Determination of Efficiency for Cleaning Quartz Sand and Dolomite Dust in A Wet Method Dust Cleaning Machine

Ergashev Nasimbek Axmadjonovich
PhD in Technical Sciences, Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: n.ergashe@ferpi.uz

Abdulazizov Abdulloh Abduqaxxor o'g'li
Assistant, Fergana Polytechnic Institute, Fergana, Uzbekistan
E-mail: abdulloh.abdulazizov@farpi.uz

Ilhomjon Mamarizayev Mahmudjon o'g'li
Assistant, Fergana Polytechnic Institute, Fergana, Uzbekistan
orcid.org/0000-0002-8518
E-mail: i.mamarizayev@ferpi.uz

ABSTRACT

The article conducts experimental studies of industrial dust in a wet dust collector with a contact element generating a flow and recommends modes for determining their cleaning efficiency.

Keywords: flow, wet method, contact element, interfacial surface, surface tension, liquid film, quartz sand and dolomite dust, air flow, gas flow

Introduction

The results of experiments to determine the hydraulic resistance as well as the research work of K.T.Semrau [1,2] were used to study the cleaning efficiency of the apparatus. It is known from K.T.Semrau's research work that the cleaning efficiency depends on the hydraulic resistance of the apparatus and not on the size and design of the apparatus. In this case, the total energy consumption should be spent on the purification of dusty gases using liquids [3,4]. Based on the above, the effect of hardware hydraulic resistance on cleaning efficiency was investigated. In the experiments, the following limits of the variables, the diameter of the fluid nozzle d_n = 2, 2.5 and 3 mm [5.6], the fluid flow increased to Q_{liquid} = 0.070 ÷ 0.327 m^3/h, the intermediate step 0.060 m^3 / h, the contact installed in the working pipe the angle of inclination of the element blades α = 30°; The number of blades of the contact elements 45° and 60° was increased to 12, the gas velocity v_g = 5 ÷ 25 m / s, the intermediate step 5 m / s, respectively, according to the installation angle. Gas density was determined for the mixture of air and quartz sand dust ρ_g = 1.89 kg/m^3 (where 1m^3 of air contains quartz sand powder PDK requirement and 345.4 mg/m^3 according to GOST-22551-77). The temperature for the water and gas system was set at 200S ± 2, taking into account the influence of the external environment during the experiments. Based on the results of the experiments obtained, comparison graphs were constructed on the effect of hydraulic resistance on the cleaning efficiency.

In the second stage, the effect of the mixture hydraulic resistance of dolomite dust and air mixture on the cleaning efficiency was studied.

In the experiments, the following limits of the variables, the diameter of the fluid nozzle d_n= 2, 2.5 and 3 mm [7], fluid consumption Q_{liquid} = 0.070 ÷ 0.327 m³/h increased the interval to 0.060 m³ / h, the contact element blades mounted on the working pipe slope angle a = 30o; The number of blades of the contact elements 45° and 60° was increased to 12, the gas velocity ρ_g = 5 ÷ 25 m / s, the intermediate step 5 m/s, respectively, according to the installation angle. The gas density was determined for the mixture of air and dolomite dust ρ_g = 2.13 kg/m³ (where 1 m³ of air contains dolomite powder PDK requirement and 360.3 mg /m³ according to GOST-23672-79). The temperature for the water and gas system was set at 200S ± 2, taking into account the influence of the external environment during the experiments. Based on the results of the experiments obtained, comparison graphs were constructed on the effect of hydraulic resistance on the cleaning efficiency. (Fig. 1). Given the multifactorial nature of the experiments, the graphs were constructed for low and high gas velocity loads.

From the data given in Figure 1, it can be seen that the cleaning efficiency at the lower limit of gas velocity when the angle of inclination of the contact element blades mounted on the working pipe is α=60° and the number of blades of the element is 12 in the range Q_{liquid}=0.070 ÷ 0.327 m³/h. , Up to 81%, at high gas velocity load of 92.71 ÷ 98.14%, the efficiency of cleaning at the lower limit of gas velocity when the angle of inclination of the contact element blades mounted on the working pipe α = 45° and the number of elements 12 pcs Q_{liquid}=0.070 ÷ At intervals of 0.327 m³/h up to 93.28 ÷ 97.19%, at high gas velocity load 96.4 ÷ 99.75% and at the lower limit of gas velocity when the angle of inclination of the contact element blades mounted on the working pipe is α= 30° and the number of elements is 12 cleaning efficiency up to 86.17 ÷ 96.81% in the range of Q_{liquid}=0.070 ÷ 0.327 m³/h of fluid flow to the device, at high gas velocity load 92.71 ÷ 98, 14%. Intermediate growth did not exceed 15%.

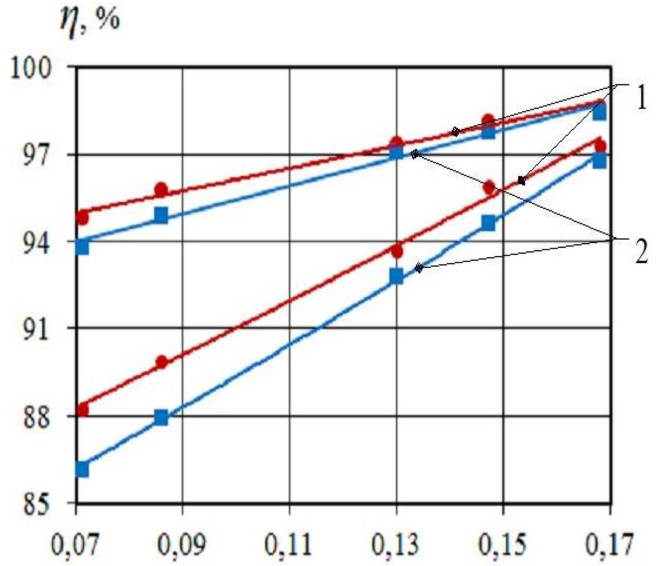

Figure 1. Purification efficiency The dependence of η on fluid flow Q_{liquid}, α = 60° - const. Q_{liquid}, m³/h 1-quartz sand powder; 2-dolomite dust

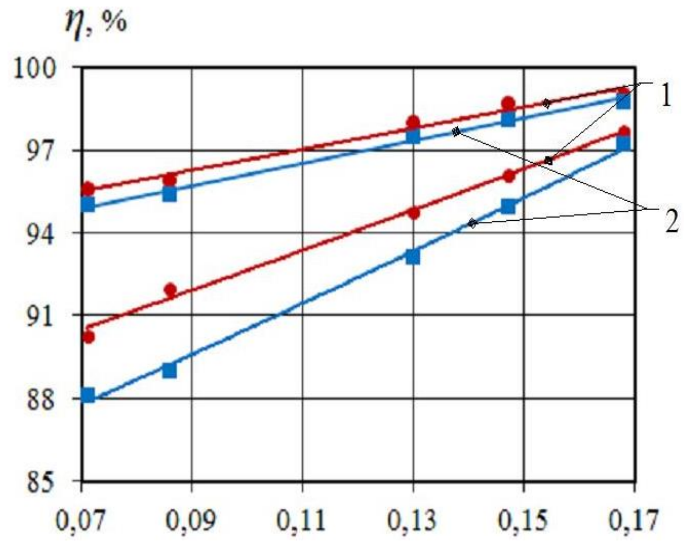

Figure 2. Purification efficiency η Dependence of liquid consumption on Q_{liquid} α = 45°-const. Q_{liquid}, m³/h

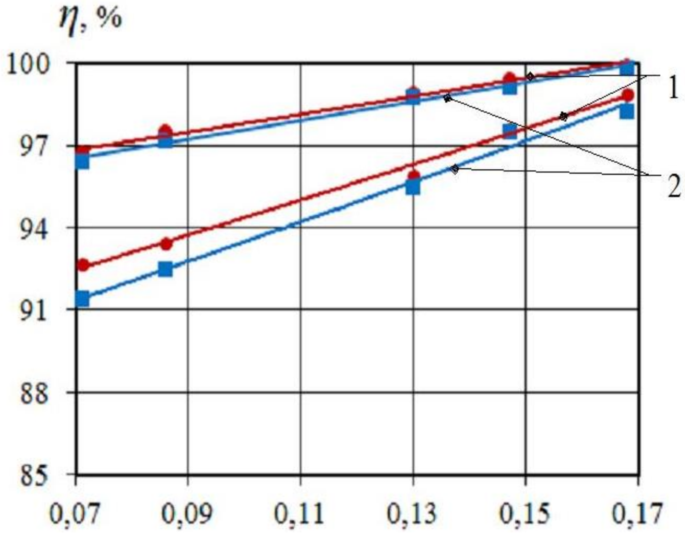

Figure 3. Purification efficiency η dependence of liquid consumption on Q_{liquid} α = 30º - const. Q_{liquid}, m³/h

The results of the experiment show that the expansion of the angle of inclination of the contact element blades mounted on the working pipe reduces the pressure lost in the apparatus, but has a negative impact on the cleaning efficiency. Conversely, the narrowing of the angle of inclination of the contact element blades mounted on the working pipe increases the pressure loss, which in turn determines the increase of the working surface of the contact element blades and the improvement of the cleaning efficiency. One of the technical requirements for this type of equipment is to increase the slope angle surfaces of the contact element blades at low energy consumption and thereby improve the cleaning efficiency.

Results

The following empirical formulas were obtained using the least squares method for the graphical dependencies shown in Figures 1.3 [8,9]:

When the angle of inclination of the contact element blades mounted on the working pipe is α = 60º;

$\upsilon_г$=5 м/с, $y = 78{,}632e^{1{,}2404x}$ R^2 = 0,9957 (1)

$\upsilon_г$=25 м/с, $y = 89{,}036e^{0{,}5931x}$ R^2 = 0,9635 (2)

When the angle of inclination of the contact element blades mounted on the working pipe is a = 45º;

$\upsilon_г$=5 м/с, $y = 90{,}823e^{0{,}4114x}$ R^2 = 0,9535 (3)

$\upsilon_г$=25 м/с, $y = 94{,}137e^{0{,}3531x}$ R^2 = 0,9906 (4)

When the angle of inclination of the contact element blades mounted on the working pipe is a = 30º;

$\upsilon_г$=5 м/с, $y = 90{,}842e^{0{,}4359x}$ R^2 = 0,9663 (5)

$\upsilon_г$=25 м/с, $y = 94{,}667e^{0{,}3319x}$ R^2 = 0,9708 (6)

Conclusion

In the experimental studies conducted to apply different constructions of the contact element and to evaluate its effect on the hardware hydraulic resistance and cleaning efficiency, the angle of inclination of the contact element blades is 45º, the diameter of the nozzle hole is d_n =2.5 mm, 1 m³ of air from dust particles. The amount of liquid used for cleaning Q_{liquid}=0.04 m³/l, the velocity of gas supplied to the device ρ_g=25 m/s, the hydraulic resistance of the device ΔP=2.7 kPa and the cleaning efficiency of the device for quartz sand η=99.72% and for dolomite dust η=99.46% was found in experiments.

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