AERODYNAMICS OF FILTER FABRIC MADE FROM GLASS FIBER AND TEFLON

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Abstract: The article analyzes the dust generated during the cement production process and the processes of its cleaning and determines the resistance coefficient of the filter fabric made of glass fibre and Teflon for the sleeve filter device. The following parameters of the changing factors were selected during the experiments: gas consumption to the device Q_{gas}=140÷990m^3/h, intermediate step Q_{gas}=285 m^3/h, gas velocity υ_{gas} = 15÷35 m/s, intermediate step 5 m/s, filter thickness made of glass fibre and Teflon δ_f=2,3,4 mm, filter frame diameter d_{fil} = 130, 140 and 150 mm, gas density ρgas was selected as 1.29 kg/m^3 for air. The experiments were conducted at a temperature of 20±2 ºC for the gas and water system.

Keywords: Teflon, fibreglass, bag filter, aerodynamic resistance, drag coefficient, gas velocity, density, cement dust, particle diameter.

SHISHA TOLA VA TEFLONDAN TAYYORLANGAN FILTR MATOSINING AERODINAMIKASI

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Annotatsiya: Maqolada sement ishlab chiqarish jarayonida hosil bo'ladigan chang va uni tozalash jarayonlari tahlil qilinadi va yengli filtr moslamasi uchun shisha tolali va teflondan tayyorlangan filtr matoning qarshilik koeffitsienti aniqlanadi. Tajribalar davomida o'zgaruvchan omillarning quyidagi parametrlari tanlab olindi: qurilmaga gaz sarfi Q_{gas}=140÷990m^3/soat, oraliq pog'ona Q_{gas}=285 m^3/soat, gaz tezligi y_{gas} = 15÷35 m/s, oraliq pog'ona 5 m/s, filtr qalinligi shisha tolali va Teflondan tayyorlangan filtr qalinligi δ_f=2,3,4 mm, diametrli filtr, d_{fil} = 130, 140 va 150 mm, gaz zichligi gaz havo uchun 1,29 kg / m^3 sifatida tanlangan. Tajribalar gaz va suv tizimi uchun 20±2 ºC haroratda o'tkazildi.

Kalit so‘zlar: Teflon, shisha tola, yengli filtr, aerodinamik qarshilik, qarshilik koeffitsienti, gaz tezligi, zichlik, sement changi, zarrachalar diametri.

АЭРОДИНАМИКА ФИЛЬТРУЮЩЕЙ ТКАНИ, ИЗГОТОВЛЕННОЙ ИЗ СТЕКЛОВОЛОКНА И ТЕФЛОНА.

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Аннотация:В статье анализируется пыль, образующаяся в процессе производства цемента, и процессы ее очистки, а также определяется коэффициент сопротивления фильтрующей ткани из стекловолокна и тефлона для рукавного фильтрующего устройства. В ходе экспериментов были выбраны следующие параметры изменяющихся факторов: расход газа в устройство Qgas = 140–990 м³/ч, промежуточная ступень Qgas = 285 м³/ч, скорость газа υ_{gas} = 15÷35 м/с, промежуточная ступень 5 м/с, толщина фильтра из стекловолокна и тефлона δf = 2, 3, 4 мм, диаметр фильтрующей рамы $d_{фыл}$ = 130, 140 и 150 мм, плотность газа ρgas для воздуха была выбрана равной 1,29 кг/м³. Эксперименты проводились при температуре 20±2 °C для газо-водной системы.

Ключевые слова: Тефлон, стекловолокно, рукавный фильтр, аэродинамическое сопротивление, коэффициент сопротивления, скорость газа, плотность, цементная пыль, диаметр частиц

Introduction:

Technological processes and devices that clean dust, secondary gases, and waste generated in industrial enterprises and eliminate environmental problems have been introduced into production processes worldwide. At the same time, it is of great importance to capture fine dust particles, secondary gases, and toxic substances in the building materials, food, chemical, and metallurgical industries and to reuse them in the production process [1].

Today, research is being conducted in the food, chemical, and building materials industries worldwide in priority areas such as separating solid, liquid, and gaseous particles, reducing atmospheric pollution, extracting valuable products, protecting technology and machinery from harmful substances that negatively affect it, and intensifying technological processes.

Research object:

This article analyzes the causes of dust and gases emitted into the atmosphere from a cement production plant and their purification devices and studies the aerodynamic resistance of a filter cloth made of glass fibre and Teflon for a sleeve filter used in the process of cleaning cement dust. The dusty gases generated in the production processes of TERRA NOVA CEMENT LLC were taken as the research object and studies were conducted. Analiz antimalaria:

First of all, a structural diagram of the zones of dusty gas formation in the production processes of the enterprise was drawn up (a structural diagram is presented in Figure 1) and the compliance of dust with sanitary standards was analyzed. When conducting research, the permissible limit value of dust in mg/m3 was determined according to GOST12.1.005-38, that is, the number of particles per unit of dust mass or dust volume. A special analytical aerosol aspirator of the AFA type (Aspirator M-822) was used as a research device, and a conical tube made of plastic was used as a filter cartridge, as a filtering material, perchlorovinyl fabric of the FPP brand (fabric mounted on a paper protective ring) was used as a filter [2].

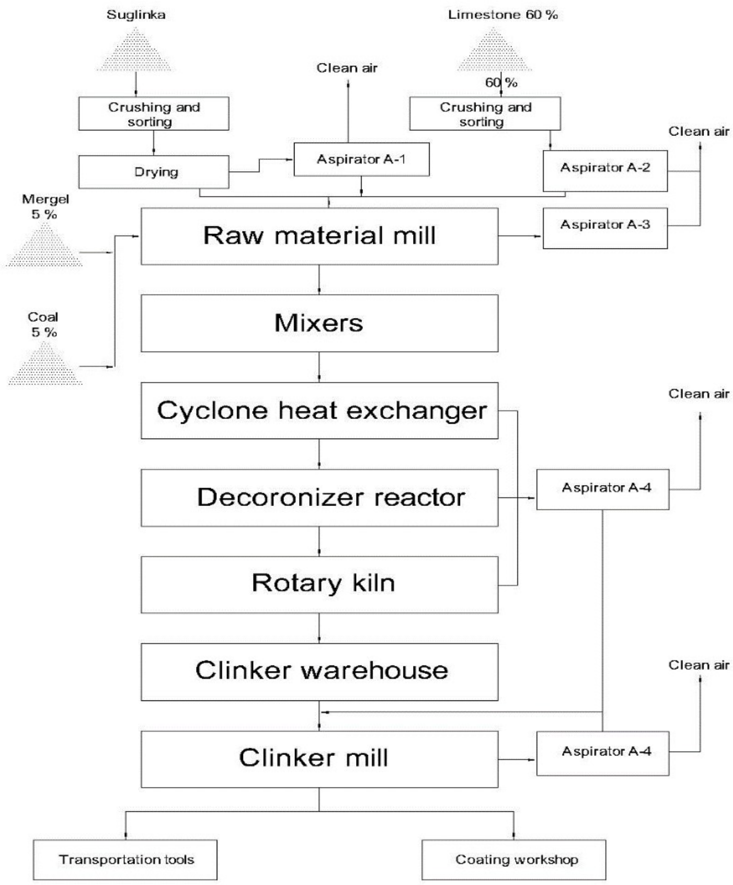

Figure 1. Structural diagram of the zones of dusty gas formation in the technological process of dry cement production

The aspirator was installed on the inlet and outlet pipes of the M-822 dust removal device, the results were obtained and the current state was analyzed. Table 1 presents the results obtained.

Table 1

Dust extraction zone	**Dust cleaning device**	**Sanitary standard, mg/m³**	**Dust content at the device inlet, mg/m³**	**Dust content at the device outlet, mg/m³**
The process of drying the sludge (Asperator A-1)	Siklon	430	≈1560	1140
	sleeve filter		≈1140	231,3
Limestone crushing and screening (Asperator A-2)	Cyclone	300	≈360	45,75
Raw material mill (Asperator A-3)	sleeve filter	480	≈1010	265,6
Cooking process (Asperator A-4)	sleeve filter	480	≈1781	101,6
Clinker grinding mill (Asperator A-5)	Cyclone	380	≈970	682
	sleeve filter		≈682	93,71

Table 1 shows that the amount of dust in all dust emission zones exceeds the sanitary (PDK) standards. However, the situation in aspirators A-2, aspirators A-3 and aspirators A-5 is relatively better. That is, the amount of dust emitted into the atmosphere meets the PDK standards. The situation in aspirators A-1 and aspirators A-4 is considered unsatisfactory. There is an opportunity to correct the situation in aspirator A-4. For example, installing a pre-cooling system for the dusty gas flow or making the filter material of the used bag filter from refractory material will increase the degree of purification of the device. However, the situation in aspirator A-4 is relatively complicated. This is because during the cooking process, the moisture content of the slurry is in the range of 15-20%, and a higher rate of heat transfer is required for drying. This, in turn, increases the discharge of raw material dust along with the flow. There are two ways to improve the process. The first is to find a way to ensure the drying intensity even at low flow rates of the heat agent in the drum dryer used in the drying process. This reduces the amount of dust particles discharged along with the flow and reduces the high load on the aspirator. This, in turn, increases the degree of purification of the device. The second is to redesign the aspirator shop by determining the average median size of dust particles discharged along with the flow of the heating agent. This will require distributing the load on the used bag filter or using a combined filter fabric for the bag filter. Of the two ways considered, the most economical is to develop a combined filter fabric and implement it in the process.

Based on the above, a combined (glass fibre and Teflon-based filter) filter fabric was developed for the existing bag filter and its resistance coefficient was determined. The following parameters of the changing factors were selected during the experiments: gas consumption Qh=140÷990m3/h with an intermediate step of Qh=285 m3/h, gas velocity υgas = 15÷35 m/s with an intermediate step of 5 m/s, filter thickness made of glass fibre and Teflon δf=2,3,4 mm, filter frame diameter df.d. = 130, 140 and 150 mm, gas density ρ for air was 1.29 kg/m3. The experiments were conducted at a temperature of 20±2ºC for gas and water systems.

THEORETICAL RESEARCH RESULTS

One of the main characteristics of a bag filter device is the selection of the optimal values of the loads acting on the working elements of the device on the dusty gas flow moving through it. This characteristic determines the aerodynamic resistance of the device and the permissible value of the amount of heat leaving the device along with the cleaned gas [3,4].

In addition, while increasing aerodynamic resistance in the working parts of the device improves cleaning efficiency, it also leads to a decrease in productivity and clogging of dust particles in the pipes, resulting in disruption of the technological cycle. This, in turn, increases energy consumption.

The bag filter consists of a dusty gas guide pipe, a diffuser attached to the guide pipe, a device body, a glass fibre filter, and a purified gas outlet pipe. The dusty gas flow moving in the device encounters resistance when passing through the guide pipe, diffuser, filter, and purified gas outlet pipe. In this case, the equation for determining the resistance coefficient of the working parts of the device can be written as follows;

$$\zeta_{r.c} = \zeta_{g.p} + \zeta_{dif} + \zeta_{fil} + \zeta_{o.p} \qquad (1)$$

where $\zeta_{o.p}$ is the coefficient of resistance of the dusty gas-conducting pipe, which is determined by the equation recommended by Blazius;

$$\zeta_{g.p} = \frac{l}{d_e}\sqrt{\frac{1}{2\lg\left[\frac{\varepsilon}{3,7}+\left(\frac{6,81}{\mathrm{Re}}\right)^{0.9}\right]}} \qquad (2)$$

where l is the pipe length, m; d_e is the equivalent pipe diameter, m; Re is the Reynolds number; and ε is the relative roughness, which is determined by the following equation;

$$\varepsilon = \frac{\Delta}{d_e} \qquad (3)$$

where Δ is the height of the unevenness, m;

Then, if we substitute equation (3) for the relative unevenness ε in equation (2), equation (2) becomes;

$$\zeta_{g.p} = \frac{l}{d_e}\sqrt{\frac{1}{2\lg\left[\frac{\Delta}{3,7d_e}+\left(\frac{6,81}{\text{Re}}\right)^{0,9}\right]}} \quad (4)$$

ζ_{dif} is the resistance coefficient of the diffuser of the device, and the dusty airflow moving in the diffuser of the device must be evenly distributed over the diffuser extension length L, which determines the full operation of the filter surfaces and the improvement of the cleaning efficiency. When designing the device, the condition shown in the diagram must be met. To determine this condition, we use the approximate equation of Idelchik and Flinger [5].

$$\zeta_{dif} = \frac{\lambda_{dif}}{8\sin\frac{\alpha_{e.a}}{2}}\left(1-\frac{1}{n_{dif}^2}\right)+\sin\frac{\alpha_{e.a}}{2}\left(1-\frac{1}{n_{dif}^2}\right)^2 \quad (5)$$

where n_{dif} is the diffuser expansion ratio; $\alpha_{e.a}$ is the diffuser expansion angle; λ_{dif} is the friction coefficient in the diffuser, which depends on the diffuser expansion angle $\alpha_{e.a}$, the expansion ratio n_{dif}, and the Reynolds number. We determine the values of λ_{dif}, $\alpha_{e.a}$ and $_{if}$ according to the above condition;

$$\lambda_{dif} = \frac{A}{\text{Re}_{dif}} \quad (6)$$

where Re_{dif} is the Reynolds criterion; A is the coefficient taking into account the shape of the diffuser. Considering that the device is supplied with dusty air flow rates in different ranges, λ_{dif} can also be determined using the Blazius equation;

$$\lambda_{dif} = \frac{0,316}{\sqrt[4]{\text{Re}_{dif}}} \quad (7)$$

In the calculations, λ_{dif}=0.015÷0.025, $\alpha_{e.a}$=60 (in practice, $\alpha_{e.a}=7^0\div9^0$ is taken to reduce the length of the diffuser), and n_{dif}=2÷4 are assumed [5].

ζ_{fil} is the resistance coefficient of the device filter, its determination is complex and requires various deviations. Therefore, when determining the resistance coefficient of the device filter, we introduce the following equation;

$$\zeta_{fil} = \Delta k\frac{(S_{c.z}+S_{o.z})\delta}{V} \quad (8)$$

where V is the total volume of the sleeve, m^3; $S_{c.z}$ is the surface area of the closed zone of the filter fabric, m^2; $S_{o.z}$ is the surface area of the open zone of the filter fabric, m^2; δ is the thickness of the fabric, m Δ*k* is the correction factor, which was determined experimentally.

From this equation, it can be seen that an increase in the closed zone and fabric thickness leads to an increase in the resistance coefficient. When designing industrial copies of the device, limited intermediate values of Δ*k* are introduced to select the optimal parameters of the closed and open zones.

$\zeta_{o.p}$ is the resistance coefficient of the cleaned air outlet pipe, which can be determined using equation (4);

$$\zeta_{o.p} = \frac{l}{d_e}\sqrt{\frac{1}{2\lg\left[\frac{\Delta}{3,7d_e}+\left(\frac{6,81}{\text{Re}}\right)^{0.9}\right]}} \quad (9)$$

Then, if we substitute equations (4), (5), (8), and (9) into the calculation equation (1), equation (1) becomes:

$$\zeta_{r.c} = \left[\frac{l}{d_e}\sqrt{\frac{1}{2\lg\left[\frac{\Delta}{3,7d_e}+\left(\frac{6,81}{\text{Re}}\right)^{0.9}\right]}}\right] + \frac{\lambda_{dif}}{8\sin\frac{\alpha_{e.a}}{2}}\left(1-\frac{1}{n_{dif}^2}\right)+\sin\frac{\alpha_{e.a}}{2}\left(1-\frac{1}{n_{dif}^2}\right)^2+\Delta k\frac{(S_{c.z}+S_{o.z})\delta}{V} \quad (10)$$

Through this equation, we determine the resistance coefficient in the working parts of the device.

RESEARCH RESULTS

When determining the resistance coefficient of the dusty gas inlet and cleaned gas outlet pipes in the device, we accept the approximate value determined in the research work of [6,7], that is, we assume the resistance coefficient of the dusty gas inlet and cleaned gas outlet pipes to be equal to 0.54.

The local resistance coefficient of the diffuser was determined experimentally. According to it, the dusty gas velocity in the diffuser (ANEMOMETER **VA06–TROTEC**), the flow regime, the degree of expansion of the diffuser, the expansion angle and the friction coefficient were determined by changing the angle of the 0°; 30°; 60°; 90o angle-forming flap installed in the suction pipe of the device ventilator. Using the results obtained in the experiment and equation (5), the resistance coefficient of the dusty gas inlet and outlet pipes was determined. Table 2 presents the experimental results.

Table 2

Resistance coefficient values of dusty gas inlet and cleaned gas outlet pipes

υ_{gaz},m/s	35	30	25	20	15
$\xi_{k.q}$	0,64	0,63	0,624	0,65	0,63
$\xi_{ch.q}$	0,43	0,44	0,44	0,45	0,443

The results of the experiment on determining the local resistance coefficients in the dusty gas inlet and cleaned gas outlet pipes and in the diffuser show that the resistance coefficient values are close to each other even in different ranges of gas velocity and flow regime. The determined resistance coefficient values are mathematically processed and with sufficient accuracy and average value, the resistance coefficient of the dusty gas inlet and cleaned gas outlet pipes can be taken as 0.54 and 0.3 in the diffuser [5].

The resistance coefficient of the glass fibre-based fabric was determined using equation (8) [5,7]. Figure 2 shows a graph of the change in the correction coefficient as a function of the ratio of the difference between the closed and open zones of the filter and the product of the fabric thickness to the total fabric size.

It can be seen from Figure 2 that the increase in the closed zone and the thickness of the fabric causes a decrease in the value of the correction coefficient. When (($S_{yo.z} - S_{o.z}$) δ/ V = 2.76, Δk = 1.2; when ($S_{yo.z} - S_{o.z}$) δ/ V = 3.28, Δk = 1.1 and when ($S_{yo.z} - S_{o.z}$) δ/ V = 5.43, Δk = 0.68). This is due to the direct proportionality of the total resistance coefficient to the closed zone and the thickness of the fabric.

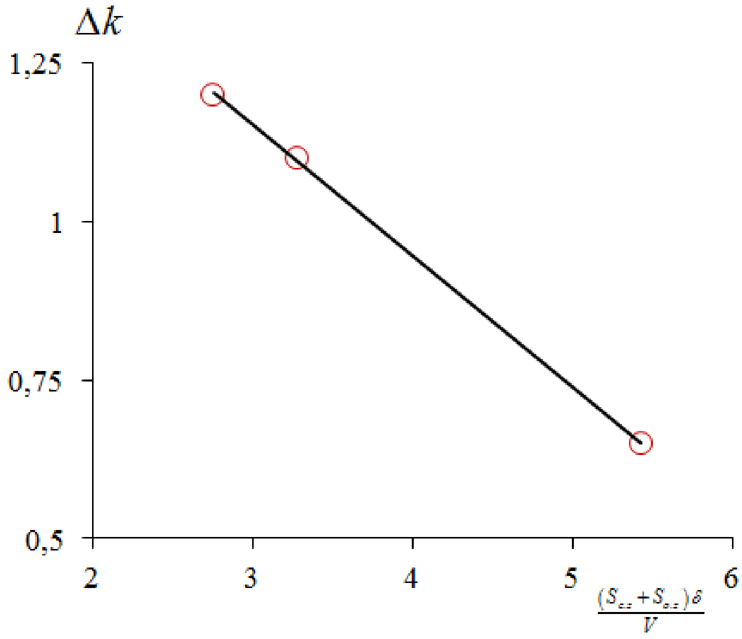

Figure 2. Dependence of the correction coefficient on the filter position

If we assume that the local resistance coefficients in the dusty gas inlet and cleaned gas outlet pipes and the diffuser are constant and substitute them into equation (10), then the equation takes the following simple form.

$$\zeta_{r.c} = 0,84 + \Delta k \frac{(S_{c.z} + S_{o.z})\delta}{V} \qquad (11)$$

In the experimental determination of the total resistance coefficient of the device, the resistances on the working surface were approximately determined based on the difference in the velocities of the gas entering and leaving the device, the difference in gas consumption, and compared with the values of the total resistance coefficient determined depending on the ratio of the difference between the closed zone of the filter and the open zone and the product of the fabric thickness to the total fabric size. Figure 3 shows a graph of the change in the resistance coefficient depending on the ratio of the difference between the closed zone of the filter and the open zone and the product of the fabric thickness to the total fabric size (Figure 3).

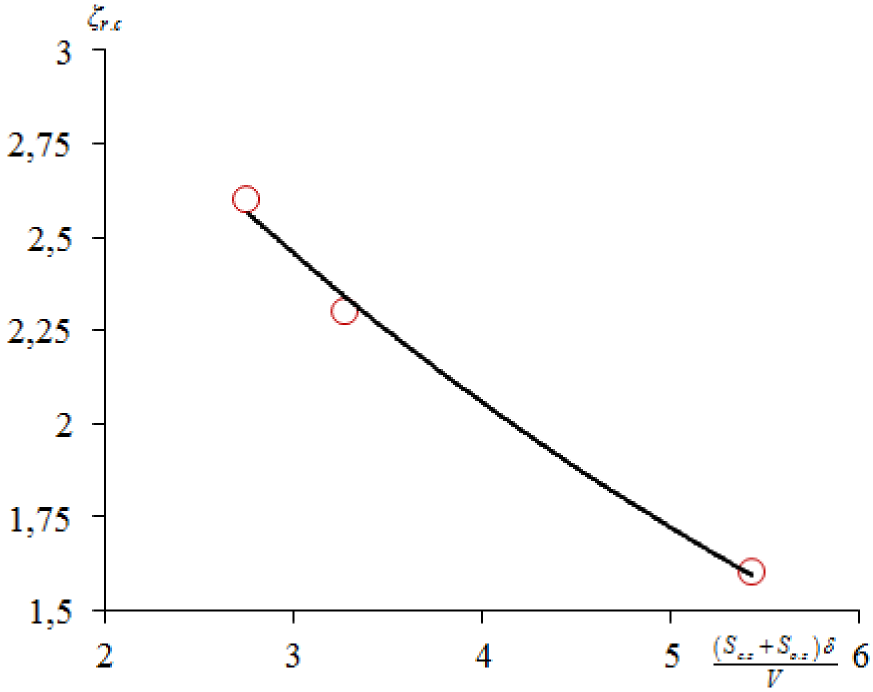

Figure 3. Dependence of the resistance coefficient ξ_{um} on the filter position

The following empirical formulas were obtained by applying the least squares method to the relationships presented in Figures 2 and 3, which adequately represent the parameters [8,9].

Regarding the dependence of the correction coefficient presented in Figure 2 on the filter position.

$y = -0,1813x + 1,746 \qquad R^2 = 0,974 \qquad (12)$

Figure 3 shows the dependence of the resistance coefficient on the filter position.

$$y = -0{,}2904x + 3{,}645 \qquad R^2 = 0{,}981 \qquad (13)$$

The total resistance coefficient of the device was calculated by substituting the resistance coefficients determined for different thicknesses of the filter made of glass fibre and Teflon into equation (11). The calculation results are as follows. It was determined that the total resistance coefficient of the device for a filter made of glass fibre and Teflon with a thickness of δ=2 mm is $\zeta_{r.c}$ =1.6, for a filter made of glass fibre and Teflon with a thickness of δ=3 mm is $\zeta_{r.c}$ =2,3, and for a filter made of δ=3 mm is $\zeta_{r.c}$ =2,6.

Experiments to determine the resistance to gas flow in the working elements of a filter made of glass fibre and Teflon and the total pressure loss in the device were carried out in the following order. Different values of the dusty gas flow rate, consumption, filter thickness and dusty gas density in the device were solved according to equation (1). The resistance coefficients of the working elements determined in paragraph 2.4.1 were used. To check the accuracy of the theoretically calculated values for pressure loss and to estimate intermediate errors, a micromanometer JM-510 was installed on the dusty gas inlet and outlet pipes of the device, and the pressure loss in the device was experimentally determined for different values of the above variable parameters. The experiments were carried out in the following sequence. According to it, the gas velocity entering the device through the LATR installed on the electric motor of the device fan was controlled in the range of ω_{gas}= 5÷35 m/s with an intermediate step of ω_{gas}= 10 m/s, and a filter made of basalt fiber (thickness δ_f=2,3,4 mm) was sequentially installed on the device depending on its thickness, and the aerodynamic resistance for different values of the variable parameters was determined based on the pressures at the inlet and outlet of the device and their difference. To assess the error between the theoretical and experimental values, comparison graphs were constructed (Figures 4; 5 and 6). The filter frame diameters $d_{fil.}$ = 130, 140 and 150 mm were not taken into account when conducting the research. For this reason, the pressure difference did not change significantly in the theoretical calculations and the results obtained with the micromanometer in the selected range. Therefore, when constructing a graph of the dependence of the total aerodynamic resistance of the device on the gas velocity, d_{fil}. = 140 mm was chosen.

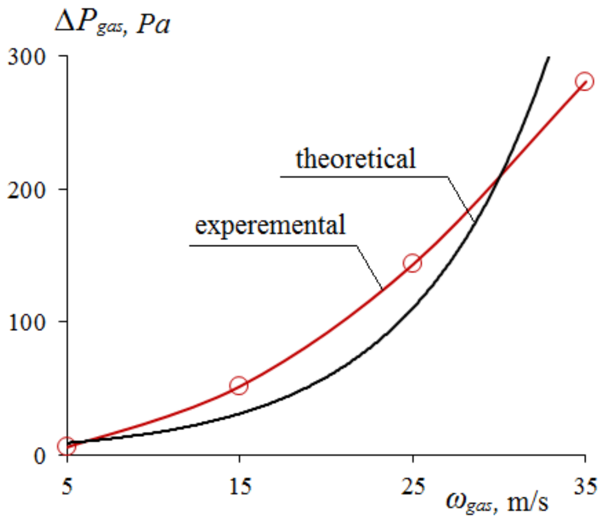

Figure 4. Plot of the aerodynamic resistance of the device ΔP_{gas} versus the gas velocity ω_{gas}. δ_{fil}=2 mm and ρ_{gas}=1.29 kg/m^3 const.

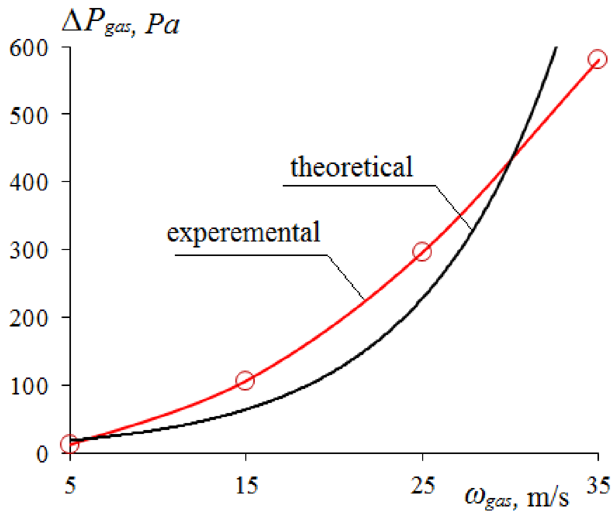

Figure 5. Plot of the aerodynamic resistance of the device ΔP_{gas} versus the gas velocity ω_{gas}. δ_{fil}=3 mm and ρ_{gas}=1.29 kg/m^3 const.

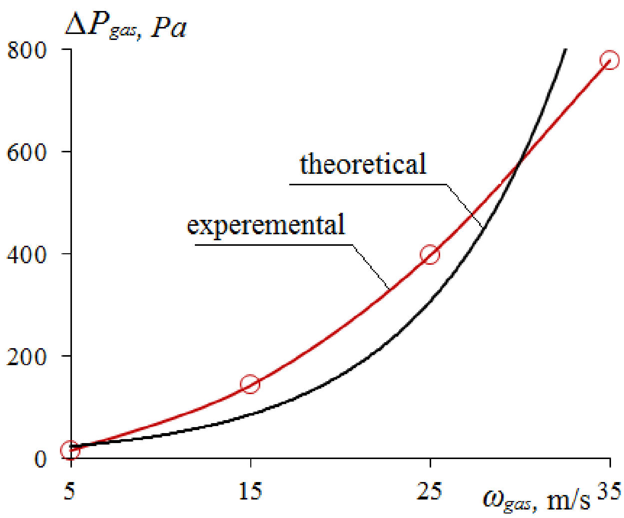

Figure 6. The graph of the aerodynamic resistance of the device ΔP_{gas} versus the gas velocity ω_{gas}. δ_{fil}=4 mm and ρ_{gas}=1.29 kg/m^3 const.

4; From the graphical relationships given in Figures 5 and 6, it can be seen that an increase in the thickness of the filter of the base fabric installed in the device leads to an increase in the resistance coefficient of the device filter. This, in turn, leads to an increase in the aerodynamic resistance of the device. In addition, an increase in the gas flow rate supplied to the device also significantly increases the aerodynamic resistance according to the Darcy-Weisbach law.

For example, when the gas density supplied to the device is ρ_{gas}=1.29 kg/m^3 const, the minimum aerodynamic resistance in the device at the minimum thickness of the basalt fabric filter δ_{fil}=2 mm was 18 Pa and the maximum aerodynamic resistance was 460 Pa, while the minimum aerodynamic resistance in the device at the maximum thickness of the basalt fabric filter δ_{fil}=4 mm was 35 Pa and the maximum aerodynamic resistance was 780 Pa. From this it can be concluded that the values of the variable parameters and the increase in the fabric thickness cause an increase in the aerodynamic resistance in the device. The error between the theoretical and experimental studies did not exceed 4%.

The following empirical formulas were obtained, which adequately represent the parameters, using the least squares method for the graphical relationships presented in Figures 4, 5 and 6 [8,9];1) δ_{fil}=2 mm va ρ_{gas}=1,29 kg/m^3 const.

$y = 0{,}5697x^2 - 7{,}8338x + 29{,}951$ $R^2 = 0{,}9984$ (14)

2) δ_{fil}=3 mm va ρ_{gas}=1,29 kg/m^3 const.

$y = 0{,}4183x^2 + 1{,}8969x - 9{,}4143$ $R^2 = 0{,}9974$ (15)

3) δ_{fil}=4 mm va ρ_{gas}=1,29 kg/m^3 const.

$y = 0{,}3101x^2 - 2{,}7979x + 23{,}64$ $R^2 = 0{,}9982$

(16)

In addition, an increase in the density of the gas and dust mixture also causes an increase in aerodynamic resistance in the device. Therefore, the study examined the change in aerodynamic resistance in the device due to an increase in gas density. The analysis of the permissible limit of dust in the air in mg/m^3 was carried out at the cement production plant of TERRA NOVA SEMENT LLC. The analysis was carried out using the method of determining the permissible limit of dust in mg/m^3 by GOST12.1.005-38, that is, the number of particles per unit of dust mass or dust volume. A special analytical aerosol aspirator of the AFA type (Aspirator M-822) was used as the research device, and a conical tube made of plastic was used as the filter cartridge, as the filtering material was perchlorovinyl fabric of the FPP brand (fabric mounted on a paper protective ring) []. According to the analysis results, the average dust content per m^3 of air was 1157.5 mg. The density of the air-dust mixture was determined according to the following equation

(3.17). The density of the dust coming out of the rotary kiln was assumed to be 1650 kg/m^3.

$$\rho_{r.c} = \rho_{gas} + (\rho_{dust}\gamma) \quad (17)$$

Based on the calculation result, the density of the air-dust mixture was determined to be 3.2 kg/m^3 and the effect of the mixture density on the aerodynamic resistance of the device was considered according to the above method. A screw feeder was used to create the air-dust mixture in laboratory conditions. The powder was quantitatively transferred for different air velocity ranges and different values of the filter thickness. In order to assess the error between the theoretical and experimental values, comparison graphs were constructed (Figures 7; 8 and 9).

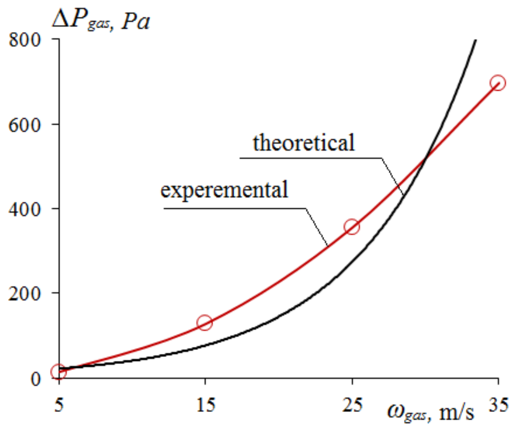

Figure 7. P$_{lot}$ of the aerodynamic resistance of the device ΔP$_{gas}$ versus the gas velocity ωgas. δ$_{fil}$=2 mm and ρ$_{gas}$=3.2 kg/m^3 const.

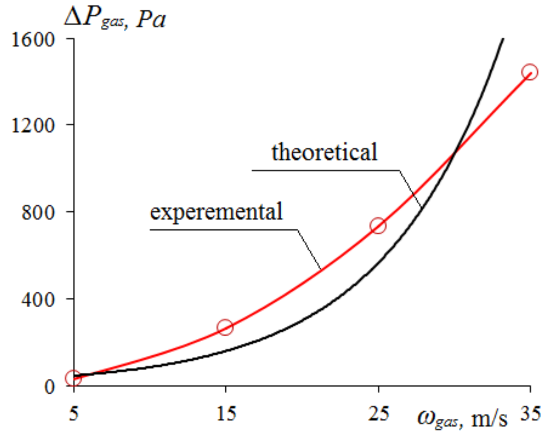

Figure 8. Graph of the aerodynamic resistance of the device ΔP$_{gas}$ versus the gas velocity ωgas. δ$_{fil}$=3 mm and ρ$_{gas}$=3.2 kg/m^3 const.

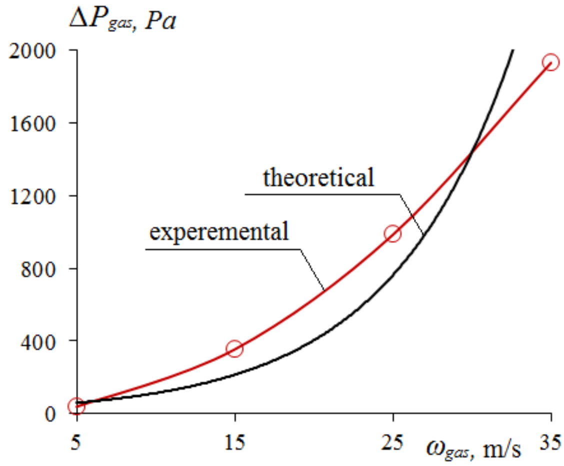

Figure 9. The graph of the aerodynamic resistance of the device ΔP_{gas} versus the gas velocity ωgas. δ_{fil}=4 mm and ρ_{gas}=3.2 kg/m^3 const.

The graphical relationships given in Figures 7; 8 and 9 show that an increase in the density of the dust and gas mixture supplied to the device causes a significant increase in the aerodynamic resistance of the device.

For example, when the gas density supplied to the device is ρgas=1.29 kg/m^3 const, the minimum aerodynamic resistance in the device at the minimum thickness of the basalt fabric filter δ_{fil}=2 mm was 18 Pa and the maximum aerodynamic resistance was 280 Pa. When the gas density is ρ_{gas}=3.2 kg/m^3 const, the minimum aerodynamic resistance in the device at the minimum thickness of the basalt fabric filter δ_{fil}=3 mm was 28.7 Pa and the maximum aerodynamic resistance was 700 Pa. At the maximum thickness of the basalt fabric filter δ_{fil}=4 mm, the minimum aerodynamic resistance in the device was 35 Pa and the maximum aerodynamic resistance was 780 Pa. When the gas density ρ_{gas}=3.2 kg/m^3 was constant, it was observed that at the maximum thickness of the basalt fabric filter δ_{fil}=4 mm, the minimum aerodynamic resistance in the device increased to 52 Pa and the maximum aerodynamic resistance to 2000 Pa. That is, an increase in the density of the air and gas mixture by about 2.5 times caused an increase in the hydraulic resistance by the same amount. The error between the theoretical and experimental studies was 4.8%.

7; 8 and 9 - the following empirical formulas were obtained, which adequately express the parameters using the least squares method for the graphical relationships presented in Figs. [8,9];

1) δ_{fil}=2 mm va ρ_{gas}=3,2 kg/m^3 const.

$y = 0,6633x^2 - 4,9111x + 58,083$ $\qquad R^2 = 0,9997$ $\qquad$ (18)

2) δ_{fil}=3 mm va ρ_{gas}=3,2 kg/m^3 const.

$y = 1,376x^2 - 7,8361x + 39,322$ $\qquad R^2 = 0,9982$

(19)

3) δ_{fil}=4 mm va ρ_{gas}=3,2 kg/m^3 const.

$$y = 1{,}7519x^2 - 9{,}18x + 108{,}57 \qquad R^2 = 0{,}9999 \qquad (20)$$

The results of the study on determining the aerodynamic resistance can be used to determine the degree of purification of the device. However, studying the effect of the basalt fibre-based filter on the working volume and service life based on the total aerodynamic resistance is complex and requires various deviations. In addition, it is necessary to take into account the temperature of the gas entering the device. This is because an increase in temperature also causes an increase in pressure according to the Mendeleev-Clapperon equation. This, in turn, increases the measurement error. Therefore, in the research work, the change in pressure due to an increase in gas temperature was also experimentally determined.

CONCLUSION

1. The increase in the closed zone of the filter fabric and the thickness of the fabric leads to an increase in the resistance coefficient. When designing industrial copies of the device, it is necessary to introduce limited intermediate values of Δk to select the optimal parameters of the closed and open zones.

2. The results of the experiment on determining the local resistance coefficients in the dusty gas inlet and cleaned gas outlet pipes and the diffuser show that the resistance coefficient values are close to each other even in different ranges of gas velocity and flow regime. The determined resistance coefficient values were mathematically processed and the resistance coefficients of the dusty gas inlet and cleaned gas outlet pipes were taken as 0.63 and 0.42 with sufficient accuracy and average value.

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