AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Pedagogical and Educational Research
ISSN (E): 2832-9791| Volume 38, |July - 2025

EXPERIMENTAL DETERMINATION OF THE RESISTANCE COEFFICIENTS OF THE DUST-CLEANING DEVICE IN THE SOLUTION METHOD

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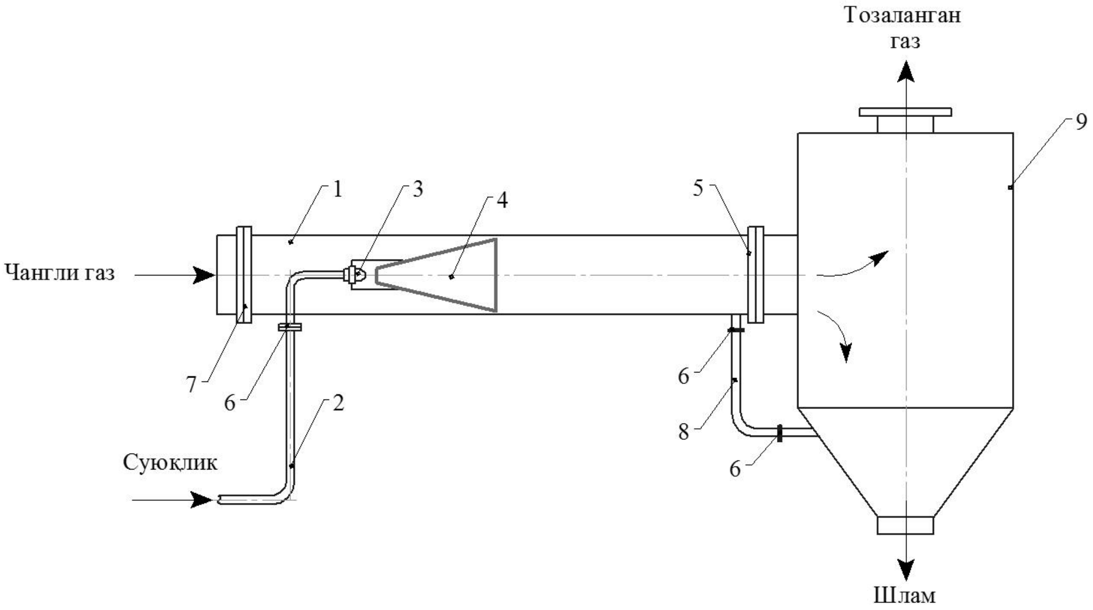
A B S T R A C T	K E Y W O R D S
In this article, the values of the resistance coefficients of the contact elements of the local and three different sizes and the liquid droplet trap in the absence of liquid are determined for a device with a conical contact element for wet cleaning of dusty gases. Determined experimentally. As a result of this, liquid is supplied to the device, and the determination of resistance coefficients, total hydraulic resistance and construction. It is possible to determine and analyse fluid consumption and energy consumption to determine optimal cleaning efficiency values.	Wet method, device, cone-shaped, contact element, gas velocity, local resistance, resistance coefficient.

INTRODUCTION

Currently, the most affordable and convenient method for cleaning dusty gases and gas mixtures emitted into the atmosphere by industrial enterprises is the wet method, which is widely used. If we analyse these devices from the point of view of cleaning efficiency, the cleaning performance of various industrial dusts is maximum, which is 99%. But we can point out the complexity of the structural structure of the devices used, the energy spent on them, and the high hydrodynamic and aerodynamic resistance in the device as a general drawback. In order to eliminate the above-mentioned shortcomings and increase the contact surface between the dusty gases and the liquid supplied to the apparatus, a cone-shaped wet dusty gas cleaning device was developed. A new design of a contact element device is proposed [1]. The general and calculation diagrams of the device are given below (1 and 2).

Research Object

The research was a device with a conical contact element created by us, and its physical model (Figures 1 and 2) and the equation for calculating the total hydraulic resistance, derived as a result of theoretical studies, were obtained [1]. The general and calculation scheme of this device is presented below (Figure 1).



1 - working chamber pipe, 2- liquid delivery pipe, 3- liquid delivery nozzle, 4- conical cut of the element, 4- drop catching device 5,6- connecting flanges, 7- flange connecting the device to the dust source, 8- sludge discharge pipe, 9- drip catcher. Cyclone is installed.

1 - p asm. The general circuit diagram

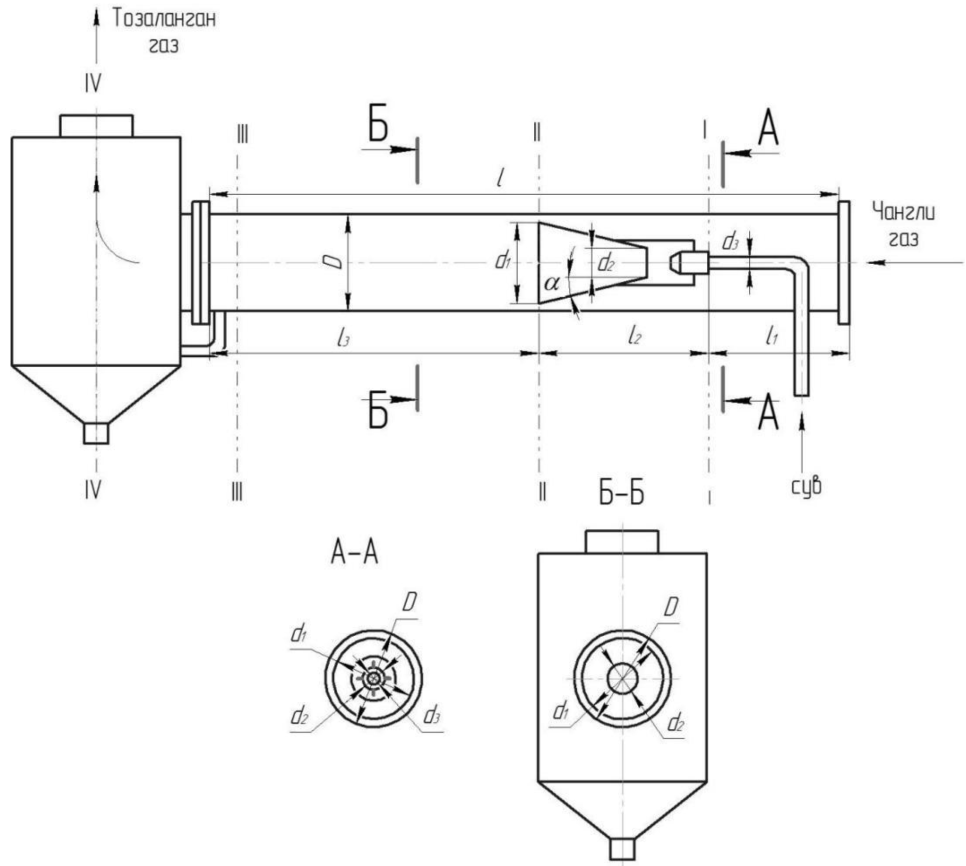


Figure 2. Calculation scheme of the device

Through theoretical studies, the pressure losses in the sections shown in Figure 2 and the total pressure losses in the device were determined. [1] Pa;

$$\Delta P_{ум} = P_1 + P_2 + P_3 + P_4 \quad (1)$$

where: ΔP – total lost pressure in the apparatus, in section II, P_1 – pressure lost due to the friction of dust gas in the inlet pipe of the apparatus.

In section II-II. P_2 – Device Pressure loss in the contact element, in section III-III. P_3 - pressure loss due to the friction of the dusty gas impinging on the contact element with the liquid film formed in the pipe. In section IV. P_4 - pressure loss in the device that traps the droplets that mix with the purified air. [1] Pa.

$$\Delta P = \lambda_1 \cdot \frac{l_1 \cdot \rho_{ap} \cdot \omega_{ap}{}^2}{2D} + \left(\xi_{сув} + \xi_к\right) \cdot \frac{\rho_{ap} \cdot \omega_{ap}^2}{2} + \lambda_2 \frac{l_3 \cdot \rho \cdot \omega^2}{2D} + \xi_m \frac{\rho \cdot \omega^2}{2} \quad (2)$$

, formula (2) was derived to calculate the total pressure loss in the proposed device. This formula determines the total pressure loss depending on the hydrodynamic parameters of the device.
Using this equation, we can write the total resistance coefficient of the device as follows.

$$\xi_{mind} = \xi_1 + (\xi_{suv} + \xi_k) + \xi_t \quad (3)$$

Here, ξ_1 is the coefficient of resistance resulting from the friction force when introducing the gas to be purified into the device, ξ water $_{is}$ the coefficient of resistance resulting from the water sprayed onto the contact device of the device, ξ_k is the coefficient of resistance of the conical contact device of the device, ξ_t is the coefficient of resistance of the device that captures liquid droplets.
In this article, the local resistance coefficients at the inlet and outlet, as well as the resistance coefficients of the conical contact element and the droplet catcher device, were determined for the device without water spraying. Experimental studies were conducted on a prototype of the device (Figure 3).

3 . General view of the experiment.

The results obtained

The gas speed, consumption and resistance coefficients of the working bodies of the device performance Q_{max} = 750 m ^{3} /h; electric motor power N_{dv} =0.7 kW; rotation frequency n =1200 rpm) is equipped with a centrifugal fan. To determine the dust gas velocity, an electronic gas velocity measuring device with a digital display, brand ANEMOMETER **VA06 - TROTEC** (Measurement range 1.1÷50 m/s, error coefficient 0.2%, when the gas velocity exceeds 50 m/s, the error coefficient is up to 5%). To control the gas velocity, a damper is installed on the suction pipe of the fan, forming an angle of 0 ^{0}, 30 0, 45 0, 60 0, 90 $^{0.}$

Experimental studies were carried out in the following sequence. At the initial stage of the experiments, a gas suction fan was installed in the device, which supplied the dusty gas. The damper (movable barrier) was changed in the range of 30÷90 ^{0} (in steps of 15 ^{0}), and the gas velocities exiting the fan and the gas consumption associated with them were determined. According to it, when the damper was opened to 30 ^{0}, the gas velocity υ_{gas} *=5 m/s*, gas consumption Q_g = 141m ^{3} /h, when opened to 45 ^{0} gas velocity y_{gas} *= 10 m/s* b when it dies Q_g = 282 m ^{3} /hour, gas velocity y_{gas} *= 15 m/s* b when opening to 60 ^{0}, Q_g = 423 m ^{3} /hour, when opening to 75 ^{0} gas velocity y_{gas} = *20* m / s b Q_g =564m ^{3} /hour, $^{\text{When opening to}}$ 90 $^{0,\ \text{the}}$ gas velocity y_{gas} = *25 m/s* b when it dies Q_g =705m ^{3} /h. In the subsequent course of the experiments, a fan was installed in the apparatus body and experiments were conducted without liquid being supplied to the device without contact elements and a droplet catcher. The gas flow rates determined above were given as Q=141÷732m3/h (in steps of 141 m3/h), and the local resistance coefficients of the device were determined by the difference in gas velocities exiting the device. To determine these differences, an electronic device of the ANEMOMETER VA06–TROTEC brand was used at all stages of the experiments. The diameter of the gas inlet and outlet pipes of the device is D=100 mm. The experimental results obtained are presented in Table 1 below.

1 – table Local resistance coefficient of the device values

Gas inlet speed, υ_{gas}, m/s	5	1 0	15	20	25
Gas exit speed, υ_{gas}, m/s	4.2	8.3	12.5	16.5	20.8
Local resistance coefficient, ξ_m	1.19	1.2	1, 2	1, 21	1, 2
Selected resistance coefficient, ξ_m	1.2				

Local resistance of the device coefficient ξ_m = 0.2.

In one of the experiments, a droplet catcher was installed in the device, and the drag coefficient of the droplet catcher was determined by applying the above-mentioned gas velocities. The experimental results are presented in Table 2.

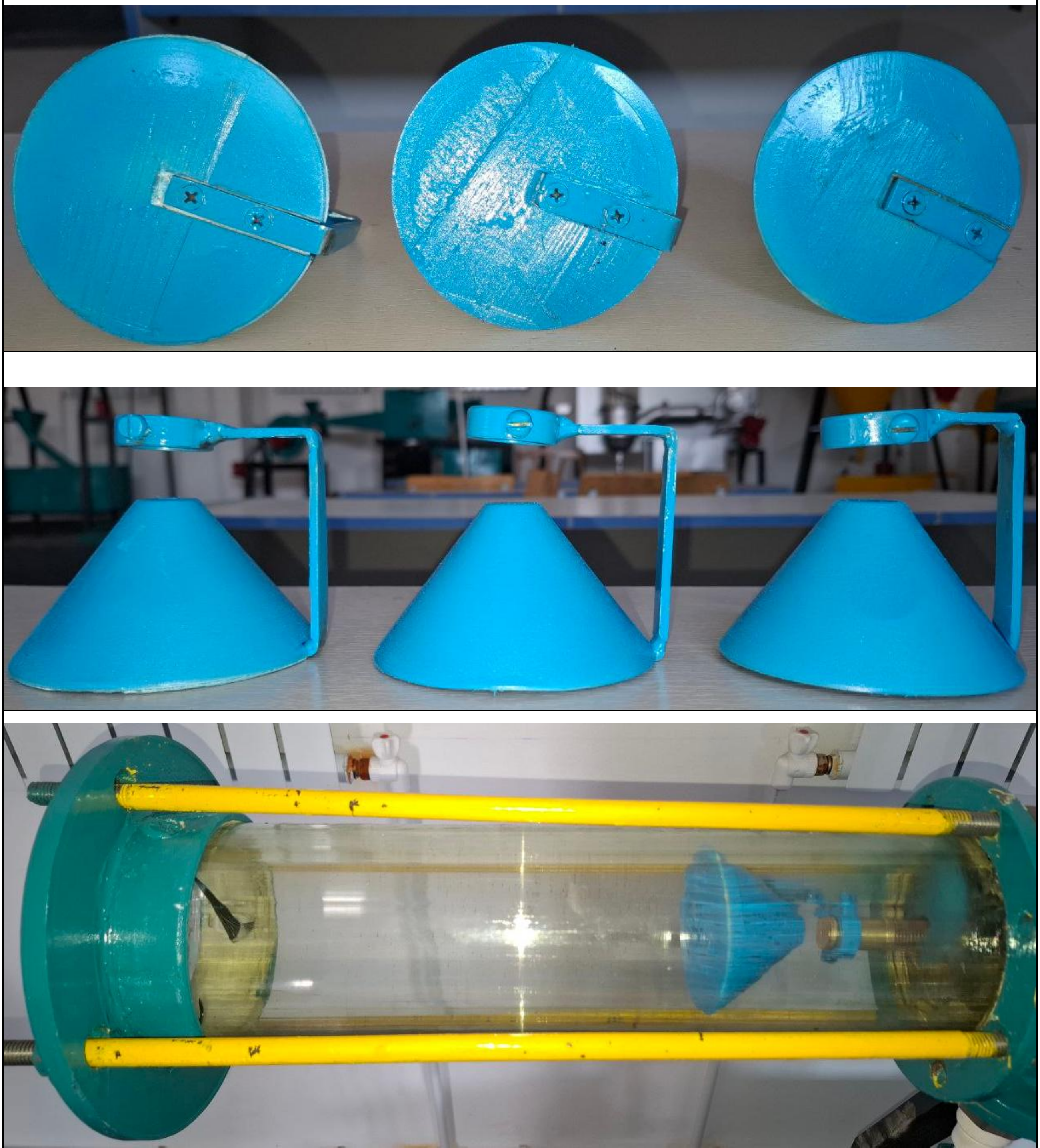
Table **2 Tomchi is the catcher's drag coefficient values**

Gas inlet velocity, υ_{gas}, m/s	5	1 0	15	2 0	25
Gas exit speed, υ_{gas}, m/s	3.2	6.5	9.6	13	16
Droplet catcher and local drag coefficients, sum ($\xi_m + \xi_t$)	1.56	1.53	1.56	1.54	1.56
Selected resistance coefficient ($\xi_m + \xi_t$)	1.55				

the results of the conducted experimental studies, Table 2 shows the results of the conducted experimental studies, and to determine the resistance coefficient of the droplet catcher, we subtract the determined local resistance coefficient of the device. According to it, the resistance coefficient of the droplet catcher was ξ_T =0.35.

In the next phase of experiments, do not crash In a position parallel to the working chamber, three different sizes of conical contact elements with a large base diameter d_1 = 80; 90; 100 mm were installed in series on the fitting, and experimental studies were conducted (Fig. 4) and the total resistance coefficients of the structure were determined.

A). d_1 =100 mm B). d_1 = 90mm B). d_1 = 80mm



4 - picture. Contact element views.

In experimental studies, the regimes of gas velocities mentioned above were kept. The obtained experimental results are presented in Tables 3, 4, and 5.

Table 3 **The total resistance of the device is the sum of the resistance coefficient values The diameter of the large base of the contact element d_1=80 mm**

Inlet gas velocity, υ_{gas}, m/s	*5*	*1 0*	*15*	*2 0*	*25*
Outlet gas velocity y_{gas}, m/s (average)	*3.1*	*6.3*	*9.4*	*12.5*	*15.6*
Resistance coefficient, ξ_t	*1.61*	*1.58*	*1.59*	*1.6*	*1.6*
The selected average resistance coefficient, ξ_t	*1.6*				

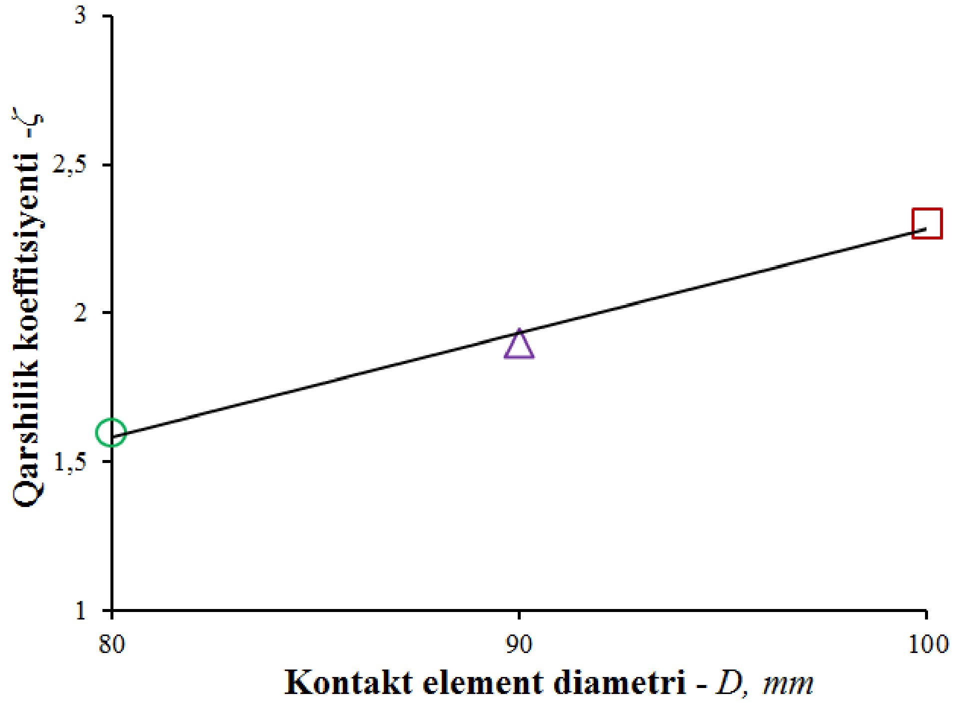
Table 4 **The total resistance of the device is the sum of the resistance coefficient values The diameter of the large base of the contact element is d_1 = 90 mm.**

Inlet gas velocity, υ_{gas}, m/s	*5*	*1 0*	*15*	*2 0*	*25*
Outlet gas velocity y_{gas}, m/s (average)	*2.6*	*5.3*	*7.9*	*10.5*	*13*
Resistance coefficient, ξ_t	*1.92*	*1.89*	*2*	*1.9*	*1.92*
The selected average resistance coefficient, ξ_t	*1.9*				

Table 5 **The total resistance of the device is the sum of the resistance coefficient values The diameter of the large base of the contact element is d_1 = 100 mm**

Inlet gas velocity, υ_{gas}, m/s	5	1 0	15	2 0	25
Outlet gas velocity y_{gas}, m/s (average)	2.2	4.4	6.5	8.7	11
Resistance coefficient, ξ_t	2.3	2.2	2.3	2.3	2.27
The selected average resistance coefficient, ξ_t	2.3				

They were processed using a computer program, and a correlation graph was constructed (Figure 5).



○the contact element diameter is D = 80 mm; -When △the contact element diameter is D = 9 0 mm; -When □the contact element diameter is D = 100 mm;

Fig. 5. The conical contact element depends on the diameter of the large base in the case graph of the change of the total resistance coefficient of the movement.

The resulting regression equation looks like this.

$$y = 0.035x - 1.2167 \qquad R^2 = 0.9932$$

5 above is the total resistance coefficient of the device, and we determine the resistance coefficient of the conical contact element. To do this, we subtract the local resistance coefficients of the gap and the droplet catcher from this total resistance coefficient.

1. d_1 =80 mm ; $\xi_k = \xi_{um} - (\xi_m + \xi_t) = 1.6 - (0.2 + 0.35) = 1.05$
2. d_1 =80 mm ; $\xi_k = \xi_{um} - (\xi_m + \xi_t) = 1.9 - (0.2 + 0.35) = 1.35$
3. 3. When d_1 = 100 mm ; $\xi_k = x_{um} - (x_m + x_t) = 2.3 - (0.2 + 0.35) = 1.75$

Based on the results of the calculation, a correlation graph was built (Fig.... 6).

A graph is constructed.

6 **- picture. Conical contact element, the coefficient of abundance q, Graph of dependence on the diameter of the large base.**

Built into the device based on experimental research, the following empirical equation was obtained to calculate the resistance coefficient of a conical contact element with dimensions d_1 =80, 90, 100 mm [].

$$\xi_k = \Delta K\,(d_1 / D) \qquad (4)$$

Where Δ K is the correction factor, which is determined by the following equation.

$$\Delta K = \xi_k / \xi_n \qquad (5)$$

Where ξ_T is the resistance coefficient of the conical contact element determined by experiments; ξ_n is the relative resistance coefficient of the conical contact element, which is determined as follows.

$$\xi_n = d_1 / D \qquad (6)$$

Where d_1 is the diameter of the large base of the conical contact element in mm, D is the working chamber in which the conical contact element is installed. The diameter is D 110 mm.

(6), We determine the relative resistance coefficients of the conical contact element. In this case, d_1 =80 mm.

$$\xi_n = d_1 / D = 80 / 110 = 0.73$$

(5).

$$D\,K = x_k / x_n = 1.05/0.73 = 1\,,44$$

Conical contact elements d_1 = 90;100 mm. The correction coefficient values for the dimensions were also determined in the same way. The correction coefficient value when a contact element with d_1 = 90 mm is installed is When installing a contact element with Δ K 1.64 and d_1 = 100 mm, the value of the correction coefficient was Δ K 1.94, and dependence graphs were constructed (Fig. 7).
A graph is constructed.

7 . The values of the correction coefficient Δ K, Dependence of the base diameter d_1 of the contact element on the cone.

Using the recommended empirical equation, the theoretical values of the resistance coefficients were determined and compared with the experimental values. The error between them was Δ = ± 3 %.

Conclusion

The resistance coefficients of the contact elements of different sizes and local and three different sizes, as well as the liquid droplet trap, in various gas flow regimes in the absence of liquid in a device with a conical contact element for wet cleaning of dusty gases. Prices were determined. As a result of this, liquid is supplied to the device, and the determination of resistance coefficients, total hydraulic resistance and construction. An opportunity has been created to determine and analyse fluid consumption and energy consumption to determine optimal cleaning efficiency values.

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