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EXPERIMENTAL RESEARCH OF PROBLEM PROCESSES IN THE APPARATUS WORKING ON THE WET METHOD OF CLEANING DUST GASES

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Abstract

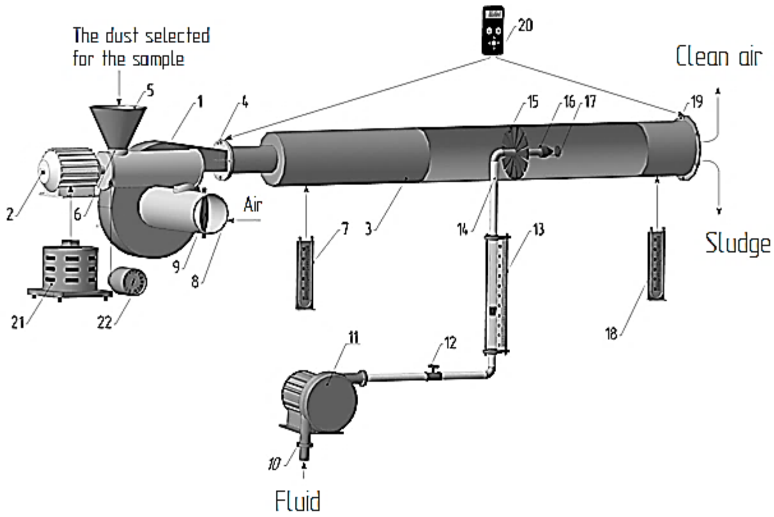
This article presents experimental investigations into gas cleaning processes within wet dust filtration apparatus. Through a series of experiments, the study explores the dynamics of mass exchange along the length of the liquid film formed in the working pipe. It identifies and analyzes the primary factors influencing the efficiency of the cleaning process in wet vacuum systems. The article emphasizes key elements such as gas flow dynamics, lumped flow phenomena, contact elements, the characteristics of the liquid film, guide angle effects, and various flow regimes, providing comprehensive insights into the nuanced dynamics of gas cleaning mechanisms.

The aims - to highlight the experimental focus and the specific factors investigated within the context of gas cleaning in wet dust filtration systems. Adjustments can be made to accommodate any additional details or specific emphases in your study.

Keywords: gas flow, lumped flow, contact element, liquid film, guide angle, flow regime.

Introduction

In the experimental model of the newly developed wet vacuum cleaner, the main operational factors affecting the cleaning process were determined (Fig. 1). [1-3]. In the apparatus, gas velocity, gas and liquid consumption, through the length of the liquid film, and the working surfaces were determined based on experiments. Contact elements with blades of different slopes were selected for the device, creating a lumped current. On the basis of theoretical and experimental studies, preliminary requirements for the apparatus and technical tasks were developed. The following devices and equipment were selected for the experimental model in determining the length of the liquid film through the gas velocity, liquid and gas consumption, flow regime and hydraulic resistance coefficients in the wet dust collector [4-11].



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

S32412 nozzle (hole diameter 2; 2,5 and 3 mm nozzle according to GOST-384610), centrifugal pump (PEDRJLLA – Qmax =40 l/min; Ndv =0.37 kw; Nmax = 38 m; V=220 V; pipe =3000 rpm according to GOST-2757030-91), rotometer (PC-5; scale indicators in the range 0÷100; according to GOST-1304581) was selected. The determination of working surfaces by the length of the liquid film depending on the diameters of the nozzle holes and gas velocities was determined for the variation of liquid and gas consumption. Centrifugal fan Ventilator-VTs-14-07 for supplying dusty gas to the working pipe of the device; productivity Qmax =400 m3/h; electric power Ndv=1,5 kw; number of revolutions n=1200 rev/min; The Pitot Prandl tube is 100 mm in size; According to Gosreestr 50123-12; The gas velocity detector consists of a metal pipe with D=100 mm, L=1200 mm. 2 Prandl tubes with an inner diameter of 7 mm, which determine the static and dynamic forces in the pipe, were selected as the experimental model, respectively [9-14].

Working surfaces were defined by the length of the liquid film by the resistance coefficients, depending on the change of gas velocities and the inclination angles of the contact elements (zavikhritel) depending on the change of the liquid and gas consumption supplied to the device. Experiments on the process of mass exchange in the case of liquid being supplied to the wet gas cleaning device were carried out in the following order [15-31]. To determine the mass exchange process of the device with a liquid, the diameter of the nozzle hole dsh=2 mm; dsh=2.5 mm; d_{sh}=3 mm, liquid consumption Q_s=0,07÷0,253 m^3/h; Q_s=0,071÷0,295 m^3/h; Q_s=0,072÷0,327 m^3/h, the slope of the working body of the contact elements forming a lumped flow to the gas flow a=30^o ; 45^o and 60^o were installed successively, and experiments were carried out by changing the intermediate step υ_g=7,07÷28,3 m/s with 4 m/s on the surface of each installed contact element. In the experiments, the number of blades that create a lumped flow to the gas flow of the contact element was n=12 and the gas density r was chosen as 1,29 kg/m^3 for air [32-44]. The experiments were conducted at a temperature of 20 ± 2 °C for the water and gas system. The length of the liquid film formed in the working pipe is given (Fig. 2) [45-51].

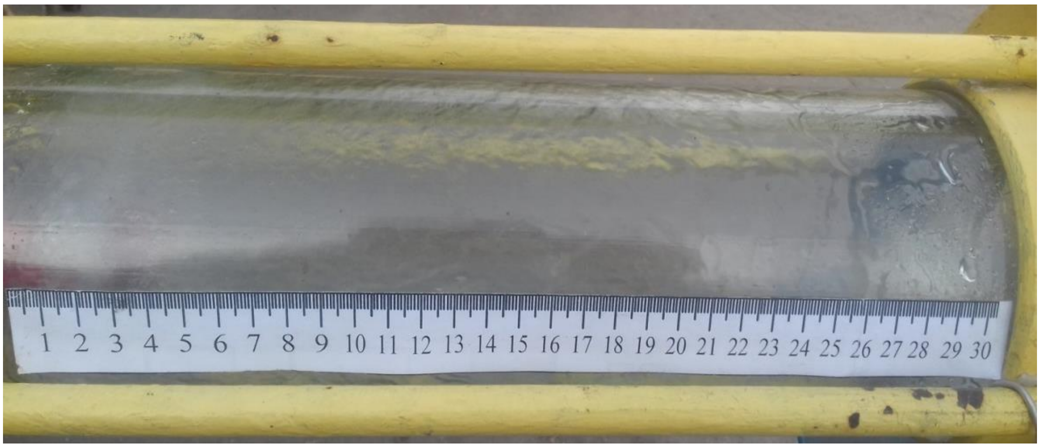
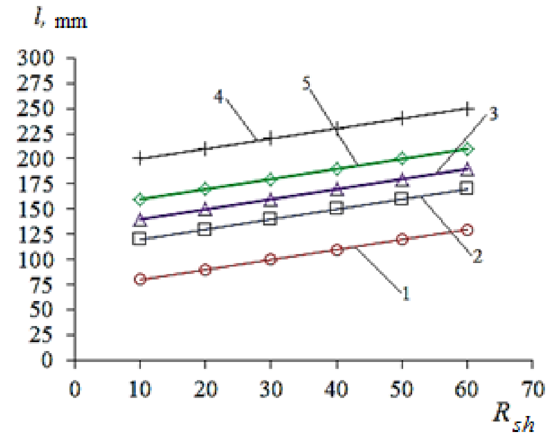


Figure 2. View of the length of the liquid film formed in the working pipe of the apparatus.

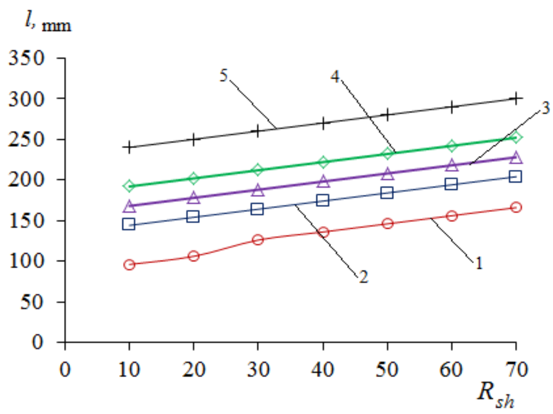
Experiments were conducted to determine the length and working surface of the liquid film formed in the working pipe when the diameter of the nozzle hole dsh =2 mm, depending on the gas velocities, the angle of inclination of the contact element pieces (zavikhritel) α=30^o depending on the changes in the liquid and gas consumption supplied to the device. According to the results of the experiment, it was determined that the length of the liquid film formed in the working pipe of the device was 80÷250 mm when the liquid consumption rotometer scale was 0÷100 and the gas velocity was υg =7,07÷28,37 m/s [52-58]. Experiments were conducted to determine the length and working surface of the liquid film formed in the working pipe when the diameter of the nozzle hole dsh =2 mm, depending on the gas velocities, the angle of inclination of the contact element pieces (zavikhritel) α=45o depending on the changes in the liquid and gas consumption supplied to the device. According to the results of the experiment, it was determined in the experiments that the length of the liquid film formed in the working pipe of the apparatus was 73÷230 mm when the indicator of the liquid consumption rotometer scale was 0÷100 and the gas velocity was up to $υ_g$ =7,07÷28,37 m/s. Experiments were conducted to determine the length and working surface of the liquid film formed in the working pipe when the diameter of the nozzle hole d_{sh} =2 mm, depending on the gas velocities, the angle of inclination of the contact element pieces (zavikhritel) α=60^o depending on the changes in the liquid and gas consumption supplied to the device [22-29]. According to the results of the experiment, it was determined that the length of the liquid film formed in the working pipe of the apparatus was 64÷200 mm when the liquid consumption rotometer scale was 0÷100 and the gas velocity was $υ_g$=7,07÷28,37 m/s. 1.1; 1.2; In table 1.3, contact element α=30^o; The values of the liquid film length determined at 45^o and 60^o and d_{sh} =2; 2,5 and 3 mm are presented.

Table 1.

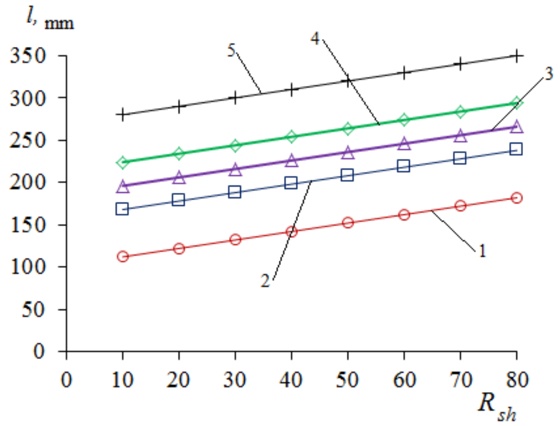
R_{sh}	d_{sh}=2 mm					d_{sh}=2,5 mm					d_{sh}=3 mm				
	0°	30°	45°	60°	90°	0°	30°	45°	60°	90°	0°	30°	45°	60°	90°
10	80	120	140	160	200	96	144	168	192	240	112	168	196	224	280
20	90	130	150	170	210	106	154	178	202	250	122	178	206	234	290
30	100	140	160	180	220	126	164	188	212	260	132	188	216	244	300
40	110	150	170	190	230	136	174	198	222	270	142	198	226	254	310
50	120	160	180	200	240	146	184	208	232	280	152	108	236	264	320
60	130	170	190	210	250	156	194	218	242	290	162	118	246	274	330
70	-	-	-	-	-	166	204	228	252	300	172	128	256	284	340
80	-	-	-	-	-	-	-	-	-	-	182	138	266	294	350
90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



a). When α=30°



b). When α=45°



1-Air temperature β=0°
2-Air temperature β=30°
3-Air temperature β=45°
4-Air temperature β=60°
5-Air temperature β=90°

c). When α=60°

Figure 3. Dependence of the determined film length on liquid consumption when the diameter of the nozzle hole is dsh=2 mm.

Experiments were conducted to determine the length of the liquid film formed in the working pipe and the working surface when the diameter of the nozzle hole dsh =2,5 mm, depending on the gas velocities, the angle of inclination of the contact element pieces (zavikhritel) $\alpha=30^o$, and the diameter of the nozzle hole dsh=2,5 mm, depending on the change of the liquid and gas consumption supplied to the device. According to the results of the experiment, it was determined that the length of the liquid film formed in the working pipe of the device was 96÷300 mm when the liquid consumption rotometer scale was 0÷100 and the gas velocity was υg=7,07÷28,37 m/s.

Conclusion

Depending on the changes in the gas and liquid consumption supplied to the device, it can be concluded from the experiments conducted on the study of the effect of gas velocities, the angle of inclination of the contact element pieces and its effect on the cleaning efficiency, that the increase in the angle of the contact element that directs the gas flow in the device, which creates a convective flow to the gas flow, decreases the length of the liquid film. , ensured that the layer thickens. This led to the reduction of the working surface of the liquid film. On the contrary, the reduction of the angle directing the gas flow ensured the thinning of the liquid film layer. This caused an increase in the working surface. By increasing the length of the liquid film in the working pipe of the device and increasing the working surface, a high efficiency of dust particles in the air was achieved.

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