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Improving the Efficiency of Trapping Moving Dust Flow in Aspiration Networks and Dry Dust Catcher Equipment

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Abstract. In the research work carried out, the efficiency of the capture of fine-particle Dust, which is thrown into the atmosphere from the production of industrial enterprises, was achieved by the practical application of the energy-efficient mesh structural dust capture equipment. This equipment is installed as a second-step dust catcher in the production workshops. Increased efficiency in the capture of small dust particles that are not completely cleaned in production cexes is important. With this, it is achieved that the amount of dust flow inside and outside the territory of the enterprise does not exceed the permissible amount of air content (REM)and improves the state of the environment.

Key words: wise, collector equipment, energizer, purifier, particle, allowing ethylgan quantity, strength, karshilik coefficient.

In industrial enterprises, it is important to improve technological processes, hermetically close conductive pipes, install closed transmission devices and small particle dust capture equipment in reducing atmospheric air pollution of dust and other pollutants thrown into the atmosphere.
The parameters of the dust flow include the following (density, fluidity, wetting, edge and angle of inclination). They are used in the calculation work of dust capture equipment, fittings, bunkers and auxiliary equipment, as well as for the disposal of retained dust, assessment of economic efficiency [1].
Cyclone dust traps are the most common type in the production of gas cleaning equipment. The widespread use of cyclones is explained by the simplicity of their construction, reliability in application, relatively low material costs that go to their manufacture and operation [2-4].
Cyclones can be applied for gas purification at high temperatures and pressures. They do not have moving parts, which increases their reliability in operation.
It is based on the appearance of the rotational motion of the cyclone's pollinated gas, in which centrifugal forces acting on the dust particles in the direction of the cyclone walls occur [3-10].
In our study, we determine the loss of pressure caused by friction in the conducting pipe, which has an invariant cross section. We take two clippings of 1-1, 2-2 cuts (See Figure 1).

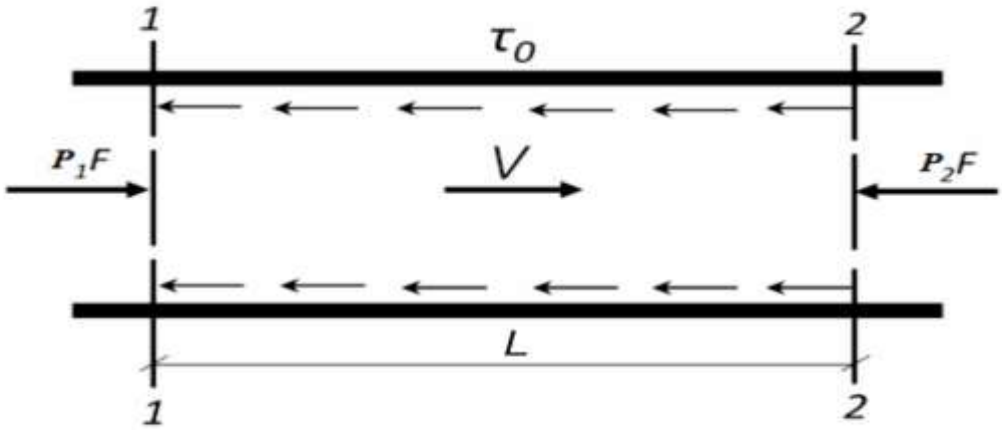

Figure 1. The cross section of a permanent air conductor.

Assuming that the speed pressures are the same in both cuts, we write the Bernoulli equation, without:

$p_1 = p_2 + \Delta p$ (1)

From here we determine the pressure loss from the friction result:

$\Delta p = p_1 - p_2$ (2)

Choosing the volume of closed air between the cuts, we write the equation of the pulse on the axis of the pipe according to the projections:

$(p_1 - p_2)\frac{\pi D^2}{4} - \tau_0 \pi dl = 0$ (3)

The following expression follows from the last equation:

$(p_1 - p_2) = \frac{\pi D^2}{4} 4\tau_o \frac{L}{D} = 0$ (4)

By placing this expression in the equation above, we determine the difference between the pressures:

$\Delta p = 4\tau_o \frac{L}{D}$ (5)

Based on the experiments, it was noted that the displacement voltage in the wall of the pipe channel is proportional to the speed pressure calculated from the average speed.

Based on the experiments, it was noted that the shear voltage in the pipe wall is proportional to the speed pressure calculated at an average speed.

$\tau_o = \Psi \frac{\rho \upsilon^2}{2}$ (6)

Where Ψ is the coefficient of proportionality.

We will have the following expression by putting instead of τo in the formula above:

$\Delta p = 4\, \Psi \frac{L}{D} \frac{\rho \upsilon^2}{2}$ (7)

$4\, \Psi = \lambda$ by defining, we bring the expression to the following view:

$\Delta p = \lambda \frac{L}{D} \frac{\rho \upsilon^2}{2}$ (8)

Where λ is the coefficient of friction resistance.

$\lambda = 64/R_e$ (9)

For dry dust trap apparatus, we determine the pressure loss and resistance coefficient, and in this we get the limit of the transition from laminar flow to turbulent flow. This value is equal to Re= 2320.

$\lambda = 64/R_e = 64/2320 = 0{,}0276$

$\Delta p = \lambda \frac{L}{D} \frac{\rho \upsilon^2}{2} = 0{,}0276 * \frac{8{,}2}{0{,}52} * \frac{0{,}846*15{,}8^2}{2} = 45{,}9$ Pa

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Pressure loss in a pneumatic conductor with an invariable cross-section surface

$\Delta p_{пн} = \Delta p\ (1 + k\mu_{пр}) = 45{,}9\ (1 + 0{,}8 * 1{,}1) = 133{,}1$ Pa

k – coefficient of proportionality,0,8

$\mu_{пр}$ – weight concentration of powder mixture

$\mu_{пр} = G_т/G = 580{,}3/526{,}6 = 1{,}1$

$G_т$ – the weight concentration of the mixture, G – the weight concentration of the air.

The pressure loss due to local resistance was determined as follows:

$\Delta p = \xi\frac{\rho\upsilon^2}{2} = 0{,}82 * \frac{0{,}64*15{,}4^2}{2} = 62{,}2$ Pa

Loss of pressure at the entrance to the air suction

$\Delta p = \xi\frac{\rho\upsilon^2}{2} = 1\ \frac{0{,}64*14{,}8^2}{2} = 70{,}1$ Pa

$\xi = \frac{\Delta p}{\rho\upsilon^2/2} = 1$

Loss of pressure in expansion when transverse cross section changes

$\Delta p = \eta\ \frac{\rho}{2}\ (\upsilon_1 - \upsilon_2) = 0{,}92\ \frac{0{,}64}{2}\ (15{,}5 – 3{,}64) = 3{,}4$ Pa

Loss of pressure in narrowing when transverse cross section changes

$\Delta p = \eta_в\ \frac{\rho}{2}\ \upsilon_2\ (\upsilon_2 - \upsilon_1) = 0{,}9\ \frac{0{,}64}{2}\ 14{,}6(14{,}6 – 3{,}44) = 46{,}9$ Pa

Local resistance coefficients

Local resistance coefficient in conductive pipes

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{45{,}9}{0{,}64*15{,}8^2/2} = 0{,}57$

Local resistance in the pneumo-conductor

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{133{,}1}{0{,}64*15{,}4/2} = 1{,}75$

Local resistance in expansion when entering the air suction

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{62{,}2}{0{,}64*14{,}8^2/2} = 0{,}88$

Local resistance in narrowing at the entrance to the air suction

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{46{,}9}{0{,}64*14{,}6^2/2} = 0{,}69$

The results of calculating the pressure loss and local resistance coefficient in a pneumatic conductor with an invariant cross-sectional surface shown in Figure 1 and their dependencies are shown in Table 1 and Figure 2.

Table 1
Dependence of pressure loss on resistance coefficient

Indicators	1	2	3	4
Pressure, ΔP, Pa	45,9	133,1	62,2	46,9
Resistance coefficient, ξ	0,57	1,75	0,88	0,69

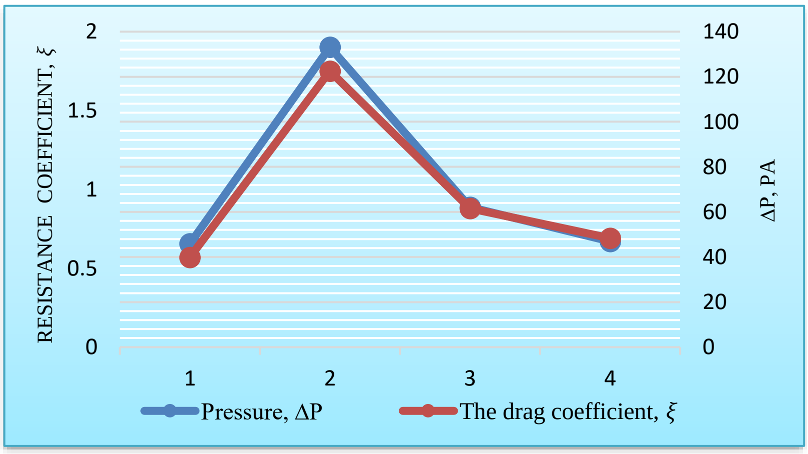

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Figure 2. Graph of dependence on the local resistance coefficient of pressure loss

Dry dust trap apparatus we determine the pressure loss and resistance coefficient, and in this we get the limit of the transition from laminar flow to turbulent flow. This value is equal to R_e= 2320.

$\lambda = 64/R_e = 64/2340 = 0{,}0273$

$\Delta p = \lambda \frac{L}{D} \frac{\rho \upsilon^2}{2} = 0{,}0273 * \frac{3{,}2}{0{,}45} * \frac{0{,}86*15{,}58^2}{2} = 23{,}6$ Pa

Pressure loss in a pneumatic conductor with an invariable cross-section surface:

$\Delta p_{pn} = \Delta p\ (1 + k\mu_{pr}) = 23{,}6\ (1 + 0{,}8 * 1{,}1) = 68{,}4$ Pa

k – coefficient of proportionality, 0,8;

μ_{np} – weight concentration of powder mixture;

$\mu_{np} = G_T/G = 508{,}4/484{,}6 = 1{,}05$.

G_T – the weight concentration of the mixture, G – the weight concentration of the air.

The pressure loss due to local resistance was determined as follows:

$\Delta p = \xi \frac{\rho \upsilon^2}{2} = 0{,}86 * \frac{0{,}64*14{,}7^2}{2} = 59{,}5$ Pa

Loss of pressure at the entrance to the air suction:

$\Delta p = \xi \frac{\rho \upsilon^2}{2} = 1 \frac{0{,}64*14{,}89^2}{2} = 70{,}9$ Pa

$\xi = \frac{\Delta p}{\rho \upsilon^2/2} = 1$

Loss of pressure in expansion when transverse cross section changes:

$\Delta p = \eta \frac{\rho}{2} (\upsilon_1 - \upsilon_2) = 0{,}92 \frac{0{,}86}{2} (14{,}9 - 3{,}64) = 4{,}5$ Pa

Loss of pressure in narrowing when transverse cross section changes:

$\Delta p = \eta_в \frac{\rho}{2} \upsilon_2 (\upsilon_2 - \upsilon_1) = 0{,}94 \frac{0{,}64}{2} 14{,}89(14{,}89 - 3{,}41) = 51{,}4$ Pa

Local resistance coefficients

Local resistance coefficient in conductive pipes:

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{23{,}6}{0{,}86*15{,}58^2/2} = 0{,}23$

Local resistance in the pneumo-conductor:

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{68{,}4}{0{,}86*14{,}9^2/2} = 0{,}72$

Local resistance at air suction inlet, expansion:

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{59{,}5}{0{,}64*14{,}9^2/2} = 0{,}84$

Local resistance in narrowing, when entering the air suction:

$\xi = \frac{\Delta p_a}{\rho w^2/2} = \frac{51{,}4}{0{,}64*14{,}58^2/2} = 0{,}75$

The results of the calculation of the pressure loss and local resistance coefficient after the installation of fine particle dust trap mesh dust catcher equipment and their dependencies are shown in Table 2.2 and figure 2.7.

Table 2
Dependence of pressure loss on resistance coefficient

Indicators	1	2	3	4
pressure, Δp,Pa	23,6	68,4	59,5	51,4
resistance coefficient, ξ	0,23	0,72	0,84	0,75

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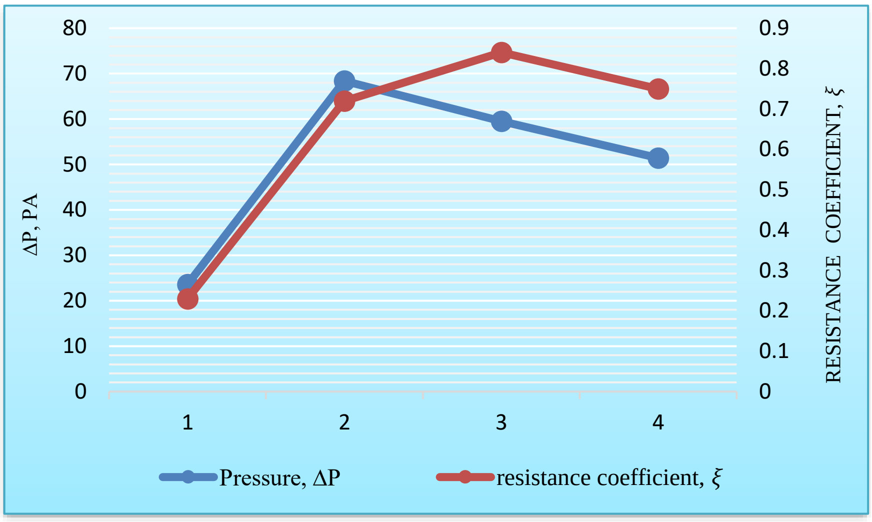

Figure 3. Graph of pressure loss dependent on local resistance coefficient

Measurement errors at the time of air flow motion experiments are evaluated according to the simple error distribution (Gaussian) law.

In this case, the arithmetic mean results $\bar{x}$ are determined by the following formula:

$$\bar{x}=\sum_{1}^{n} x_i /n \qquad (10)$$

Here, x_i is a value that does not depend on the results of the measurement; n is the number of measurements.

The largest and relative errors are determined as follows:

$$\Delta x_i = \bar{x} - x_i \qquad (11)$$

$$\Delta x_{отн.} = \Delta x_i \, 100/\bar{x} \qquad (12)$$

A random measurement error is evaluated through a standard or mean quadritic error (mean quadratic deviation).

The mean quadratic error of the results of a separate measurement S is determined by the following formula through a random variable x:

$$S=\sqrt{\frac{1}{n-1}\sum_{1}^{n}(\bar{x}-x_i)^2} \qquad (13)$$

Based on the law of normalizing the distribution of solid particles, the following formula is used to determine the σ2 error:

$$\sigma^2 = \sum_{1}^{n} (\bar{x} - x_i)^2/(n-1) \qquad (14)$$

the estimate of the accuracy measurement h is determined by the following formula:

$$h = 1/\sqrt{2}\sigma \qquad (15)$$

If the mean quadratic error is of different accuracy according to the quantity x of the value x_i that represents σ, then the optimal value of x is their average value:

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$$x = \frac{\Omega_1\sigma_1 + \Omega_2\sigma_2 + \Omega_3\sigma_3 + \ldots + \Omega_n\sigma_n}{\Omega_1 + \Omega_2 + \Omega_3 + \ldots + \Omega_n} \quad (16)$$

As you know, with an increase in measurements, the number of measurements of the accuracy of measurements increases by n. Therefore, when reducing errors in the results, it is necessary to take the value n sufficiently large. But with an increase in the value of n leads to an increase in time, equipment resources, product and energy quantities. Mathematical statistics make it possible to determine the required value of n when determining the pre-accuracy of the results:

$$n = t^2 w^2/p^2, \quad (17)$$

Here, T is the norm of error (t = Δxi/σ) coefficient, which gives a guarantee of accuracy determining the accuracy value, *w* is the variable coefficient, p is the average arithmetic value at which the error can be allowed.

Conclusion. It is advisable to carry out the process in the cyclone at high speed and not too large in diameter, increasing the efficiency of dust particle retention. But increasing the speed will cause small particles to come out with the dust mixture during the cleaning process. Therefore, it is considered more effective to reduce the diameter of the apparatus to increase the cleaning effect. It is desirable when the optimal ratio of the height and diameter of the cyclone is equal to N/DTS = 2 - 3.

Existing vacuum cleaner equipment at industrial enterprises to improve the retention efficiency of fine-particle dust energy-efficient mesh structural dust trap equipment is achieved through practical application. It is considered one of the important measures to achieve the non-increase in the permissible norm (REM) of dust capacity in the composition of atmospheric air by increasing the efficiency of the retention of fine-particle dust in the production workshops of the enterprise.

Energotejamkor simple-looking tiny set vacuum cleaner processing methods and promising directions were considered, and optimal indicators for dynamic renewal of this process were proposed. The proposed new structural solution of the developed energotejamkor simple-looking small set vacuum cleaner has been found to be a cost-effective solution with reliable performance under the action of various types of polluted air and higher efficiency of cleaning technology.

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