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EXPERIMENTAL DETERMINATION OF HYDRAULIC RESISTANCE OF WET METHOD DUSHANGER AND GAS CLEANER

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ABSTRACT

The article recommends the hydrodynamic modes of the wet dust collection and gas cleaning apparatus. The results of an experimental study on the determination of hydraulic resistance in a wet dust collector and gas purifier are presented. In studying the effect of the working bodies on the gas flow, defined and comparative graphs were constructed for different values of hydraulic resistance and variable factors. Empirical formulas were obtained to adequately describe the process using the least squares method for experimental results and graphical dependencies.

KEYWORDS

Wet method, contact element, coefficient of resistance, reference angle, hydraulic resistance, torsional motion, gas flow, gas velocity.

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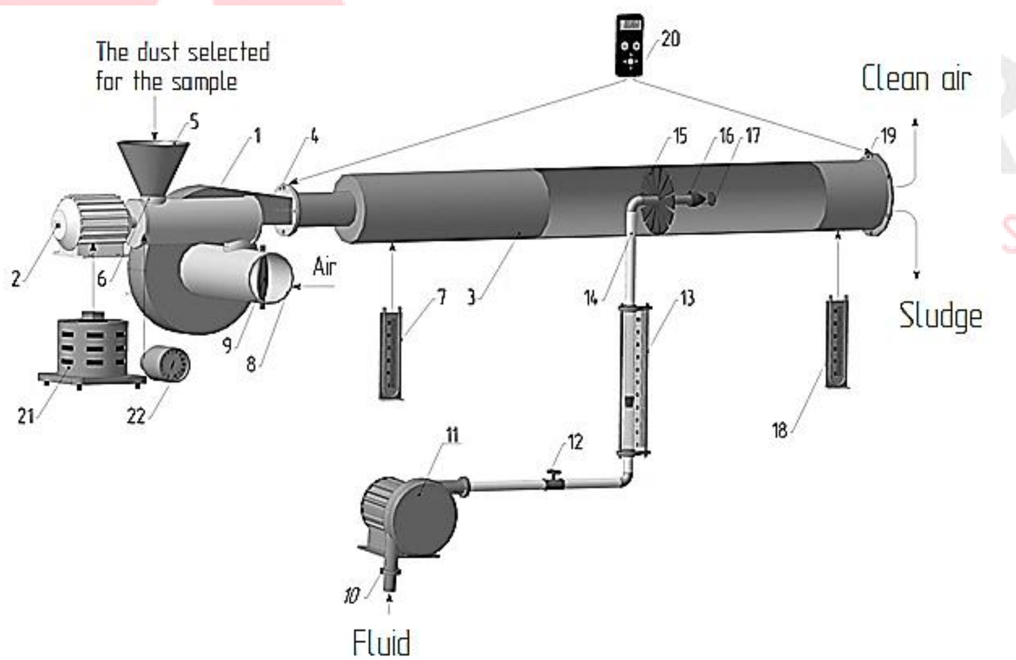
INTRODUCTION

With the development of industrial enterprises around the world, pollution of the environment with dust and toxic gases is also increasing. It is therefore the only way to protect the environment and find solutions to industrial problems. There are several types of dust and toxic gases emitted from industrial plants, and the unfortunate one is the presence of toxic substances among them that have toxic properties. At present, enterprises use devices of various constructions to clean dust and toxic gases. One of the most effective ways to clean dust and toxic gases from manufacturing plants is wet cleaning, which uses a number of designs of this type of equipment. Various contact elements are used to soak dusty gases in the devices used. However, the low efficiency of the contact elements, hydrodynamic resistance, low efficiency of dust removal from the resulting sludge does not allow optimal use of the apparatus. Therefore, in order to achieve 100% results in wet dust cleaning, it is advisable to ensure the interaction of liquid and dust with each other and to select the optimal options of hardware hydrodynamics [1,2,3]. In order to solve these problems, we conducted experimental studies to determine the coefficient of resistance in the apparatus through the liquid and gas flow in the wet dust collection and gas cleaning apparatus, designed and developed by us. [4,5,6]. Figure 1 below shows an overview of the apparatus.



1 – fan; 2 – electromotor; 3 – metal pipe; 4 –10 – 19 Flanges; 5 – dust collector; 6 – dust supplier; 7,18 – Pito Prandl tube; 8-dusty air inlet lane 9 – stacker 11 – Pump; 12 – valve; 13 – rotameter; 14 – water supply pipe; 15 – gas flow-forming element; (fluorite) 16 – stutter of fluid ; 17 – water repellent; 20 – anemometer electronic meter; 21 – electromotor speed control apparatus; 22 – Instrument showing the velocity.

Figure 1. Total view of experimental device

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The following equipment and apparatus were selected as the experimental model in determining the gas velocity, flow rate, flow regime and local resistance coefficients in the wet dust collection and gas cleaning apparatus. Centrifugal fan; work productivity Qmax=360 m3/ hour; Electromotive force NDV=0,7 kW; number of revolutions n=1200 rpm; Pito prandl tube 100 mm dimensional; The pipe has 2 prandl tubes with an inner diameter of 7 mm, which determine the static and dynamic forces; Anemometer VA06-TROTEC (error coefficient at measuring range 1.1÷50 m/s, error coefficient up to 5 % when the gas velocity exceeds 50 m/s) to determine the velocity of dusty gas supplied to the experimental model electronic meter; metal pipe with D = 100 mm, L = 1200 mm in determining the gas velocity.

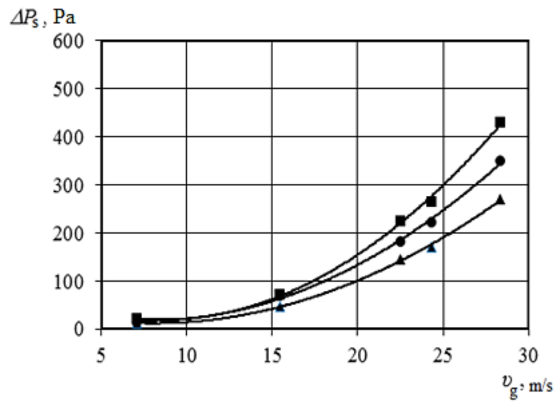
One of the main parameters that determine the stable operation of dust gas cleaning in the apparatus is its hydraulic resistance. Therefore, in determining the gas velocity, a suction tube was installed at an angle of 00, 300, 450, 600, 900 to the suction tube of the fan. The main reason for this is to determine the coefficients of hydraulic resistance of the apparatus at different velocities of the gas and thus to conduct experimental studies.

Each experiment was performed 5 times and the arithmetic mean value of the detected quantities was selected. (The kinematic viscosity of the air was assumed to be 1,51•10-5 m2/s).

In the experimental determination of the gas velocity, each experiment was repeated five times, and the square dimensions of each point and the resulting errors were determined. The directing angle of the contact element, which moves the gas flow to the device, is α=300; Experimental studies of gas velocities were carried out, each of which was set to 450 and 600 (swirler).

The device is equipped with a contact element that moves in the direction of the gas flow with a reference angle α=300 (swirler) and the pressure when the gas inlet speed is υ=7,07÷28,37 m/s and the outlet speed is υ=3,2÷11,03 m/s. 21,2 Pa and 430 Pa each; When the contact speed of the contact element, which moves in the gas flow, is set to the angle of α=450 (swirler), the gas inlet speed is up to υ=7,07÷28,37 m/s and the outlet speed is up to υ=3,6÷12,3 m/s when the pressure is from 14.8 Pa to 350 Pa and the inclination of the device is α=600, the contact element (swirler) is installed and the gas inlet speed is υ=7,07÷28,37 m/s and the outlet speed is υ=3,8 experimental studies have shown that the pressure ranged from 12 Pa to 270 Pa at 13.1 m/s.

In Figure 2 below, the angle of contact of the contact element, which moves the wet dust collector and gas cleaning device in the absence of liquid, is α=300; A graph of the pressure change depending on the gas velocity at 450 and 600 (swirler) is given.



1 - when the angle of inclination of the contact element is 60°; 2 - when the angle of inclination of the contact element is 45°; 3 - when the angle of inclination of the contact element is 30°;

Figure 2. The hydraulic resistance of a non-liquid apparatus depends on the gas velocity υ_g of ΔP_{nl}

The average change in gas velocity for each indicator increased by a step of 4 m/s. The reference angle α=30° of the contact element acting on the gas flow installed in the apparatus; The following hydraulic resistances in the apparatus were determined by the gas velocities supplied at 45° and 60° (swirler).

Hydraulic resistance ξ_1=2,2 when the contact angle of the contact element, which moves the gas flow to the device, is α=30°; the hydraulic resistance ξ_1=2 when the contact angle of the contact element moving in the gas flow is α=45°; it was found that the hydraulic resistance ξ_1=1,8 when the reference angle of the contact element moving in the gas flow is α=60°.

The graphical relationships shown in Figure 2 can be expressed by the following empirical formulas determined by the least squares method [7,8,9].

On the dependence of the gas velocity υ_g on the hydraulic resistance ΔP_{nl} in a non-liquid apparatus;

1. y = 0,6176x2 - 9,8756x + 51,272 R^2 = 0,9988 (1.1)

2. y = 0,7627x2 - 11,630x + 60,998 R^2 = 0,9980 (1.2)

3. y = 1,0398x2 - 17,921x + 97,084 R^2 = 0,9983 (1.3)

In this case, the total resistance coefficient of the device is 1.8 when the angle of inclination of the surface through which the gas flow passes sinβ=30°; experiments have shown that sinβ=45° is equal to 2 and sinβ=60° is equal to 2.2.

Figure 3 shows graphs of the coefficient of resistance depending on the angle of inclination of the gas flowing surface.

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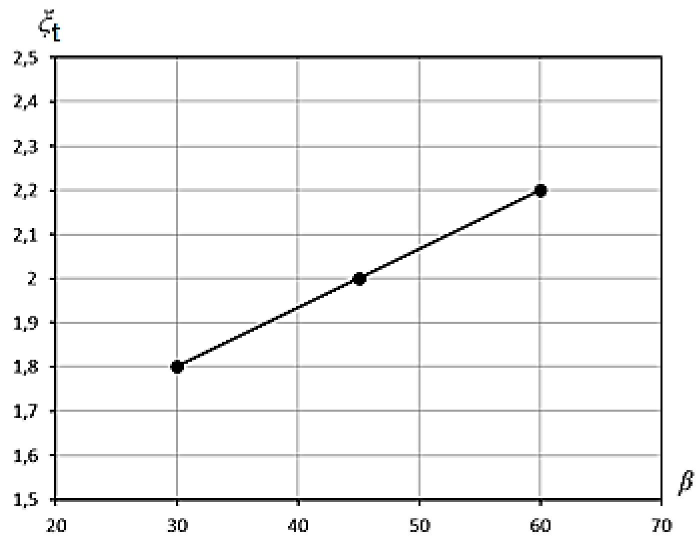

Figure 3. The dependence of the total resistance coefficient b on the angle of inclination b of the surface through which the raw gas flow passes

The following empirical formulas were obtained by determining the graphical dependences shown in Fig. 3 by the least squares method [10-12].

According to the dependence of the total resistance coefficient ξ_t on the angle of inclination β of the passing surface of the humus gas flow.

y = 0,0133x + 1,4

R^2 = 0,9978 (1.4)

The obtained experimental results show that the reference angle α=30°; of the contact element acting on the gas flow installed in the apparatus; The hydraulic resistances of the apparatus were determined by 45° and 60°.

In this case, the suitability of the device for the selection of the optimal gas velocity based on the overall size and gas velocity was determined experimentally, using the angle-forming gate, contact elements (swirler) and the correlation of the resistance coefficient.

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