To Increase the Degree of Capture of Fine-Grained Dust Particles, the Development of a Mathematical Model of the Motion and Separation of Solid Particles during Dynamic Regeneration

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Abstract--- *Increasing the capture of fine dust particles, energy-saving mesh devices (dust collector) are installed. Dust collectors are installed with dust retention with small dust collectors as a second step after existing equipment. Retention of fine dust particles that have not been completely cleaned will increase dust removal efficiency and reduce the environmental impact of dust. The use of such dust collectors for cleaning fine dust particles formed in the production department. The dust emission does not exceed the maximum permissible dust emissions (MPE).*

Keywords--- *Spontaneous Peгmissible Concentгation, Dust, Pollutants, Stationaгy Souгce, Spontaneous-Peгmissible Гelease, Atmospheгic Layeг, Dust-Gas-Concentгation Plants.*

I. Introduction

The degree of impact of pollutants on the environment and the efficiency of cleaning emissions depend on their properties, which in principle. Can be defined by a set of physicochemical characteristics of all ingredients. However, there are significant difficulties that do not allow taking into account the totality of the processes occurring in a mixture of at least several substances. Therefore, usually only one or two main pollutants (in terms of quantity or toxicity) are considered and one process that is most characteristic of these conditions. Real processes are described by simplified mathematical models. For example, dispersed emissions with a low content of suspended particles, such as air with low dust content, combustion products of gas, liquid, and even low-ash grades of solid fuel, are considered homogeneous. If the presence of suspended particles has a significant effect on the properties of the emissions, then the dispersed and homogeneous parts of the aerosol are considered separately as two independent systems.

In a grain processing enterprise, it is considered more efficient to introduce a two-stage cleaning process to increase the efficiency of equipment for removing fine-grained dust particles. In such enterprises, dust is cleaned up to 85% and emitted into the atmosphere. Using the equipment for cleaning the dust stream using the recommended absorbent moving additional materials, the reduction of atmospheric pollutants can be achieved by removing pollutants by 95-98%.

II. Object of Research

Existing suction lines and equipment for dust collection in the elevator workshop of grain cleaning enterprises

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lead to the fact that it reduces the degree of dust collection and reduces the cleaning efficiency.

The research and calculation results show that the efficiency of the dust cleaning plant in the suction network is 86.5% on average, the Bsn-5 dust collector is 86.3%, the second Bsn-5 is 87.7%, and the Bsn-8 is 87.7%. 86.8%, and the second Bsn-8 - 87.8%.

The efficiency of the Bcs-500 brand 4 treatment plant installed on the third floor of the elevator shop is 89.8%, the efficiency of the second Bcs -500 installation is 88.8%, and the efficiency of the third Bcs -500 4 is 88.6%. % of the fourth 4 Bcs -500, 87.7%, the efficiency of the treatment plant of the 4- Bcs -250 brand is 87.1%, the efficiency of cleaning 4 Bcs -400 is 87.1%.

Gaseous and dust impurities are scattered in the atmosphere by turbulent windfalls. Accordingly, the transport mechanism of impurities is twofold: convective transport by averaged motion and diffusion transport by turbulent pulsations. Impurities are usually considered passive in the sense that their presence does not have a noticeable effect on the kinematics and dynamics of the flows. Such an assumption may turn out to be rude for large aerosol particles.

To create a device with a high degree of emission purification for a specific production process is possible only on the basis of a full cycle of research, design and commissioning, as production processes and their associated emissions are so diverse that existing standard solutions almost always require thorough refinement .

Detailed studies to determine the parameters of emissions, to identify the dynamics of their changes at different stages of the technological cycle are often not within the purview of the developers of purification systems, as a result of which they have to use data on more or less similar processes. In order to exclude the possibility of gross errors, it is necessary to first study the features of the production facility and the process as a source of emissions. Among a large number of factors that should be taken into account, a number of general and necessary for the development of treatment devices can be distinguished.

III. METHOD OF RESEARCH

An energy-saving simple dust collector with micron-sized cells differs from fine dispersed dust in grain storage and processing rooms, reduces the dust flow in an existing suction pipe and acts on dust particles in the pipes, reduces dust in the air. increases dust retention by trapping dust particles.

An energy-saving dust collector of a simple type consists of: inlet pipes; pneumatic pipe; micromanometer; dust collecting pipe; AFA filter; pressure gauge; thermometer; aspirator; U-shaped pressure gauge; housing; small-sized metal mesh; output pipes; bin for garbage. The micromanometer determines the dust flow rate (Figure-1).

The research method is sampling from the dust stream from the inlet and outlet of the source.

The purpose of the work (installation of equipment) is to reduce the amount of dust that is generated in the elevator shop of the bakery plant and emitted into the atmosphere. At the same time, the proportion of atmospheric dust in the air at the site, within the boundaries and outside the enterprise, if the settlement is close, does not exceed the allowable air throughput. Adverse effects on the environment and human health are prevented.

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The source is equipped with a dust collector brand 4 Bcs -500. The operating time of the source is 290 days /year or 6380 hours/year. Source parameters: height H = 3.4 m, source diameter D = 0.45 m.

Atmospheric pressure during measurement was 732 mm r.s. The pressure at the suction pipe at the inlet to the vacuum cleaner is 5.8 mm. air temperature 24 ° C. The dust collector is designed to hold grain dust from the BIT-100 separator and the operation of the transmitter in the workshop. Prior to the first cleaning process, the speed of the dust mixture was V_1 = 15.3 m/s, concentration C_1 = 612.1 mg/m^3. The consumption of the dust mixture was determined by the following expression:

$$W_1 = \pi * D^2/4 * V_1 = 3{,}14 * 0{,}45^2/4 * 15{,}3 = 2{,}43\ m^3/s$$

Surge per second:

$$M_{sec.1} = W_1 * C_1 * 10^{-3} = 2{,}43 * 612{,}1 * 10^{-3} = 1{,}49\ g/s$$

The annual dust emission amounted to:

$$M_{year.1} = M_{sec.1} * T * 3600 * 10^{-6} = 1{,}49 * 6380 * 3600 * 10^{-6} = 34{,}22\ t/year.$$

A graph of dust concentration before cleaning is shown in *Figure - 2*.

The pressure in the first dust collector after collection is 7.6 mm. temperature 24° C. The velocity was V_2 = 14.7 m/sec, the dust concentration was C_2 = 86.3 mg/m^3. We determine the flow rate of the dust mixture by the following expression:

$$W_2 = \pi * D^2/4 * V_2 = 3{,}14 * 0{,}45^2/4 * 14{,}7 = 2{,}34\ m^3/sec$$

Surge per second:

$$M_{sec.2} = W_2 * C_2 * 10^{-3} = 2{,}34 * 86{,}3 * 10^{-3} = 0{,}202\ g/sec$$

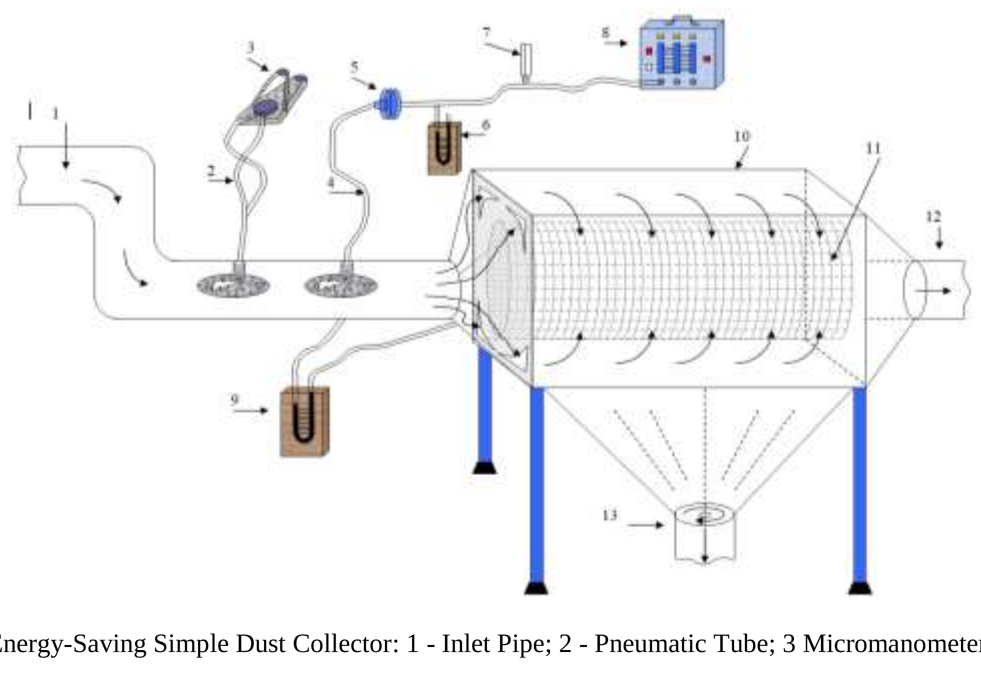

Figure 1: Energy-Saving Simple Dust Collector: 1 - Inlet Pipe; 2 - Pneumatic Tube; 3 Micromanometer; 4-Pipe for Collecting Dust; 5-Filter AFA; 6-Manometer; 7-Thermometer; 8-Aspirator; 9-U-Shaped Pressure Gauge; 10-Case; 11 - Small-sized Metal Mesh; 12-Outlet Pipes; 13-bin for Garbage

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$$M_{year.2} = M_{sec.2} * T * 3600 * 10^{-6} = 0{,}202 * 6380 * 3600 * 10^{-6} = 4{,}64 \text{ t/year.}$$

Dust collector efficiency is:

$$\eta = (M_{year.1} – M_{year.2})/M_{year.1} = (34{,}22 – 4{,}64)/34{,}22 *100 = 86{,}4\%$$

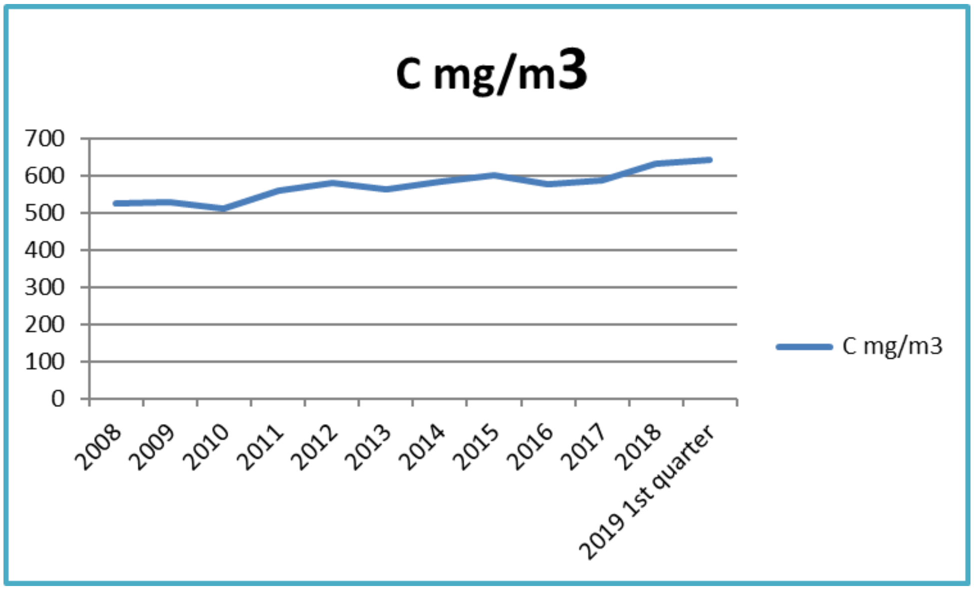

Figure 2: Concentration of Grain Dust before Cleaning in the Elevator

The amount of dust and the effectiveness of the dust held by a simple energy-saving fine-grained dust of the trap was calculated as follows.

The operating time of the source is 290 days / year or 6380 hours / year. Initial parameters: height H = 2.8 m, cross-sectional area D = 0.30 m.

Atmospheric pressure during measurement was 732 mm. s. The pressure at the suction pump at the inlet in the dust collector is 5.8 mm. s. temperature 24°C.

The device delays incomplete trapped dust in the dust of the trap type 4 BTsSch-500. The velocity of the dust mixture when entering the dust collector was V_3 = 13.8 m / s, the dust concentration was C_3 = 85.6 mg / m^3. We determine the flow rate of the mixture by the following expression:

$$W_3 = \pi * D^2/4 * V_1 = 3{,}14 * 0{,}30^2/4 * 13{,}8 = 1{,}06 \text{ m}^3\text{/sec}$$

Surge per second:

$$M_{sec\ 3} = W_3 * C_3 * 10^{-3} = 1{,}06 * 85{,}6 * 10^{-3} = 0{,}091 \text{ g/sec}$$

The annual emission is:

$$M_{year.3} = M_{sec.3} * T * 3600 * 10^{-6} = 0{,}091 * 6380 * 3600 * 10^{-6} = 2{,}09 \text{ t/year.}$$

After the treatment plant, the pressure is 7.6 mm. s. temperature 24^0C. The flow velocity V_4 = 11.8 m/sec, the dust concentration is C_4 = 2.42 mg/m^3. We determine the dust consumption by the following expression:

$$W_4 = \pi * D^2/4 * V_2 = 3{,}14 * 0{,}30^2 *11{,}8 = 0{,}903 \text{ m}^3\text{/sec}$$

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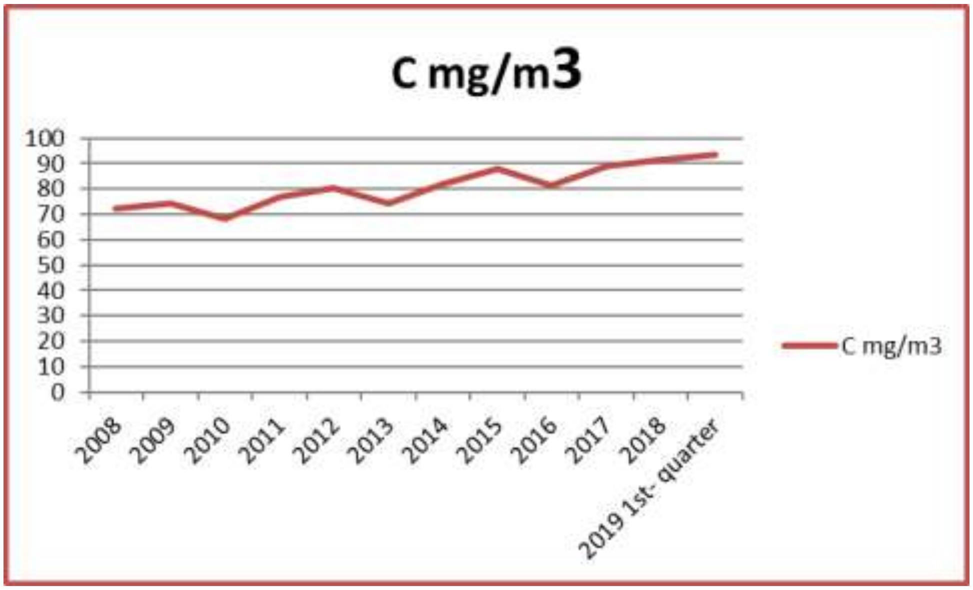

Figure 3: Concentration of Grain dust after Cleaning in the Elevator

Discharge per second after capture:

$$M_{sec.4} = W_4 * C_4 * 10^{-3} = 0{,}903 * 2{,}42 * 10^{-3} = 0{,}022 \text{ g/sec}$$

Annual release after capture:

$$M_{year.4} = M_{Sec.4} * T * 3600 * 10^{-6} = 0{,}022 * 6380 * 3600 * 10^{-6} = 0{,}505 \text{ t/year.}$$

Dust collector efficiency of a simple energy-saving device:

$$\eta = (M_{.1} - M_{.2})/M_{.1} = (34{,}22 - 0{,}505)/34{,}22 *100 = 98{,}5\%$$

The efficiency of the new dust collector amounted to 98,5%.

Speed, Flow Rate, Volume of Dust Flow before and after Dust Retention and Dust Retention Efficiency.

Table 1

source number	Dust flow rate, m/sec	Dust flow rate, m^3/sec	Dust Concentration before cleaning, mg/m^3	Dust concentration after cleaning, mg/m^3	Amount of dust t/year	Dust collector efficiency, %
3	14,7	2,24	508,4	15,2	0,781	97,2
4	14,3	2,18	607,6	64,3	3,22	90,9
5	14,5	2,22	612,4	89,2	4,55	86,5
6	14,3	2,18	615,3	76,4	3,84	88,2
7	14,9	2,27	624,2	75,2	3,93	88,6
8	11,8	0,903	85,6	2,42	0,505	98,5
9	14,64	2,23	623,5	72,1	3,57	88,9
10	13,94	2,13	630,4	68,3	3,21	89,8
11	14,66	2,24	619,5	74,3	3,68	88,4
12	14,25	2,17	632,2	71,4	3,44	89,2
13	14,28	2,18	618,7	70,8	3,41	89,4

Development of a Mathematical Model for the Movement and Separation of Solid Particles

In studying the motion of a solid particle, the basic is the differential equation of motion of its center of mass:

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$$(1 + M)\, mdv/dt = \sum P$$

Where, M-coefficient when connecting mass; m is the mass of the solid particle; particle absolute velocity v-vector; $\sum P$ – sum of force vectors acting on a particle.

The mass of the spherical particle accepted in the calculations

$$m = \pi\delta^3\rho/6$$

where δ-sedimentation particle diameter, that is, the diameter of a ball with the same density and sedimentation rate as a real particle is not spherical in shape; ρ is the density of the material.

Under real conditions characteristic of dust traps, the ratio of the density of the gas and the material of the dust particles is small. For example, for air and grain particles ρ_e / ρ = 7.5 * 10-4. As a result, the value of M can be neglected.

In the general case, the sum of the forces acting on a solid particle,

$$\sum P = P_\alpha + P_c + P_k + (P_G + P_A) + P_\rho + P_{pr}$$

Where P_α – aerodynamic drag force of a particle in a gas stream; P_G +P_A – equally acting gravity and Archimedean forces; P_ρ - force acting on a particle when it is in an uneven pressure field; P_c - centrifugal inertia; P_k – Coriolis force of inertia; P_{pr}- resultant of other forces.

The aerodynamic drag force for a spherical particle is considered directed against the velocity w of its motion relative to the gas:

$$P_\alpha = -C\ 0{,}25\ \pi\delta^2 0{,}5\ \rho_t\ \omega^2 (w/\omega)$$

Where, C- drag coefficient.

If v and u – absolute velocity of the particle and gas, then when flowing around the particle.

IV. CONCLUSION

The environmental impact of industrial and industrial enterprises is not positive, even if the ecological state of industrial and industrial enterprises operating in the Republic of Uzbekistan is considered satisfactory. Smoke and dust, nitrogen and carbon monoxide generated from them cannot be considered within or within the permissible limits even after passing through treatment plants.

Therefore, it is considered more efficient to introduce a two-stage cleaning process to increase the efficiency of dust removal equipment. At industrial enterprises, dust is cleaned up to 85% and is released into the atmosphere. Using gas purification equipment using recommended absorbent moving additional materials, a reduction in atmospheric pollutants can be achieved by removing pollutants by 95-98%.

An energy-saving dust collector of a simple type differs from other dust containment equipment with dispersion of fine particles in grain storages and grain processing plants, which reduces the dust flow in the suction pipe, reduces the amount of dust in the air, increases the efficiency of dust removal, trapping small solid particles.

The inventive method is used to clean small particles of dust generated in the workshop, using small-sized mesh

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equipment. Maximum permissible concentration (MPC) does not exceed emissions of dust and other pollutants.

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