INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

AN EXPERIMENTAL STUDY OF PRESSURE LOSSES IN A WET VACUUM DRUM DEVICE

Gulmirakhan Madaminova
Assistant, Fergana Polytechnic Institute, Fergana, Republic of Uzbekistan
E-mail: g.madaminova@ferpi.uz

Jasur Omonov
Student, Fergana Polytechnic Institute, Fergana, Republic of Uzbekistan

Abstract

The article presents the results of an experimental study in an experimental setup, a drum wet dust cleaning apparatus under various gas and liquid flow regimes. The local and general coefficients of resistance and the loss of total pressures in the working sections of the device are determined. As a result, depending on these pressures, it is possible to determine the optimal values of the efficiency of dust and gas cleaning and the energy consumption of the device.

Keywords: wet method, drum, screen, gas flow, liquid flow, pressure, dust, speed, apparatus.

Introduction

Today, as a result of the development of industry on a global scale, the level of atmospheric air pollution is increasing. The amount of emissions released into the atmosphere from chemical, building materials, and hydrometallurgical industries is especially high [1,7,8,9]. To solve these problems, dust and gas cleaning devices with different structural structures are being created and scientific research is being carried out worldwide [2,3,4,5,6]. The main requirements for the devices being created are the simplicity of the construction structure, high cleaning efficiency and low energy consumption. Based on these requirements, we have developed a new structure of the apparatus working in the wet method and are conducting scientific research [10].

ISSN: 2776-0987 Volume 4, Issue 4 April 2023

Materials and Methods

The kinematic diagram of the newly created drum dust cleaning device is shown in Fig. 1 and the general view is shown in Fig. 2.

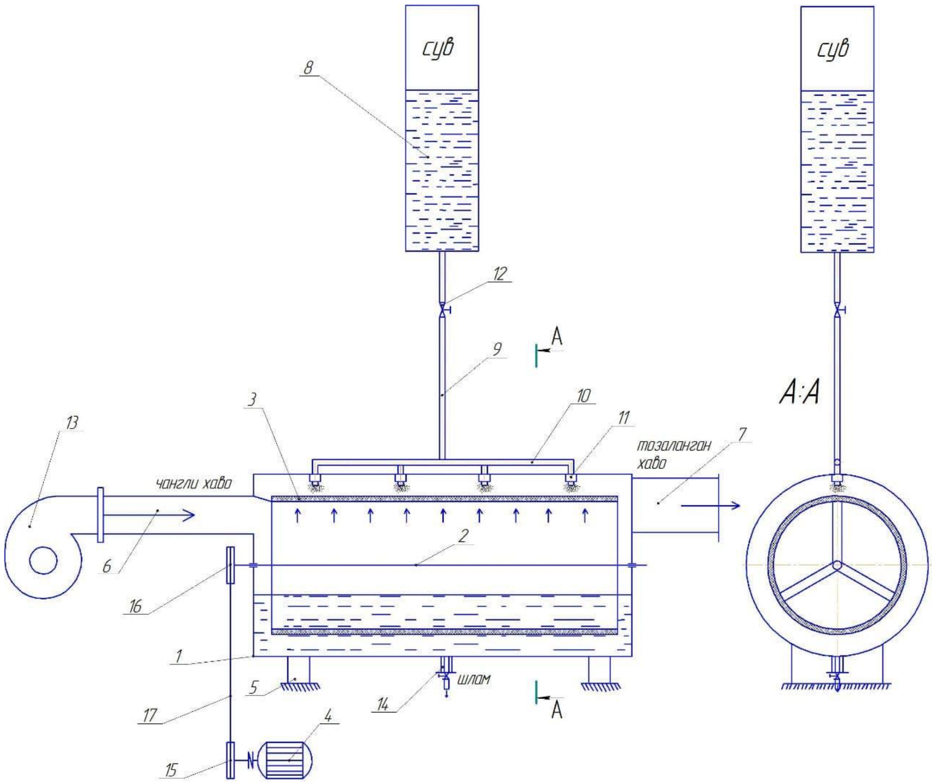

Figure 1. Scheme of the device with a wet dust cleaning drum

1. Cylinder body, 2. Shaft, 3. Drum, 4. Electric motor, 5. Support, 6. Dust air inlet pipe, 7. Purified air outlet pipe, 8. Water tank, 9. Water transfer pipe, 10. Water distribution pipe, 11-stuck, 12-water valve. 13-fan, 14-sludge valve, 15-drive pulley, 16-drive, 17-belt.

Figure 2. Overview of the drum device.

Theoretical studies were carried out to calculate the drum device. As a result, the equation for calculating the total pressure in the apparatus was derived [10,11].

$$P_{об} = \lambda_1 \cdot \frac{l}{d} \cdot \rho_{см} \cdot \frac{\omega_{см}^{\ 2}}{2} + \Delta\Pi \frac{\Sigma S_c \cdot \delta}{\Sigma S_c \cdot a} \cdot \frac{\rho_{см} \cdot \omega_{см}^2}{2} + \lambda_2 \cdot \frac{l}{d} \cdot \rho \cdot \frac{\omega^2}{2} \quad (1)$$

where λ_1 is the coefficient of friction with the pipe wall that transmits dust gas to the device, l is the length of the pipe through which dust gas moves, m; d-pipe diameter, m; ρ_{sm} -dusty air mixture density, kg/m^3; velocity of dusty air mixture moving in ω_{sm} -pipe, m/s. The density of the mixture.
ω_{sm} is the movement speed of the dusty air mixture on the surface of the drum screen, m/s; ξ_c is the resistance coefficient of the drum grid.
The theoretical total resistance coefficient of the device is equal to (2,3) [10].

$$\xi_{ум} = \xi_к + \xi_c + \xi_ч \quad (2)$$

$$\xi_{ум} = \lambda_1 \frac{l}{d} + \Delta\Pi \frac{\sum S \cdot \delta}{\sum S \cdot a} + \lambda_2 \frac{l}{d} \quad (3)$$

The overall resistance coefficient of the drum sieve is determined as follows depending on the surface of the dusty air passing through the sieve [10-17].

$$\xi_c = \Delta\Pi \frac{\sum S_c \cdot \delta}{\sum S_c \cdot a}, \quad (4)$$

where ΔP is the correction coefficient, determined by experiments, ΣS_c- the total surface of the part through which dusty air passes through the grid, m^2; δ -thickness of mesh wire, m; dimensions of the square hole of a mesh, m; where λ_2 is the coefficient of friction in the exhaust pipe of purified air; l-length of the pipe through which purified air moves, m; d-pipe diameter, m; ρ -purified air density, kg/m^3; velocity of purified air moving in the ω-pipe, m/s.

Results

The fan in the experimental determination of the coefficient of resistance of the device the gas consumption in the suction part, the fan installed in the device body, and the gas consumption coming out of the device were determined. The local resistance coefficients of the apparatus were determined from the difference in gas consumption. The local resistance of the device was $\xi_м$=0,35. To simplify calculations, formula 3 looks like this.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

$$\xi_y = 0,35 + \Delta\Pi \frac{\sum S_c \cdot \delta}{\sum S_c \cdot a} \qquad (5)$$

At the next stage of the experiments, a square hole size a=0.6, 0.8, 1 mm was wrapped around the working drum to form a drum. According to the results, the resistance coefficient ξ_c=2 when the mesh square hole size is a=0.6mm, the mesh wire thickness is δ=0,25, the hole size is a=0.8mm, and the mesh wire thickness is δ =0.325mm ξ_c =1,8; ξ_c=1.6 when the hole size is a=1mm, and the thickness of the grid wire is δ =0.4mm. Based on the obtained results, a graph is constructed (Fig. 2).

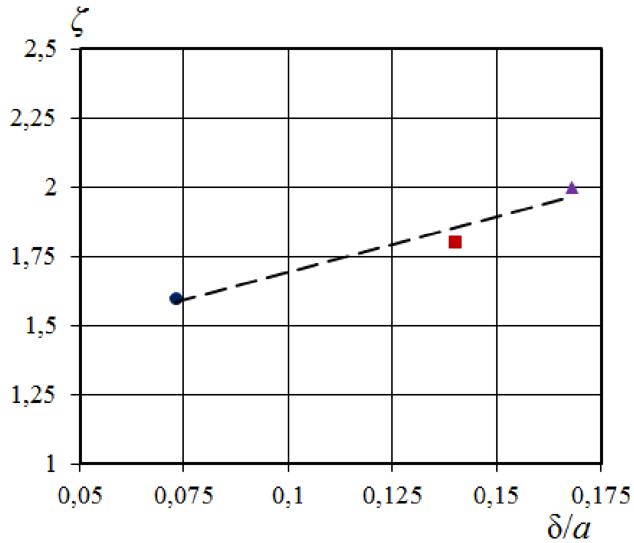

Figure 2. The graph of the change of the resistance coefficient depending on the size of the mesh installed on the device

The resulting regression equation looks like this.

$y = 3.9866x + 1.2937$ $R^2 = 0.9468$

Based on the results of the experimental study, the correction coefficients for determining the grid resistance coefficients were determined (Table 1).

Table 1. The results of experiments to determine the correction coefficient

No	Setka square hole dimensions; a, mm	The thickness of the wire; δ, mm	The number of wires in the set; n, piece	Resistance coefficient; ξ	Correction factor ΔP
1	0.6	0.25	1176	1.65	17.6
2	0.8	0.325	888	1.45	17
3	1.0	0.4	714	1.25	16

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

In the next stage of the experiments, the pressure loss was determined when the mesh was installed in the apparatus body without spraying water and when water was sprayed. The obtained experimental results were processed based on a computer program and a graph was constructed (Fig. 3).

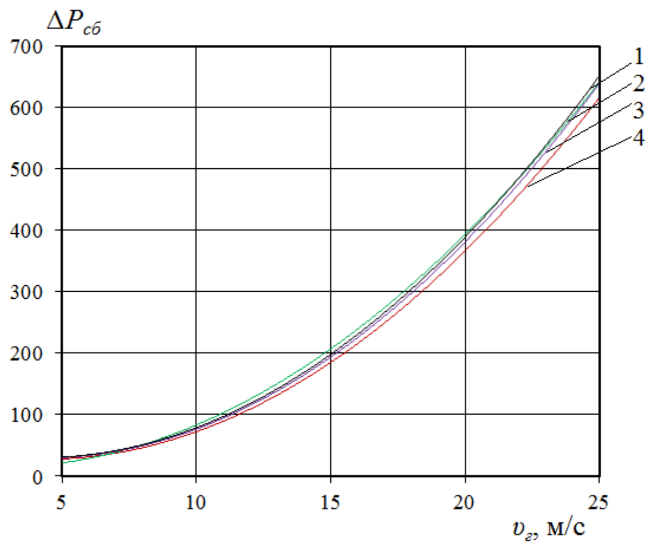

Figure 3. The graph of the change of the lost pressure depends on the gas velocity.

(unwatered)
1-d=0.6mm; 2-d=0.8mm; 3-d=1mm;

The resulting regression equations are as follows
y = 1.407x2 - 11.76x + 53.5 R^2 = 0.9843
y = 1.4264x2 - 11.787x + 54.088 R^2 = 0.9849
y = 1.2384x2 - 6.1803x + 21.296 R^2 = 0.9979
y = 1.3665x2 - 11.608x + 51.668 R^2 = 0.9846
Fixed gas consumption Q=141÷732m³/hour (with the step of 141 m³/hour) was given to the meeting drums with square hole sizes a=0.6, 0.8, and 1mm separately. In each gas consumption, the device connected to the drummer was sprinkled from 4 S32-412 brand nozzles Qs=0.075÷0.3m³/hour (with a step of 0.075 m3/hour). At each step of the water sprinkled on the selected grids, gas velocities and flow rates were determined. The total resistance coefficients in the case of the device being sprinkled with water were determined by the differences in gas consumption.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

The total pressure lost depending on the determined resistance coefficients and gas velocities for each mode was determined. The obtained experimental results were processed based on the computer program and graphs of dependence were built (Figures 3, 4, 5, 6).

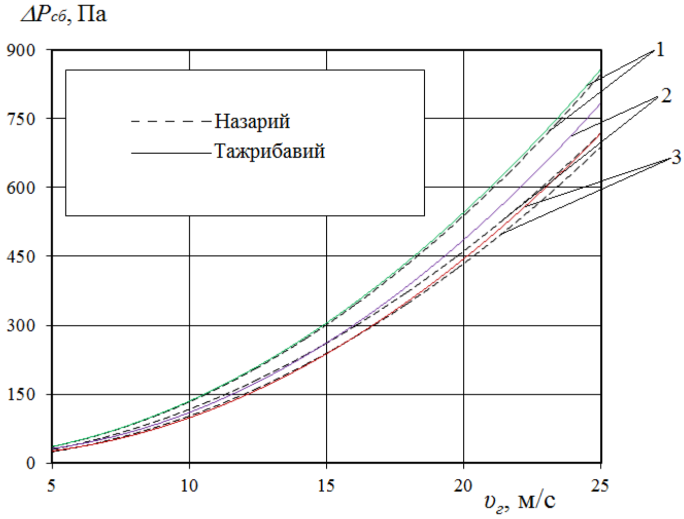

Figure 4. Dependence of the total pressure loss on the gas velocity when the liquid consumption is Qs=0.075 m³/h- const.

The resulting regression equation looks like this

y = 1.3665x2 - 11.608x + 51.668 R^2 = 0.9846

y = 1.4563x2 - 6.0986x + 25.67 R^2 = 0.9988

y = 1.3423x2 - 5.6846x + 21.27 R^2 = 0.9996

y = 1.4147x2 - 1.3914x + 7.586 R^2 = 0.9999

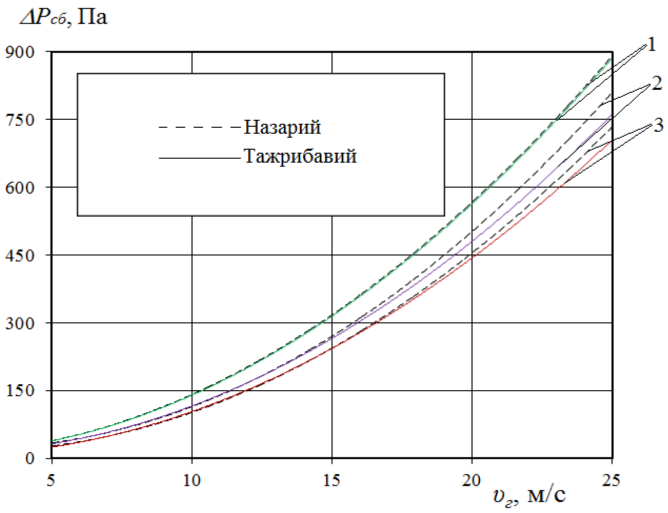

Figure 5. Dependence of the total pressure loss on the gas velocity when the fluid consumption is Qs=0.150 m³/h -const.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

The resulting regression equation looks like this.

y = 1.2384x2 - 6.1803x + 21.296 R^2 = 0,9979

y = 1.3681x2 - 5.7122x + 21.856 R^2 = 0,9996

y = 1.518x2 - 6.758x + 30.23 R^2 = 0.9984

y = 1.4715x2 - 1.5511x + 9.866 R^2 = 0,9997

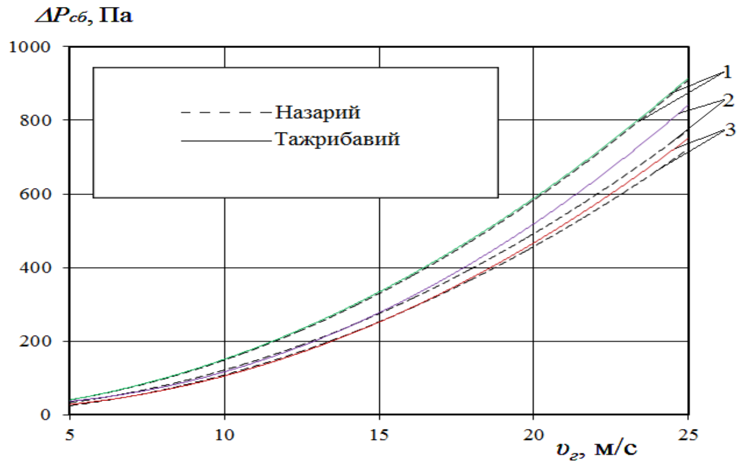

Figure 6. Dependence of the total pressure loss on the gas velocity when the fluid consumption is Qs=0.225 m³/h- const.

The resulting regression equation looks like this.

y = 1.407x2 - 11.76x + 53.5 R^2 = 0.9843

y = 1.3785x2 - 5.2229x + 19.744 R^2 = 0,9997

y = 1.6174x2 - 8.3427x + 38.432 R^2 = 0.998

y = 1.4376x2 + 0.5688x + 1.684 R^2 = 0,9994

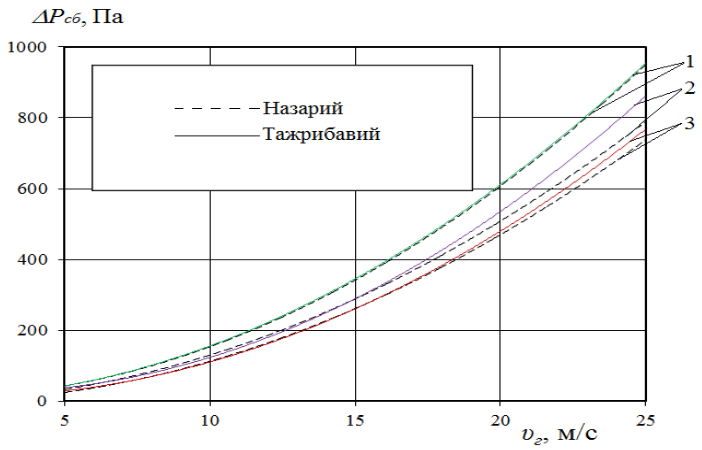

Figure 7. Dependence of the total pressure loss on the gas velocity when the liquid consumption is Qs=0.3 m³/h -const.

The resulting regression equation looks like this.
y = 1.4264x2 - 11.787x + 54.088 R^2 = 0,9849
y = 1.3721x2 - 4.2562x + 15.886 R^2 = 0,9997
y = 1.6017x2 - 6.9114x + 32.53 R^2 = 0.9979
y = 1.5273x2 - 0.3005x + 6.406 R^2 = 0
When the diameter of the 1st mesh is d=0.6 mm; When the diameter of the 2nd mesh is d=0.8 mm; When the diameter of the 3rd mesh is d=0.6 mm;
It can be seen from the graphs presented in the above figures 4, 5, 6, and 7 that the value of the lost pressure increases with the decrease in the size of the mesh holes at constant fluid consumption. The value of the lost total pressure also increased when the liquid consumption was changed in the interval Qs=0.150÷0.3 m3/h (with a step of 0.075 m^3/h). The error between the theoretical and experimental values of the lost total pressure does not exceed Д=5%. The conducted experimental studies fully confirmed the proposed formula 1.

Conclusion

In the article, the results of the experimental study of the wet dust cleaning drum apparatus in the pilot plant, in different gas and liquid flow regimes, were presented. Local and general resistance coefficients and lost total pressures in the working parts of the device were determined. As a result, depending on these pressures, it was possible to determine the optimal values of the dust gas cleaning efficiency and energy consumption of the device.

References

1. Rasuljon, T., Sulaymanov, A., Madaminova, G., & Agzamov, S. U. (2022). Grinding of materials: main characteristics. *International Journal of Advance Scientific Research*, *2*(11), 25-34.
2. Alizafarov, B., Madaminova, G., & Abdulazizov, A. (2022). Based on acceptable parameters of cleaning efficiency of a rotor-filter device equipped with a surface contact element. *Journal of Integrated Education and Research*, *1*(2), 36-48.

ISSN: 2776-0987 Volume 4, Issue 4 April 2023

3. Madaminova, G. I. (2023). Issiqlik almashinishda issiqlik agenti tezligi va mahalliy qarshilik koeffitsientlarini tajribaviy tadqiq etish. *Scientific progress*, *4*(1), 176-184.

4. Ikromaliyevnab, M. G. (2022). New design of wet method wet cleaning blade-drum device. *American Journal Of Applied Science And Technology*, *2*(05), 106-113.

5. Мадаминова, Г. И. (2022). Экспериментальные исследования по определению коэффициентов сопротивления барабанного аппарата мокрой пылеочистки. *Universum: технические науки*, (10-4 (103)), 46-52.

6. Мадаминова, Г. И. (2022). Исследования по определению контактных поверхностей пыли. *Universum: технические науки*, (5-7 (98)), 63-67.

7. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Wet method dust remover black drum device. *Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali*, *1*(5), 57-63.

8. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Hydrodynamics of wet dush powder black drum equipment. *Barqarorlik va yetakchi tadqiqotlar onlayn ilmiy jurnali*, *1*(5), 49-56.

9. Isomidinov, A., Madaminova, G., Qodirov, D., & Ahmadaliyeva, M. (2021). Studying the Effect of Interior Scrubber Hydraulic Resistance on Cleaning Efficiency. *International Journal of Innovative Analyses and Emerging Technology*, *1*(5), 87-93.

10. Isomidinov, A., Madaminova, G., & Zokirova, M. (2021). Analysis of modern industrial dust gas cleaning devices. *Scientific progress*, *2*(8), 137-144.

11. Isomidinov, A., Madaminova, G., & Zokirova, M. (2021). Rationale of appropriate parameters of cleaning efficiency of rotor-filter device equipped with face contact element. *Scientific progress*, *2*(8), 126-136.

12. Домуладжанов, И. Х., & Мадаминова, Г. И. (2021). Вредные вещества после сухой очистки в циклонах и фильтрах. *Universum: технические науки*, (6-1 (87)), 5-10.

13. Мадаминова, Г. И., Тожиев, Р. Ж., & Каримов, И. Т. (2021). Барабанное устройство для мокрой очистки запыленного газа и воздуха. *Universum: технические науки*, (5-4 (86)), 45-49.

INNOVATIVE TECHNOLOGICA
METHODICAL RESEARCH JOURNAL
ISSN: 2776-0987 Volume 4, Issue 4 April 2023

14. Gulmiraxon, M., Ismoiljon, X., Abduraxmon, S., Bekzod, A., & Muhammadbobur, X. (2022). Crushing and appetite of the process efficiency increase. *Conferencea*, 22-27.
15. Gulmiraxon, M., Abduraxmon, S., Ismoiljon, X., Bekzod, A., & Muhammadbobur, X. (2022). Roller grate with increasing coverage ground survey work corner. *Conferencea*, 17-22.
16. Abduraxmon, S., Gulmiraxon, M., Ismoiljon, X., Bekzod, A., & Muhammadbobur, X. (2022). The klinker cement in the production of gas fuel from use sparingly. *Conferencea*, 23-28.
17. Abduraxmon, S., Gulmiraxon, M., Ismoiljon, X., Bekzod, A., & Muhammadbobur, X. (2022). Calculation of the rotation speed of the clinker crushing mill. *Conferencea*, 12-Abduraxmon, S., Gulmiraxon, M., Ismoiljon, X., Bekzod, A., & Muhammadbobur, X. (2022). Ecological drying of fine materials. *Conferencea*, 4-11.