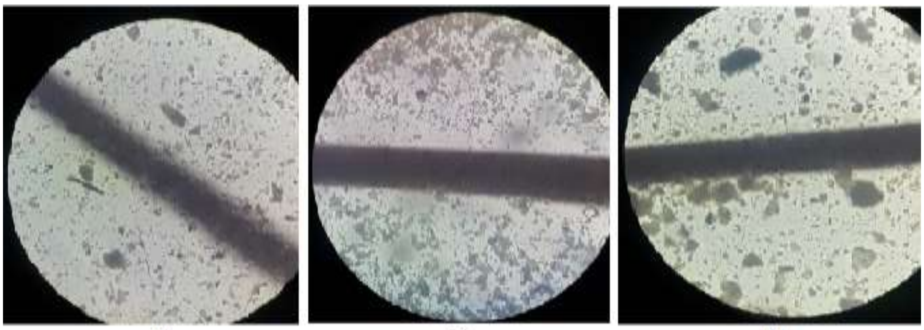
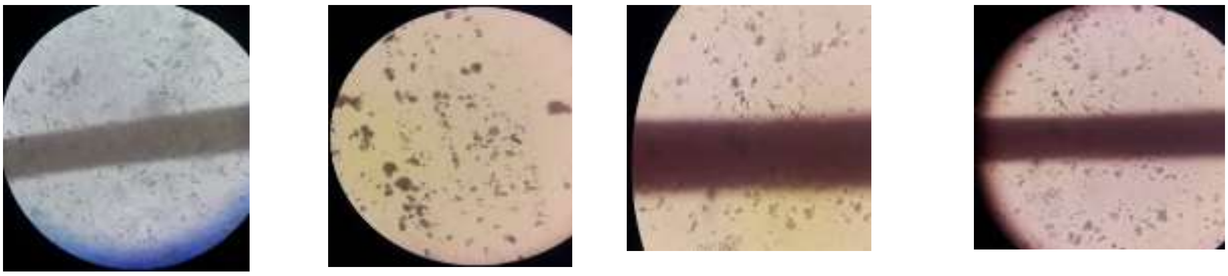
In the second stage, the method of optical microscopy was used to determine the dispersed composition of dust. The relative error of particle analysis in a biological microscope is ±1.5%. The relative error of the measurements to the average value is ±3.4% [6].

Photographs of each powder sample were taken by optical microscopy. A hair fiber was used as a scale to determine the size of the dust samples and fractionated in percentages. The average median size of a hair fiber is 40 mkm.

Photography was carried out with a DSM-310 camera and a LANGDORPSSESTENGER-1603201 SM001-CYANS biological microscope. Photo processing was done on the basis of a computer program. The magnification of the microscope was 400 times, and the percentage of dust samples in the range of 1÷100 mkm was determined by comparison with the size of a hair fiber. Examples of the obtained photos are shown in Fig. 1. Other dust samples were also determined in the same way.



a) б) в)



g) d) e) m)

a - ammonium nitrate dust; b – urea dust; v – ammophos dust; g- dolomite dust; d- quartz sand dust; e- soil dust; m-cement dust

Figure 1. 400 times magnified view of the powders selected for the sample under the SM001-SYANS microscope

Conclusion.

The error between the results of the laboratory analysis between the conducted sieve and the microscopy method was ±7%. As a result of laboratory studies, the average relative size of dust particles was determined. Depending on these dimensions, the cleaning efficiency of wet dust cleaning devices is determined according to the volume surface diameters of dust and the amount of water supplied in relation to the dust content of 1 m^3 of air or gas.

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