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LIQUID GASES TRANSMISSION MEDIUM TOZALOVCHI INERTIAL HYDRODYNAMIC SCRUBBER

Ergashev Nasimbek Akhmadjonovich
Researcher Fergana Polytechnic Institute
n.ergashev@ferpi.uz

Isomidinov Azizjon Salomidinovich
Technical Sciences, PhD Fergana Polytechnic Institute
The Republic of Uzbekistan
asisomidinov@ferpi.uz

Siddikov Rasuljon Uktamovich
Tashkent state named after Islam Karimov Technical University Kokan Branch
Head of the Department of Technical Sciences Doctor of Philosophy (PhD)

Ummatov Rustambek Bektoshevich
Tashkent State named after Islam Karimov
Senior Teacher of Kokan Branch of Technical University

Madaliyev Akhrorbek Niizonidin ogli
Tashkent State Named after Islam Karimov
Technical University, Kokan Branch, Assistant Student

A B S T R A C T	*K E Y W O R D S*
The article presents the theoretical research work carried out on determining the hydraulic resistance and resistance coefficient in the working bodies of the scrubber that washes the industrial secondary waste gases. The equation for determining the total hydraulic resistance of the scrubber is formulated, and the equations for determining the hydraulic resistance and resistance coefficient of each working body are proposed.	hydraulic resistance, pipe, guide pipe, conical plug, grid nozzle, resistance coefficient, exhaust gas, gas flow power.

There are dry and wet methods of cleaning secondary gases in the industry, and these types of devices have low hydraulic resistance and high efficiency. However, the level of cleaning in the dry method is much lower than the level of manual cleaning. Therefore, the trend of using the wet method in the cleaning of industrial dust and secondary gases is increasing in the world today. This method is effective in trapping particles with a high dispersion composition (particle size smaller than 5 μm) in a liquid medium. For example: it makes up 95-96% of fuel smoke produced in boiler rooms of thermal power plants, secondary toxic gases released during the reaction in the chemical industry, and paraffin smoke released during the refining process at the oil plant [1, 2, 3, 4] .

Constructions of wet dust and gas cleaning installations are different, and the most common among these installations are scrubbers. The main advantage of scrubbers compared to other wet-type installations is that the waste water is less likely to clog the installation pipes and the sludge produced during cleaning is less likely to stick to the walls of the installation. In addition, it is highly effective in cleaning aggressive gases with high temperature and flow rate [1,5,8,9,10].

This method also has its own disadvantages, for example, it requires more energy for cleaning than the dry method, and it has to process dust and gases absorbed into the liquid medium. In addition, the efficiency of the scrubbers used in the industry does not always meet the requirements of the current environmental standards in terms of the PDK level of harmful substances released into the atmosphere. This is mainly due to the external influences imposed on the structure and the high level of addition of dust and secondary gases to the gas stream.

Therefore, to increase the collision probability of dust and secondary gases with liquid droplets, it is necessary to create new effective methods, improve the design of the device, or apply external energy [6,7].

Based on the above, some constructions and their working parameters of the structures that are currently used and have been proven promising in scientific and research work were systematically analyzed. [3, 4, etc.]. The results of the systematic analysis were processed in the MatLAB program and the advantages and disadvantages of the devices were determined. Using the obtained results, an improved structural scheme of the cleaning scrubber was developed by the method of passing gases through a liquid medium [5]. Figure 1 shows the scheme of the scrubber.

1 - body ; 2 - fan ; 3 - electric motor ; 4 - guide pipe ; 5 – rotating nozzle ; 6 – gas pipe ; 7 - liquid pipe ; 8 - connector ; 9 - sludge pipe .

1.14-rasm. Inertial Scrubberning Schematics

The scrubber is composed of a cylindrical vertical body equipped with a rotating shaft and a secondary gas transmission pipe and a fan, a liquid spraying nozzle, a liquid collecting bath and a slurry pipe , and a pipe for releasing the purified gas to the atmosphere. . A rotary nozzle (four nozzles at 90 degree intervals are installed on the rotary nozzle, and it is connected to the guide pipe with a seal and a sealing ring. The nozzle holes are arranged parallel to the liquid) and is immersed in a bath where the working liquid is collected. When the gas to be cleaned passes into the nozzle, the nozzles rotate in the liquid medium due to the difference in gas pressure in the guide pipe and the nozzle. The gas to be cleaned is ejected through the nozzle holes and interacts with the working fluid. During its movement in the liquid medium, the gas is purified. Purified gas is released into the atmosphere through a pipe .

The main advantage of the device compared to existing scrubbers is, firstly, the amount of working fluid used due to the fact that its nozzles rotate in the liquid medium. increases , secondly, the rotary motion of the valve ensures the curved motion of the gas flow in the liquid medium. This, in turn, increases the mass transfer coefficient .

But the operational parameters of inertial devices, including hydraulic resistance , methods of calculating resistance coefficient of working bodies and cleaning efficiency have not been studied.

Therefore, this work is inertial directed to the basis of scrubber calculation methods .

Research of loads affecting the gas velocity in the working bodies of the installation in secondary exhaust gas neutralization installations and the correct construction of the calculation equations is of great importance. This condition is the main factor that determines the optimal parameters of the hydraulic resistance of the structure , the coefficient of resistance in the working bodies and the work performance . An increase in hydraulic resistance in the working bodies of the device has a good effect on the cleaning efficiency , but it causes a decrease in work efficiency. This, in turn, increases energy consumption for cleaning . The investigated scrubber consists of a pipe (8) directing secondary gases and a pipe (2) that circulates the gas flow in the liquid medium under the influence of flow energy. The gas flow experiences hydraulic resistance during its movement in the pipe, when it passes through the guide hole of the pipe, and during its movement in the liquid medium.

The general hydraulic resistance affecting the gas being purified in the installation can be written as follows using the calculation equations given in the literature and the section A - A of the calculation scheme of the installation . Fig. 2 shows the calculation scheme of the scrubber.

The equation determining the total hydraulic resistance of the structure can be formulated as follows , Pa;

$$\Delta P_{ум} = P_{йк} + P_{mc} + P_{c} \text{, Pa} \tag{1}$$

in which P_{yk} - is the pressure lost during the movement of secondary gases in the pipeline, which is determined using the Darcy-Weisbach equation [1, 6]. Then the equation can be written as follows, Pa;

$$P_{йк} = \xi_{йк} \frac{\rho_{ap} \cdot \upsilon^2{}_{йк}}{2} \tag{2}$$

where υ_{yk} is the speed of the secondary gas in the guide pipe, m/s; ξ_{yk} is the local resistance coefficient of the guide pipe , it is determined according to the following equation;

$$\xi_{йк} = \lambda \frac{l}{d_э} \tag{3}$$

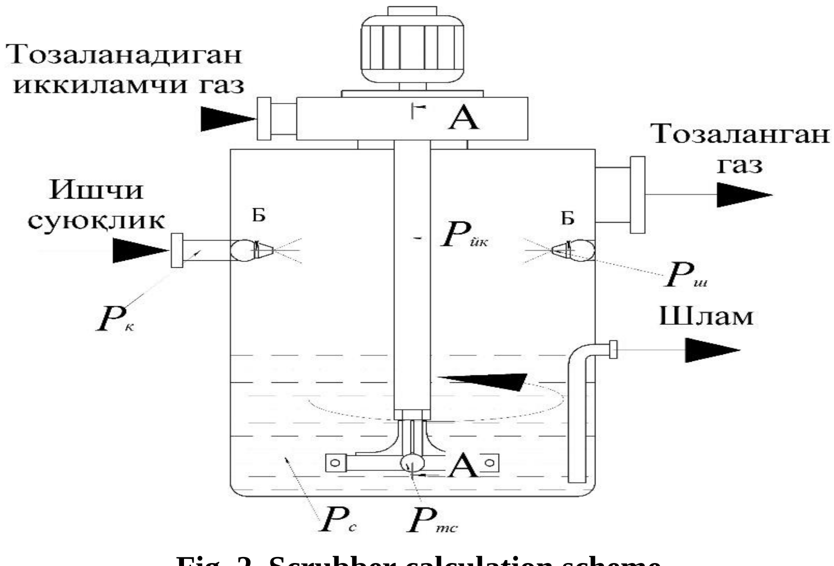

Fig. 2. Scrubber calculation scheme

where *l* is the length of the line, m; d_e - the equivalent diameter of the pipe , m; l -Darcy's coefficient is determined to be dependent on many factors when expressing the law of change with empirical equations . Based on the structure of the experiment, the Darcy coefficient in the equation was determined according to the Blasius law [6]. Then the equation (3) becomes the following form;

$$\xi_{йк} = \frac{0,3164l}{d_э \sqrt[4]{\mathrm{Re}}} \qquad (4)$$

If you put the equation (2.4) into the equation (2.2), then the equation (2.2) will look like this, Pa;

$$P_{йк} = \frac{0,3164l\rho_{ap}\upsilon^2{}_{йк}}{2d_э \sqrt[4]{\mathrm{Re}}} \qquad (5)$$

P_{ts} is the lost pressure when passing through the diverting hole of the gas flow distributor, it is determined by the following equation, Pa;

$$P_{mc} = \xi_{mc} \frac{\rho_{ap} \cdot \upsilon^2{}_{mc}}{2} \qquad (6)$$

where υ_{ts} is the speed of the gas flow coming out of the valve hole, m/s; ξ_{ts} is the resistance coefficient of the pipe hole, and we determine it using the experimental method conducted by B.A. Alimatov and I.T. Karimov on the change of the pipe hole resistance coefficient depending on the ratio of the thickness of the pipe hole to the hole diameter [7]. In that case, the calculation equation can be written as follows;

$$\xi_{mc} = \frac{\delta}{d_m} \qquad (7)$$

where *d* is the thickness of the symnik hole, mm; d_t - the diameter of the hole of the symnik, mm
If you put equation (7) in equation (6), then equation (6) will look like this, Pa;

$$P_{mc} = \frac{\delta \cdot \rho_{ap} \cdot \upsilon^2{}_{mc}}{2d_m} \qquad (8)$$

P_{ts} is the lost pressure of the gas stream when it passes through the liquid medium, it is determined by the following equation, Pa;

$$P_c = \xi_c \frac{\rho_{ap} \cdot \upsilon^2{}_c}{2} \qquad (9)$$

where y_s is the lost speed of the gas stream passing through the liquid medium, m/s; x_s is the coefficient of resistance of the working fluid to the gas flow, which can only be determined experimentally.
$r\ ar_{is}$ the density of the secondary gas and air mixture, which is determined by the following equation. kg/m ^{3};

$$\rho_{ap} = \rho_x + (\rho_г \cdot \gamma), \qquad (10)$$

here ρ_d _ - secondary gas density, kg/m ^{3}; ρ_x - air density, kg/m ^{3}; γ is the amount of secondary gas in the air , %.
(5) into equation (8) and (9) into equation (1), it will look like this, Pa;

$$\Delta P_{ум} = \rho_{ap}\left(\frac{0{,}3164 l\upsilon^2{}_{йк}}{2d_э \sqrt[4]{\mathrm{Re}}} + \frac{\delta\upsilon^2{}_{mc}}{2d_m} + \frac{\xi_c \upsilon^2{}_c}{2}\right) \qquad (11)$$

resulting equation (11) .

(9) the resistance coefficient in equation ξ_s identification is complicated and requires various exceptions. Therefore, we introduce the equation for determining the resistance coefficient by the ratio of the number of revolutions in the open circuit and in the liquid under the influence of the gas flow force of the cylinder .

$$\xi_c = k\frac{n_{хб}}{n_{сб}}, \qquad (12)$$

in which n_{xb} - the number of revolutions of the syomnik under the influence of natural air pressure , marta/minute; n_{sb} - the number of revolutions of the syomnik under the influence of water pressure , marta/minute; k is the correction coefficient, which is determined by experiment.

From this equation, it can be seen that an increase in water pressure or viscosity causes an increase in the drag coefficient.

, by changing the equation (11), it will be possible to determine the total hydraulic resistance of the structure as follows , Pa;

$$\Delta P_{ум} = \rho_{ap}\left(\frac{0{,}3164 l\upsilon^2{}_{йк}}{2d_э \sqrt[4]{\mathrm{Re}}} + \frac{\delta\upsilon^2{}_{mc}}{2d_m} + k\frac{n_{хб}\upsilon^2{}_c}{2n_{сб}}\right) \qquad (13)$$

Through the equation (13), we will be able to determine the total hydraulic resistance of the scrubber.

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