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Research Article

NEW DESIGN OF WET METHOD WET CLEANING BLADE-DRUM DEVICE

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ABSTRACT

The article proposes a new design of the device for wet cleaning of dusty air and gases, high efficiency, energy saving, compact blade-drum. On the basis of theoretical studies, the effect of hydraulic resistance to dusty air supplied to the apparatus was studied and an equation calculating the total pressure lost was obtained. As a result, it is possible to determine the dust air consumption depending on the optimal value of the total pressure.

KEYWORDS

Dusty gas, wet method, liquid, lattice drum, base, water tank, blade.

INTRODUCTION

Around the world, devices of various constructions are used to clean the atmosphere from dust and toxic gases. At the same time, in the chemical, food, construction materials, metallurgical industries, one of the most important tasks today is to capture and return to the production of fine particles emitted by the air and to solve environmental problems by cleaning dusty air. [1,2,3]. Today, research is carried out in priority areas such as purification of atmospheric air, separation of valuable products from waste, retention of harmful substances affecting technological processes and equipment, acceleration of technological processes through the purification of toxic gases and dust from industrial plants.

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Wet purification of dusty air and gases generated during production processes is widely used in various industries. The peculiarity of their use is that the dust particles mixed with gas and air directed to the chambers of the device come into contact with the liquid and the dusty air is cleaned.

These devices have the following advantages: simplicity and relative cheapness of construction, high efficiency compared to inert type dry mechanical dust cleaners, small size compared to fabric and electric filters, can be used for cleaning high temperature, high humidity gases and explosive gases and steam. and has the ability to trap solid particles from gaseous components.

In addition, the use of these devices is currently increasing due to the fact that they have the ability to trap dust with a particle size of less than 1 μm and can also be used in the process of cleaning dusty gases from dry filters [3,4,7].

Due to the small size of these devices, it is possible to install them when there is no space to place electric filters and fabric filters. If the enterprise has special reservoirs for water supply, the efficiency of wet dust treatment will increase even more.

At present, the industry uses wet-type dust collectors of various constructions. Including: felod scrubber, wet gas dust cleaning device, centrifugal inertial dust cleaner, rotor bubble gas cleaner, rotary disk apparatus CHPOSVUCHZ, rotor spray gas cleaner, porous rotary conveyor, 1.2 rotor dust cleaner [4].

If we analyze these devices in terms of design structure and efficiency, the cleaning rate of various industrial dusts is 97-99%. However, the complexity of the structural structure can indicate the high hydrodynamic and aerodynamic resistances in the energy consumed by them and the apparatus as a common shortcoming [4,6].

In order to overcome the above-mentioned shortcomings and increase the contact surface between the dust gases and the liquid supplied to the apparatus, a new design of the drum apparatus for wet cleaning of dust gases has been proposed [4]. One of the main advantages of the newly designed dust collection device is the low energy consumption and hydrodynamic and aerodynamic resistances in this device, as well as the increased contact surface of dusty air and gases with liquid droplets. The hydrodynamic processes of this apparatus are theoretically analyzed, the equations for calculating the local and grid resistance coefficients and the equation for calculating the total lost pressure in the apparatus depending on these resistance coefficients are derived. An equation for calculating the fluid flow rate to the apparatus was also obtained [4].

The structure of the device is as follows. The device consists of a cylindrical body 1, on which the drum 3 is mounted on the base studs through the shaft 2. The body of the device is fixed to the base using the base 5 s. The device is fitted with a pipe 6 to the body 1 to direct the dusty air and a pipe 7 to the exhaust air. The water is transferred to the device from the tank 8 by means of pipe 9 to the nozzles 11 through the water distribution pipe 10. The water supply is adjusted by means of valve 12. A fan 13 serves to introduce dusty air into the appliance. In the body of the device, a valve 14 serves to keep the level of water sprayed and drained to the drum at the same level and to remove the sludge.

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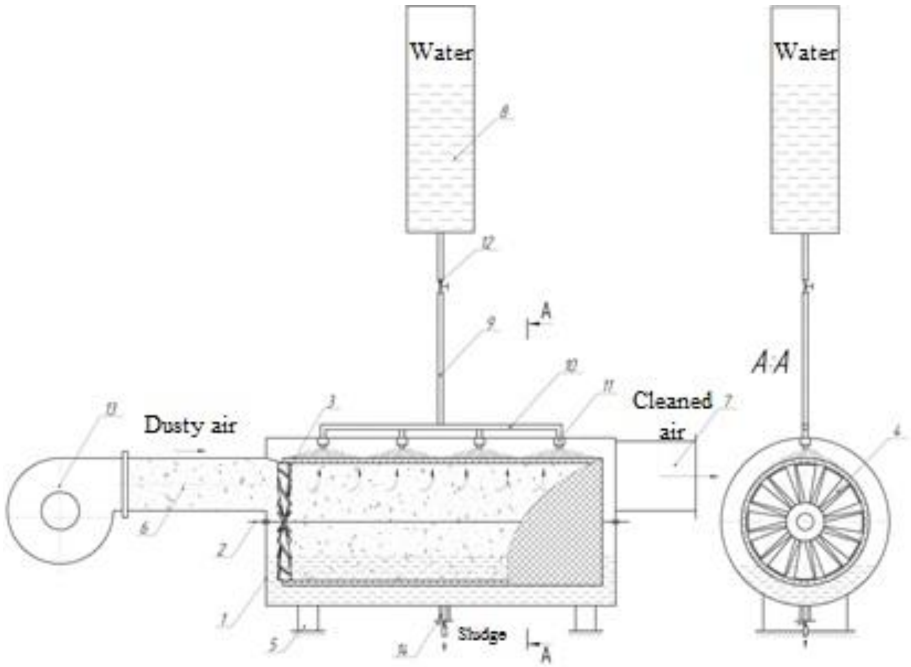

1 device body, 2 shafts, 3 mesh drum, 4 blades, 5 device support, 6 dust air tube,
7 purified air tube, 8 water tank, 9 water tube, 10 distribution tube, 11 nozzles, 12 nozzles, 13 fans, 14 slurry nozzles,
Figure 1. Diagram of a device for wet dusting with a drum

The device works as follows. Dusty air is fed to the device by means of a fan 13 through the guide tube 6 to the inside of the mesh drum 3. The dusty air passes through the metal mesh lining the drum, changing its direction to 900 in the cleaning chamber. The right side of the drum is covered with a metal disc to ensure that the dusty air passes only through the drum mesh. Water is supplied to the grid drum from the water tank 8 through pipes 9 and 10 through nozzles 11 [5]. The water supply is adjusted by means of valve 12. Water from the nozzle 11 is sprayed in the form of fine droplets over the entire surface from the top of the drum 3 and makes contact with the dusty air. As a result, dust in the air is trapped in the liquid and collects in the sedimentation zone at the bottom of the device body 1 and the mesh drum 3. This formed sludge bath also serves to wash the rotating moving drum nets.

A valve 14 serves to remove the resulting sludge from the device. The rotational motion of the lattice drum is due to the rotation of the blades 4 mounted on it according to the speed of the dusty air and gases supplied to the apparatus. The purified air is released into the atmosphere through pipe 7. The efficiency of dust cleaning of the device is determined experimentally by the dimensions of the grid on which the drum 3 is laid and the coefficients of resistance formed depending on these dimensions. The consumption of water coming out of the hole of the nozzle 11s, which sprinkles water on the drum 3, depends on the resistance coefficient of the hole and is determined experimentally. The number of nozzles 11 is selected by the size of the drum 3 and the degree of sprinkling water on the lined grids and the cleaning efficiency. The diameter and length of the drum 3 are

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determined depending on the consumption of dusty air supplied for cleaning and the cleaning efficiency of the selected grid. The number of revolutions of the drum using the dust air flow is determined by the speed of the dust air transmitted through the pipe 6 and the useful surfaces of the blades mounted on it. In determining the number of revolutions, the resistance coefficients of the blades and the resistance coefficients formed according to the height of the water level in the sludge bath are taken into account. The ratios of dusty air and water supplied to the device are determined experimentally by means of cleaning efficiency indicators depending on the resistance coefficients of the cleaning grid. The height of the vessel 8 installed to transfer water to the device is determined by the value of the static pressure of the water, which is sufficient to spray the water in fine particles and create a level of contact with dusty air in the cleaning chamber of the device, depending on the coefficients of resistance.

RESULTS

Theoretical research was conducted to calculate the improved drum device. The calculation scheme of the device is shown in Figure 2, the total lost pressure in the device on section I – I can be written as, Pa;

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

where P_1 is the pressure lost due to internal friction in the transmission of dusty air through the pipe to the device, determined by the Darcy-Weisbach formula, Pa [1,2,4];

$$P_1 = \lambda_1 \cdot \frac{l}{d} \cdot \rho_{см} \cdot \frac{\omega_{см}^{\ 2}}{2} , \qquad (2)$$

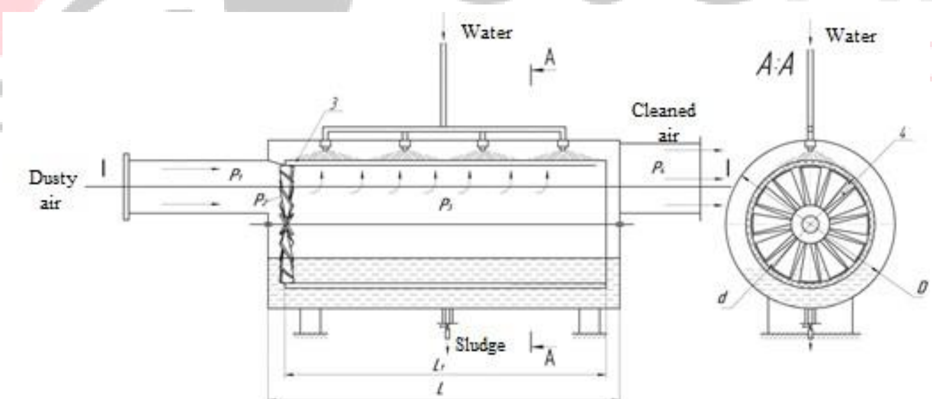

Figure 2. The calculation scheme of the device

Where λ_1- is the coefficient of Darsy or the coefficient of friction with the pipe wall that transmits the dusty gas to the device, l -is the length of the pipe through which the dusty gas moves, *m*; *d*-pipe diameter, *m*; $\rho_{см}$ -dust air mixture density, kg / m^3; $\omega_{см}$ - is the velocity of the dusty air mixture moving in the pipe, m / s. The density of the mixture is determined as follows [2,4].

$$\rho_{см} = \rho_г + (\rho_ч \cdot \gamma) \qquad (3)$$

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Where ρ_g is the air density, kg / m³; $\rho_п$ -powder density, kg / m³; γ-is the percentage of dust in the air, %.

In the process of determining the course coefficient, its law of change is determined by empirical equations, depending on many scientists. The coefficient of friction in smooth pipes can be used from the formulas Blazius, PK Konakov and L. Prandtl. Blazius formula [2,4]:

$$\lambda = \frac{1}{\sqrt[4]{100\mathrm{Re}}} = \frac{0{,}3164}{\mathrm{Re}^{0{,}25}} \quad (4)$$

This equation can be used when the Reynolds number is Re <10. For larger ranges of Reynolds numbers (quantities of Re up to 3 ÷ 10) can be used PK Konakov's equation [2,4]:

$$\lambda = \frac{1}{(1{,}81_g\,\mathrm{Re} - 1{,}5)^2} \quad (5)$$

L. Prandtl proposed the following equation [2,4]:

$$\frac{1}{\sqrt{\lambda}} = 2\lg\left(\mathrm{Re}\sqrt{\lambda} - 0{,}8\right) \quad (6)$$

The given equations are derived for smooth pipes and cannot be used for rough pipes. Based on the experiments of Colbruck and other scientists, he proposed an equation common to all zones of turbulent flow to calculate technical pipes [2,4]:

$$\frac{1}{\sqrt{\lambda}} = -2\lg\left(\frac{2{,}5}{\mathrm{Re}}\frac{1}{\sqrt{\lambda}} + \frac{\varepsilon}{3{,}7}\right) \quad (7)$$

If we simplify this equation for the quadratic resistance area or rigid turbulence area of corrugated pipes, the Prandtl equation for corrugated pipes looks like this [2,4]:

$$\lambda = \frac{0{,}25}{\left(\lg\frac{\varepsilon}{3{,}7}\right)^2} \quad (8)$$

One of the most common equations for the quadratic resistance field is the Nikuradze equation [2,4]:

$$\lambda = \frac{1}{\left(1{,}74 + 2\lg\frac{1}{\varepsilon}\right)^2} \quad (9)$$

Covering all areas of turbulent flow and more convenient than equation (8) in the computational work, A.D. Altshul λ proposed the following equation based on experiments for a wide area [2,4]:

$$\lambda = 0{,}11\left(\varepsilon + \frac{68}{\mathrm{Re}}\right)^{0{,}25} \quad (10)$$

For smooth pipes with Re< $\frac{10}{\varepsilon}$ follows [2,4]:

$$\lambda = 0{,}11\left(\frac{68}{\mathrm{Re}}\right)^{0{,}25} = \frac{0{,}3164}{R\varepsilon^{0{,}25}} \quad (11)$$

P_2 is the lost pressure in the passage of dusty air through the drum blades, which is determined as follows.

$$P_2 = \xi_л \frac{\rho_{см} \cdot \omega^2{}_{см}}{2} \quad (12)$$

where is the coefficient of resistance of $\xi_л$-blades, the calculation is of a complex nature and, as it requires different deviations, can only be found experimentally. In this case, the following equation was obtained and the correction factor was introduced to determine the resistance coefficient by the ratio of the total surface area of the contact element blades to the current-

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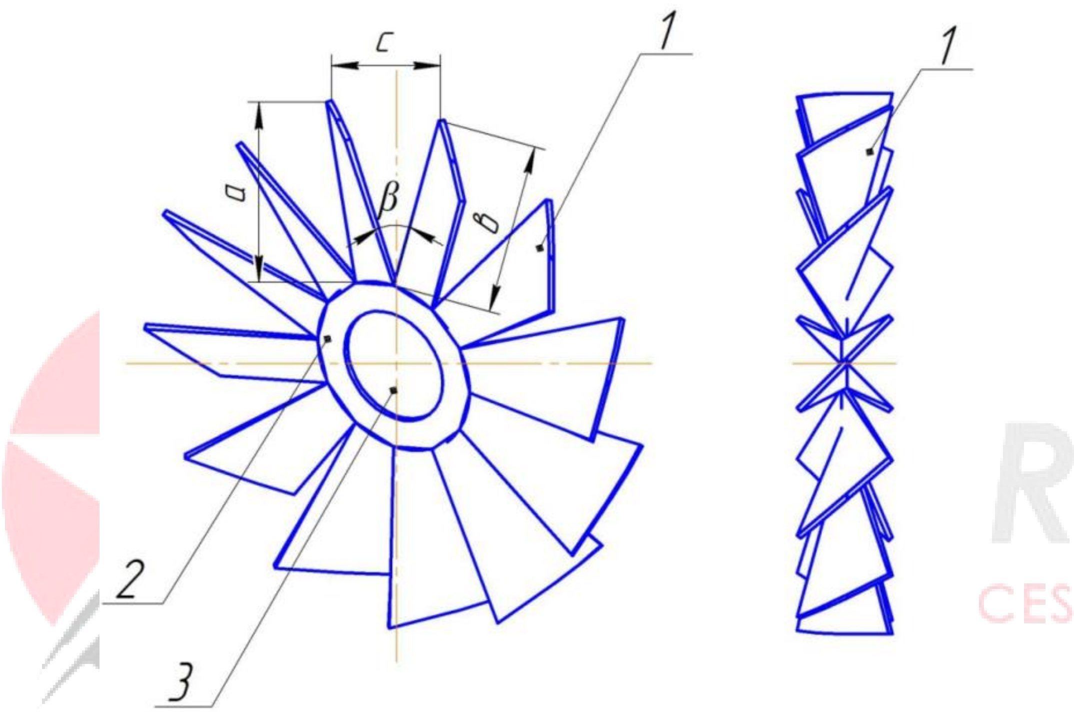
carrying surface. The contact element is shown in Figure 3 [8]

$$\xi_л = \Delta k \frac{4\pi R^2 \cdot}{n \cdot a \cdot b \sin \beta} \qquad (13)$$

where Δk is the correction coefficient, determined experimentally, n is the number of blades; a, b is the length of the side of the blade; β - is the angle of inclination of the surface through which the gas flow passes.



1 - blades; 2 - ring; 3 - shaft mounting hole.

Figure 3. General view of the contact element.

P_3 is the pressure lost in the passage of dusty air through the holes in the drum mesh, determined as follows, Pa;

$$P_3 = \xi_c \frac{\rho_{см} \cdot \omega^2_{см}}{2}, \qquad (14)$$

where $\omega_{см}$ – is the velocity of the dusty air mixture on the surface of the drum grid, m / s; ξ_c – is the coefficient of resistance of the drum grid, which is determined as follows [4].

$$\xi_c = \Delta\Pi \frac{\sum S_c \cdot \delta}{\sum S_c \cdot a}, \qquad (15)$$

where $\Delta\Pi$ is the correction factor, determined by experiments, ΣS_c is the total surface area of dusty air passing through the grid, m2; δ-grid cable thickness, m; a is the square hole size of the grid, m. The optimal values of the dimensions of the mesh holes for the drum are determined by experiments.

The pressure P_4 lost due to internal friction in the pipe discharging the purified air from the device is also determined by the Darcy-Weisbach formula, Pa.

$$P_4 = \lambda_2 \cdot \frac{l}{d} \cdot \rho \cdot \frac{\omega^2}{2} \qquad (16)$$

where λ – is the coefficient of friction in the purified air outlet pipe ;, l is the length of the purified air moving pipe, m; d-pipe diameter, m; ρ-density of purified air, kg / m³; ω- the velocity of the purified air moving in the pipe, m / s.

Now if we put equations (2), (12), (13), (14), (15), (16) into the 1st equation, the equation for calculating the total lost pressure in the device looks like this.

$$P_{об} = \lambda_1 \cdot \frac{l}{d} \cdot \rho_{см} \cdot \frac{\omega_{см}^{\ \ 2}}{2} + \Delta k \frac{4\pi R^2}{n \cdot a \cdot b \cdot \sin\beta} \cdot \frac{\rho_{см} \cdot \omega_{см}^2}{2} + \Delta П \frac{\Sigma S_c \cdot \delta}{\Sigma S_c \cdot a} \cdot \frac{\rho_{см} \cdot \omega_{см}^2}{2} + \lambda_2 \cdot \frac{l}{d} \cdot \rho \cdot \frac{\omega^2}{2} \qquad (17)$$

CONCLUSION

A new design of a drum device equipped with a wet-powered dust cleaner blade has been developed. As a result of theoretical research, the equation for calculating the total pressure loss of dusty air supplied to the device was obtained. As a result, it was possible to calculate the total lost pressure in the device. Depending on the optimal value of this total lost pressure, it is possible to determine the dusty air flow and overall dimensions supplied to the apparatus.

REFERENCES

1. Плотников К.Б. (2014). Исследование эффективности пылеуловивания и массоотдачи роторном аппарате с внутренный циркуляцией жидкости. Дисс. … канд.техн. наук. Кемерово, 150 с.
2. Исомидинов А.С. (2020). Создание эффективные методы и устройства для очистка газов от пыли химической промышленности. Дисс. …канд.техн. наук. Ташкент, 136 с.
3. Isomidinov A.S., Tojiev R.J., Karimov I.T. (2018). Rotor device for wet dust cleaning. *Scientific and technical journal of Fergana Polytechnic Institute*. 1, 195-198.
4. 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.
5. Karimov I.T., Alimatov B.A. (2019). Analysis of experimental research in determining the flow rate of heavy liquids. *Scientific and technical journal of Fergana Polytechnic Institute*, Fergana. №4. 103–110.
6. 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.
7. Домуладжанов, И. Х., & Мадаминова, Г. И. (2021). Вредные вещества после сухой очистки в циклонах и фильтрах. *Universum: технические науки*, (6-1 (87)), 5-10.
8. Эргащев Н.А. (2021). Научно-технические основы использования в промышленности аппарата для

мокрого пылеулавливания и газоочистки. Дисс. …канд.техн. наук. Ташкент, 116 с.

9. Исомидинов, А. С. (2019). Исследование гидравлического сопротивления роторно-фильтрующего аппарата. *Universum: технические науки*, (10-1 (67)), 54-58.
10. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Wet method dust remover black drum device. *Барқарорлик ва Етакчи Тадқиқотлар онлайн илмий журнали*, 1(5), 57-63.
11. Karimov, I., Tojiyev, R., Madaminova, G., Ibroximov, Q., & Xamdamov, O. T. (2021). Hydrodynamics of wet dush powder black drum equipment. *Барқарорлик ва Етакчи Тадқиқотлар онлайн илмий журнали*, 1(5), 49-56.
12. 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.
13. Isomidinov, A., Madaminova, G., & Zokirova, M. (2021). Analysis of modern industrial dust gas cleaning devices. *Scientific progress*, 2(8), 137-144.
14. 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.