IJIAET International Journal of Innovative Analyses and Emerging Technology
| e-ISSN: 2792-4025 | http://openaccessjournals.eu | Volume: 1 Issue: 5

Study of Hydraulic Resistance and Cleaning Efficiency of Gas Cleaning Scrubber

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ANNOTATION

The article presents the research work carried out on the determination of the hydraulic resistance and cleaning efficiency of the industrial secondary exhaust gas scrubber. The equation for determining the hydraulic resistance and resistance coefficients in the working bodies of the device is recommended.

Keywords: hydraulic resistance, puller, guide pipe, conical plug, grid nozzle, resistance coefficient, exhaust gas, gas flow strength.

Introduction:

Globally, technological processes and devices for the prevention of pollution of the atmosphere with secondary emissions have been introduced. At the same time, it is important to solve environmental problems and regulate their recycling through the treatment of secondary emissions generated in the food, chemical and other industries [1,2,3].

Today, a lot of research is being done in the world in priority areas such as chemical, building materials production and intensive treatment of secondary emissions in other industries [1,2,3 and others]. In recent years, our country has also conducted research aimed at creating processes and devices in this area [1,4,5,6,7, etc.]. However, as a result of growing human demand for natural and man-made products, industrial enterprises are introducing a new range of products, as well as accelerating the level of environmental pollution. Therefore, on additional measures to improve the system of public administration in the field of ecology and environmental protection,

Research methods:

Based on the above, a modern design scheme of an intensive cleaning scrubber and a laboratory device for the distribution of industrial secondary gases in the working fluid on the basis of rotational motion was developed [7] (Figure 1).

The secondary exhaust gas to be cleaned in the device passes through the gas pipe 6 to the guide pipe 8, increasing the gas velocity. In the middle of the pipe 8 there is a conical device 9, which increases the gas velocity to the maximum value, which in turn connects the pipe 8 and the puller 2, which transmits gas in the liquid. The number of gas transmission pipes of Puller 2 is 4 and their intermediate degrees are located at 900. Common openings are drilled in the pipelines, through which the purified gas passes into the liquid medium and is in the process of mass transfer in the liquid. During the transition of the purified gas to the liquid medium, it moves the syringe in a circular motion within the liquid and ensures that the gas moves on the entire inner surface of the liquid. A grid nozzle 4 is mounted on the upper part of the apparatus body to improve the mass transfer process and to keep the purified gas in the liquid medium for a longer period of time. The purified gas is released into the atmosphere through a tube 3 mounted on the upper part of the apparatus body. The sludge pipe 10 and the liquid pipe 5 serve to constantly change the sludge water inside the apparatus. The device uses an adjusting device 7 to ensure the continuous movement of the syringe and the transmission pipe in the liquid.

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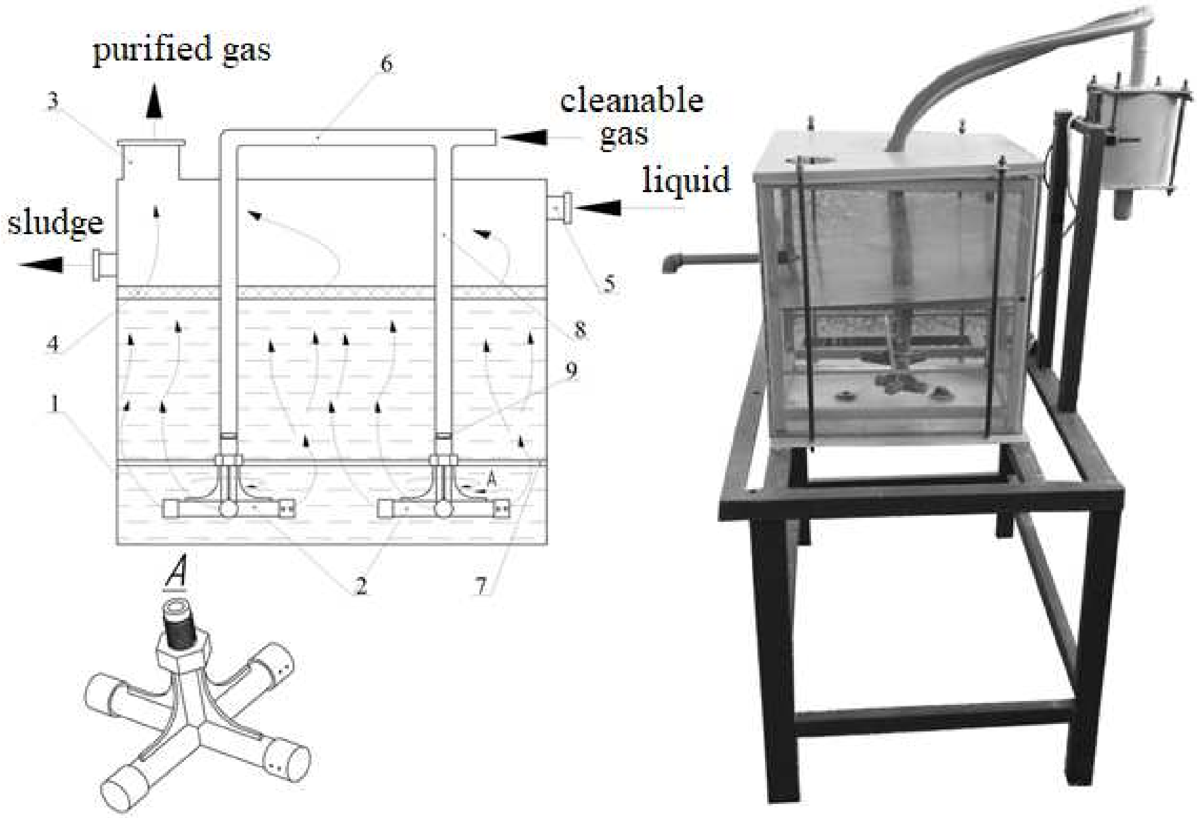

1-scrubber body; 2-secondary gas distribution puller; 3-purified gas outlet pipe;

4-lattice attachment; 5-fluid transmission pipe; 6-clean gas pipeline; 7-trestle;

8-reference pipe; 9-gas conical plug; 10-liquid sludge.

Figure 1. Scheme of a scrubber that cleans gases by circulating them in a liquid.

Research has been conducted to evaluate the effect of device hydraulic resistance on cleaning efficiency.

In devices for neutralizing secondary exhaust gases, it is important to study the loads that affect the gas velocity in the working bodies of the device and to correctly calculate the equations. This condition is the main factor determining the hydraulic resistance of the device, the coefficient of resistance in the working bodies and the optimal parameters of work efficiency.While an increase in hydraulic resistance in the working bodies of the device has a positive effect on cleaning efficiency, it leads to a decrease in work efficiency. This es in turn increases the energy consumption used for cleaning. Taking into account the above and using the design scheme of the device, we consider the optimal method for determining the hydraulic resistance and cleaning efficiency.

Research results:

The scrubber under study consists of a secondary gas guide tube (8) and a distributor syringe (2) that circulates the gas flow in the liquid medium under the influence of flow energy. In this case, the equation determining the total hydraulic resistance of the device can be constructed as follows, Pa;

$$\Delta P_{\text{um}} = P_{\text{yk}} + P_{\text{ts}} + P_s \qquad (1)$$

where P_{yk}– the pressure lost during the movement of the secondary gas in the directing pipe, which is determined using the Darcy-Weisbach equation [1,3,8,9]. Then the equation can be written as, Pa;

$$P_{\text{yk}} = \xi_{\text{yk}} \frac{\rho_{\text{ar}} \cdot \upsilon^{2}{}_{\text{yk}}}{2} \qquad (2)$$

where υ_{yk}– the velocity of the secondary gas in the pipeline, m / s; ξ_{yk}– the local resistance coefficient of the guide tube, which is determined by the following equation;

ISSN 2792-4025 (online), Published under Volume: 1 Issue: 5 in October-2021

IJIAET International Journal of Innovative Analyses and Emerging Technology
| e-ISSN: 2792-4025 | http://openaccessjournals.eu | Volume: 1 Issue: 5

$$\xi_{\text{yk}} = \lambda \frac{l}{d_e} \qquad (3)$$

where l is the length of the pipe, m; d_e is the equivalent diameter of the pipe, m; λ – Darcy coefficient is found to depend on many factors in the expression of its law of change by empirical equations. Based on the structure of the experimental device, the determination of the Darcy coefficient in the equation by Blazius's law was introduced [5,10,11]. In this case, equation (3) looks like this;

$$\xi_{\text{yk}} = \frac{0{,}3164 l}{d_e \sqrt[4]{\text{Re}}} \qquad (4)$$

If you put Equation (4) into Equation (4), then Equation (2) looks like this, Pa.

$$P_{\text{yk}} = \frac{0{,}3164 l \rho_{\text{ar}} \upsilon^{2}{}_{\text{yk}}}{2 d_e \sqrt[4]{\text{Re}}} \qquad (5)$$

P_{ts}– the pressure lost when the gas flows through the guide hole of the distributor, which is determined by the following equation, Pa;

$$P_{\text{ts}} = \xi_{\text{ts}} \frac{\rho_{\text{ar}} \cdot \upsilon^{2}{}_{\text{ts}}}{2} \qquad (6)$$

where υ_{ts} is the velocity of the gas flow through the puller hole, m / s; ξ_{ts}– the coefficient of resistance of the borehole, which is determined using the experimental method of B.A. Alimatov and I.T. Karimov on the change of the coefficient of resistance of the borehole depending on the ratio of the thickness of the borehole to the diameter of the borehole. [12,13]. In this case, the calculation equation can be written as follows;

$$\xi_{\text{ts}} = \frac{\delta}{d_t} \qquad (7)$$

where δ– the thickness of the puller hole, mm; diameter of d_t – puller hole, mm

If you put equation (7) into equation (6), then equation (6) looks like this, Pa.

$$P_{\text{ts}} = \frac{\delta \cdot \rho_{\text{at}} \cdot \upsilon^{2}{}_{\text{ts}}}{2 d_T} \qquad (8)$$

P_{ts}– is the pressure lost by the gas flow through the liquid medium, which is determined by the following equation, Pa;

$$P_s = \xi_s \frac{\rho_{\text{ar}} \cdot \upsilon^{2}{}_{s}}{2} \qquad (9)$$

where υ_s– thelost velocity of the gas flow through the liquid medium, m / s; ξ_s– the coefficient of resistance of the working fluid to the gas flow, which can only be determined experimentally.

ρ_{ar} – the density of a mixture of secondary gas and air, which is determined by the following equation. kg / m^3;

$$\rho_{\text{ar}} = \rho_x + (\rho_g \cdot \gamma) \qquad (10)$$

where ρ_g– the density of the secondary gas, kg / m3; ρ_x– airdensity, kg / m^3; ρ– amount of secondary gas in the air,%.

If we put Equations (8) and (9) into Equation (1), we get the following, Pa

$$\Delta P_{\text{um}} = \rho_{\text{ar}} \left(\frac{0{,}3164 l \upsilon^{2}{}_{\text{yk}}}{2 d_e \sqrt[4]{\text{Re}}} + \frac{\delta \upsilon^{2}{}_{\text{ts}}}{2 d_T} + \frac{\xi_s \upsilon^{2}{}_{s}}{2} \right) \qquad (10)$$

Using the resulting equation (10), we are able to determine the total hydraulic resistance in the device.

Determining the resistance coefficient ξ_s in equation (9) is complex and requires different deviations. Therefore, we introduce the equation for determining the coefficient of resistance by the ratio of the number of revolutions in the open cycle and in the liquid under the influence of the gas flow force of the syringe.

$$\xi_s = \frac{n_{\text{xb}}}{n_{\text{sb}}} \qquad (11)$$

where n_{xb}– the number of revolutions of the puller under the influence of natural air pressure, times / minute; n_{sb}– the number of revolutions of the syringe under the influence of water pressure, times / minute;

It can be seen from this equation that an increase in water pressure or viscosity leads to an increase in the coefficient of resistance.

ISSN 2792-4025 (online), Published under Volume: 1 Issue: 5 in October-2021

Based on the above factors, by modifying Equation (10), it will be possible to determine the total hydraulic resistance of the device as follows, Pa.

$$\Delta P_{\text{um}} = \rho_{\text{ar}}\left(\frac{0{,}3164 l v^{2}{}_{\text{yk}}}{2d_e\sqrt[4]{\text{Re}}} + \frac{\delta v^{2}{}_{\text{ts}}}{2d_T} + \frac{n_{\text{xb}} v^{2}{}_{s}}{2n_{\text{sb}}}\right) \qquad (12)$$

The cleaning efficiency of secondary exhaust gas washing devices is determined by the energy expended to carry out the process. It is known from K.T. Semrau's research work that the cleaning efficiency depends on the hydraulic resistance of the device and not on the size and design of the device. In this case, the total energy consumption should be spent on the purification of dusty gases using liquids [1,14,15].

The energy consumption in the proposed device also includes the energy expended due to friction in the secondary exhaust gas inlet and outlet part of the device, injectors, liquid gas washing, pump and fans.

Since it is a complex process to calculate the exact amount of energy expended on the friction of a liquid and gas stream in a device as it passes through the device, we introduce the calculation of total energy consumption using the following equation using K.T. Semrau's research work. This method of calculation gives an ± 10% error when applied to gas treatment plants with different design and working principle. The total energy consumption of the device is determined by the following equation, kJ /1000m^3;

$$K_s = \Delta P_{\text{um}} + \Delta P_{\text{kb}}\frac{V_{\text{suy}}}{V_{\text{gas}}} + \frac{N_s}{V_{\text{gas}}} \qquad (13)$$

where ΔP_s is the hydraulic resistance of the device, Pa; ΔP_{kb} is the pressure depending on the viscosity of the liquid, Pa; V_{suy} - volume consumption of liquid, m3; Volume consumption of gas, m^3; N_s - power consumption for liquid and gas transmission, W;

The relationship between gas cleaning efficiency and energy consumption is expressed as follows,%;

$$\eta_{PFA} = 1\text{-}lv^{BK^{\text{xpfa}}} \qquad (14)$$

where V and x– invariant numbers, which are determined experimentally by the dispersed composition of the powder.

To determine the exact value of the cleaning efficiency, η_s is expressed as the number of substances transferred. The number of substance transfers is determined by the following equation;

$$N_M = \ln\left(\frac{1}{1-\eta_s}\right) \qquad (15)$$

When the numerical value obtained in the equation is in the range of 0.5 ÷ 10, the determined value is compared according to Table 1 and the cleaning efficiency of the device is determined.

1-table

Cleaning efficiency depending on the number of substance transfers

Number of item transfers N_m	Cleaning efficiency η_s	Number of item transfers N_m	Cleaning efficiency η_s
0.5	39.35	4.0	98.17
1.0	63.21	6.0	99,752
2.0	86.47	10.0	99,9953

Conclusion:

According to the theoretical research, the hydraulic resistances acting on the working bodies of the dusty gas device, the coefficients of friction and local resistance in the working bodies, as well as the analytical connections that allow to conduct the cleaning efficiency were considered. On the basis of theoretical studies, an equation was determined to determine the coefficient of resistance of the device in the circuit.

It was determined that the minimum value of liquid consumption for cleaning 1m^3 of dusty gas during the cleaning of dust gases should not be less than 0.1 liters and the maximum value should not exceed 0.2 liters.

References:

1. Исомидинов А.С. Разработка эффективных методов и устройств очистки пылевых газов химической промышленности: Дисс. … PhD. – Ташкент, 2020. – 118 с.

ISSN 2792-4025 (online), Published under Volume: 1 Issue: 5 in October-2021

2. Тожиев Р.Ж., Каримов И.Т., Исомидинов А.С. Чанглигазларнихўлусулдатозаловчиқурилманисаноатдақўллашнингилмий-техник асослари: Монография.ФарПИ "Илмий-техника" журналинашриётбўлими-Фарғона 2020. – 91 б
3. Исомидинов А. С. Исследование гидравлического сопротивления роторно-фильтрующего аппарата //Universum: технические науки. – 2019. – №. 10-1 (67).
4. Isomiddinov A. et al. Application of rotor-filter dusty gas cleaner in industry and identifying its efficiency //Austrian Journal of Technical and Natural Sciences. – 2019. – №. 9-10.
5. Эргашев Н. А. Исследование гидравлического сопротивления пылеулавливающего устройства мокрым способом //Universum: технические науки. – 2020. – №. 4-2 (73). – С. 59-62.
6. Мадаминова Г. И., Тожиев Р. Ж., Каримов И. Т. Барабанное устройство для мокрой очистки запыленного газа и воздуха //Universum: технические науки. – 2021. – №. 5-4 (86). – С. 45-49.
7. Rasuljon, T., Azizbek, I., &Abdurakhmon, S. (2021). Research of the hydraulic resistance of the inertial scrubber.Universum: техническиенауки, (7-3 (88)), 44-51.
8. Isomidinov A.S., Karimov I.T., Tojiev R.J. Searching the losing of hydraulic pressure in rotor-filter gas cleaner apparatus // Scientific-technical journal. – 2021. – Т. 3.– № 1. – С. 69–72.
9. Латипов К.Ш. Гидравлика, гидромашиналарвагидроюритмалар. – Тошкент: Ўқитувчи, 1992. –405 б.
10. Исомиддинов А. С., Давронбеков А. А. Исследование гидродинамических режимов сферической углубленной трубы //Universum: технические науки. – 2021. – №. 7-1 (88). – С. 53-58.
11. Isomidinov A. S., Madaliev A. N. Hydrodynamics and aerodynamics of rotor filter cleaner for cleaning dusty gases //LI International correspondence scientific and practical conference" international scientific review of the problems and prospects of modern science and education". – 2018. – С. 29-32.
12. АлиматовБ.А.,Соколов В.Н.,Салимов З.С .,Хурсанов Б.Ж. Исследование распределения капель по размерам в многоступенчатом барботажном экстракторе // Научн.-техн. Журн. ФерПИ. Фергана, 2001.№4. С.70-73.//Сб. науч.тр. Межд. Акад. Экологии. С.-Петербург, 2002. Вып.6.С.47-52.
13. Ахроров А. А. У., Исомиддинов А. С., Тожиев Р. Ж. Гидродинамика поверхностно-контактного элемента ротор-фильтрующего пылеуловителя //Universum: технические науки. – 2020. – №. 8-3 (77).
14. Вальдберг А.Ю., Николайкина Н.Е. Процессы и аппараты защиты окружающей среды. – М. : Дрофа, 2008. –239 с.
15. Isomiddinov A. et al. Application of rotor-filter dusty gas cleaner in industry and identifying its efficiency //Austrian Journal of Technical and Natural Sciences. – 2019. – №. 9-10.
16. Ўзбекистон Республикаси Президентининг 2017 йил 7 февралдаги ПФ№4947-сон «Ўзбекистон Республикасини янада ривожлантириш бўйича Ҳаракатлар стратегияси тўғрисида» ги Фармони.

ISSN 2792-4025 (online), Published under Volume: 1 Issue: 5 in October-2021