INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 8 | Aug 2023

Results of Cleaning Oil Smoke Gases from Atmospheric Air

Hurmamatov A. M., Boyto'rayev S. B.

Uzbekistan Science Academy, Institute of General and Inorganic Chemistry, Tashkent city, Namangan institute of engineering technology, Namangan

---***---

Annotation: The article considers the parameters that change as a result of the volume consumption of the proposed new device. As a result of changing the volume flow, the volume of the absorbent, the volume of absorbed gas, and the change in the mass of inert gas in the purified gas were analyzed. In this case, the effects of mutual forces between the phases in the absorption device were analyzed. An absorption process was used to effectively purify oils.

Keywords: Metal, oil dust, absorption, gas, concentration, absorber, driving force, material balance.

Introduction

In addition to causing environmental problems, industrial development also affects human health. Volatile organic compounds (VOCs) have been shown to have several adverse effects on human health. Gaseous wastes are recognized as an important group of pollutants [1,2]. Reduction of volatile organic compounds through air cleaning systems has long been studied as an effective way to control industrial emissions, control exposure to workplaces, and improve indoor air quality in industrial off-site environments [3-4] .

Almost all technological processes in industry use heat treatment, which is known to cause physicochemical changes in solids. Currently, much attention is being paid to the role of heat treatment [5].

The analysis of modern scientific and technical achievements aimed at the destruction of the heaviest wastes shows that despite the variety of technologies, methods and tools for neutralization of solid and liquid oily wastes, they can all be divided into two main groups [6].

- methods and means of neutralization and disposal without prior separation of valuable hydrocarbon components from oily waste;
- methods and tools used as secondary raw materials for obtaining oil and oil product residues from oily waste. In addition, cleaning with environmentally inert substances used for various purposes or for safe disposal.

Sensitive and selective detection of volatile organic compound vapor mixtures is very important because their high volatility, non-specific interaction with sensing surfaces and potential interference of the same chemical groups negatively affect the detection process [7-8].

Activation of technological processes in ferrous and non-ferrous metallurgy, chemistry, mechanical engineering and other industries, in practice, serves to increase the volume of product production, improve quality and reduce costs [9]. Compressed gases, especially air, oil products are mainly used in these processes [10, 11, 12]. Cleaning of oily gases released into the atmosphere as a result of oiling the metal surface by absorption method is considered effective. Separation mass transfer processes are widely used in industry and are mainly carried out in column-type apparatus. The absorption process is widely used to separate gas mixtures [13,14].

Experience

Mode indicators in production conditions were used to clean the air from oily smoke gases. Experiments were conducted in different conditions to determine the mode-constructive parameters. In the experiments, an absorber with a cylindrical furnace equipped with a skin was used.

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

In the experiments, the following mode indicators were obtained: volume consumption of gas, V= 30 m3/h; initial concentration of oil gas, yb= 0.06 kg/m3; concentration of oily particles in purified gas, no = 0.002 kg/m3; amount of mechanical additives in pure absorbent, xb= 0.01%; initial temperature, t=25□C; initial pressure of the device, P=1 atm.

The material balance of the mass of hydrocarbons passing from the gas mixture to the absorber is determined using the following formula:

$$M = G(\bar{Y}_b - \bar{Y}_{ox}) = L(\bar{x}_{ox} - \bar{x}_b), \qquad (1)$$

here; L,G - costs of clean absorber and inert part of gas, kg/s; ox, b are the initial and final concentrations of smoke gases in the absorbing oil, kgBu/kgM, in which the amount of substances is determined in the process of mass exchange. Based on the above formula, the necessary parameters were determined. The amount of oil in the initial gas:

$$\bar{Y_b} = \frac{y_b}{\rho_{oy} - y_b}. \qquad (2)$$

Amount of oil droplets in purified gas:

$$\overline{Y_{ox}} = \frac{y_{ox}}{\rho_{oy} - y_{ox}}. \qquad (3)$$

Particle concentration in absorbent oil:

$$\overline{X_b} = \frac{x_b}{100 - x_b}, \qquad (4)$$

where, - the mass of the initial and final concentrations of oil droplets in flue gas, kg/kg, - the density of air under normal conditions. [1].

$\bar{X}_{ox}$ – is the final concentration, that is, the material balance equation:

$$M = L_{min}(\bar{X}^*_{\bar{Y}_b} - \bar{x}_b) = 1{,}5\ L_{min}(\bar{x}_{ox} - \bar{x}_b) \qquad (5)$$

Out of this:

$$\bar{X}_{ox} = \frac{\bar{X}^*_{\bar{Y}_b} + 0{,}5\bar{X}_b}{1{,}5} \qquad (6)$$

here, $\bar{X}^*_{\bar{Y}_b}$ – sı concentration of oil in the liquid phase

Consumption of the non-absorbed inert part of flue gas:

$$G = V_0 \ (1 - y_{haj})(\rho - y_b), \qquad (7)$$

here, y_{haj} - volume fraction of oil in flue gas.

Absorbent productivity according to the absorbent:

$$M = G(\bar{Y_b} - \overline{Y_{ok}}) \qquad (8)$$

Absorptive consumption per unit of time:

$$L = \frac{M}{\overline{X_b} - \overline{X_{ok}}} \qquad (9)$$

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY
https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071
Volume: 5 Issue: 8 | Aug 2023

Comparative consumption of absorbent and absorbent:

$$l = \frac{L}{G} \tag{10}$$

Based on the theoretical basis, the material balance of the absorption process was determined and the obtained values are presented in Table 1.

Table 1. Calculation results of the absorption process

V (m^3/soat)	$\overline{Y_b}$ (kg/kg)	$\bar{Y}_{ox}$ (kg/kg)	$\overline{X_b}$ (kg/kg)	M (kg/s)	L (kg/s)	l (kg/kg)	G (kg/s)
30	0.0487	0.00155	$1*10^{-6}$	$4.78*10^{-4}$	0.0292	2.90	0.01
50	0.0487	0.00155	$1*10^{-6}$	$7.9*10^{-4}$	0.0486	2.90	0.0167
70	0.0487	0.00155	$1*10^{-6}$	$1*10^{-3}$	0.068	2.90	0.0234
90	0.0487	0.00155	$1*10^{-6}$	$1.42*10^{-3}$	0.0875	2.90	0.03
110	0.0487	0.00155	$1*10^{-6}$	$1.74*10^{-3}$	0.107	2.90	0.0368
130	0.0487	0.00155	$1*10^{-6}$	$2*10^{-3}$	0.1264	2.90	0.0435
150	0.0487	0.00155	$1*10^{-6}$	$2.37*10^{-3}$	0.146	2.90	0.05

In the given table, when the volumetric consumption of oily smoke gas supplied to the absorber is changed to 30, 50, 70, 90, 110, 130 and 150 m¬3/hour, the gas efficiency of the absorbent changes accordingly: $4.78*10^{-4}$, $7.9*10^{-4}$, $1*10^{-3}$, $1.42*10^{-3}$, $1.74*10^{-3}$, $2*10^{-3}$ va $2.37*10^{-3}$ kg/s. At the same time, the relationship between the phases also changes. In this case, the ratio between absorbed gas and absorbing substance increases with the change of volume consumption of gas. The initial gas concentration in the system and the volume of the inert part of the purified gas do not change when the absorption process is carried out under standard pressure with a change in volume consumption.

An experiment was conducted to determine the consumption of the inert part of the gas in the absorption process. During the experiment, when the volume consumption of oil gas supplied to the absorber is changed to 30, 50, 70, 90, 110, 130 and 150 m¬3/h, the volume of the absorbed gas inert part changes to 0.01, 0.0167, 0.0234, 0.03, 0.0368, 0.0435, 0.05 kg/s. change was detected. As a result of the change in volume consumption, the ratio of phase consumption also changes. When the volume consumption is changed to 30, 50, 70, 90, 110, 130 and 150 m¬3/h, the relative consumption of phases is determined to change by 0.01, 0.0167, 0.0234, 0.03, 0.0368, 0.0435, 0.05 kg/kg.

The change in absorption efficiency with the increase in volume consumption of flue gas is shown in Fig. 1.

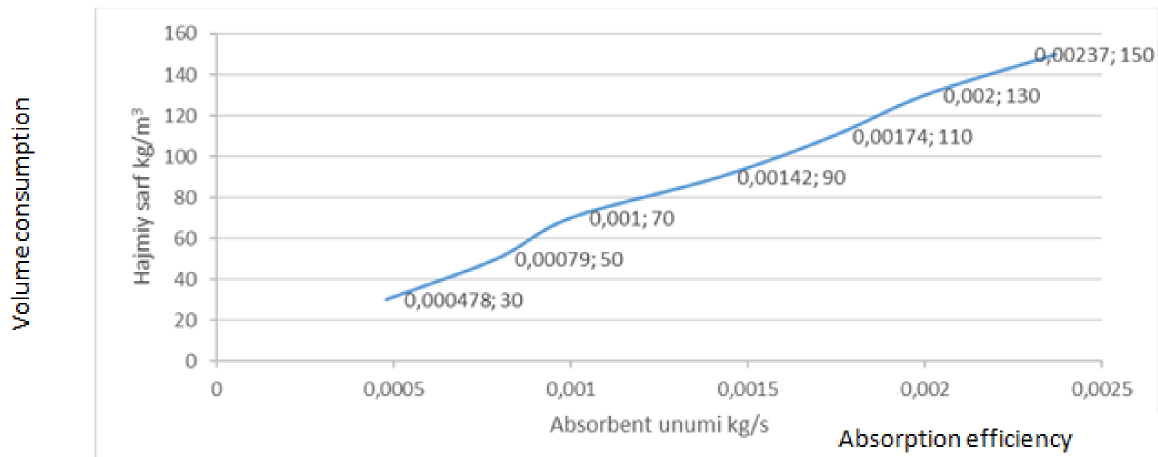

Figure 1. The effect of the increase in volume consumption of flue gas on absorption efficiency

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit ht Absorption efficiency censes/by/4.0/

Figure 1 shows the change in absorption efficiency by changing the volume consumption of gas supplied to the absorbent. The obtained results were used to calculate the geometric dimensions of the device. It was found that when the volumetric consumption of the absorber increases from 30 m3/h to 150 m3/h, the absorbent increases from 0.000478 kg/s to 0.00237 kg/s, respectively.

As a result of changing the volumetric consumption of flue gas, the mass consumption of absorbed gas was determined. The obtained results are presented in Figure 2.

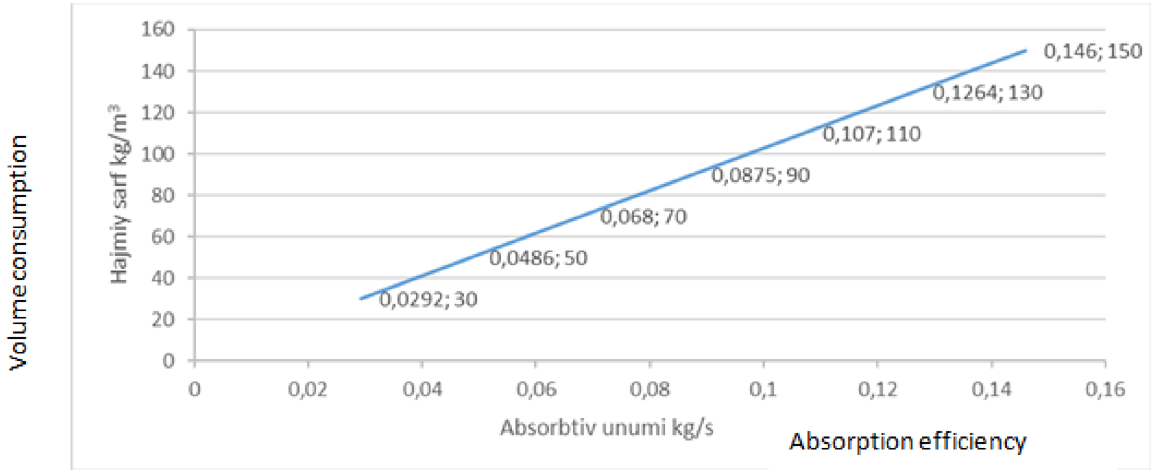

Figure 2. Performance of absorbent over time

As can be seen from Fig. 2, it is possible to observe the change of the absorptive consumption with the change in the volume consumption of the flue gas. In this case, when the amount of volumetric consumption was increased from 30 m3/h to 150 m3/h, the consumption of absorbent increased from 0.0292 kg/s to 0.146 kg/s. From this it can be concluded that the absorption efficiency changes in connection with the change in absorbent consumption.

The inert part of the absorbed gas is determined in connection with the volume consumption of the gas. The composition of unabsorbed gas consists mainly of inert non-absorbable particles. The values obtained as a result of the determination of non-absorbable gases are given in Figure 3.

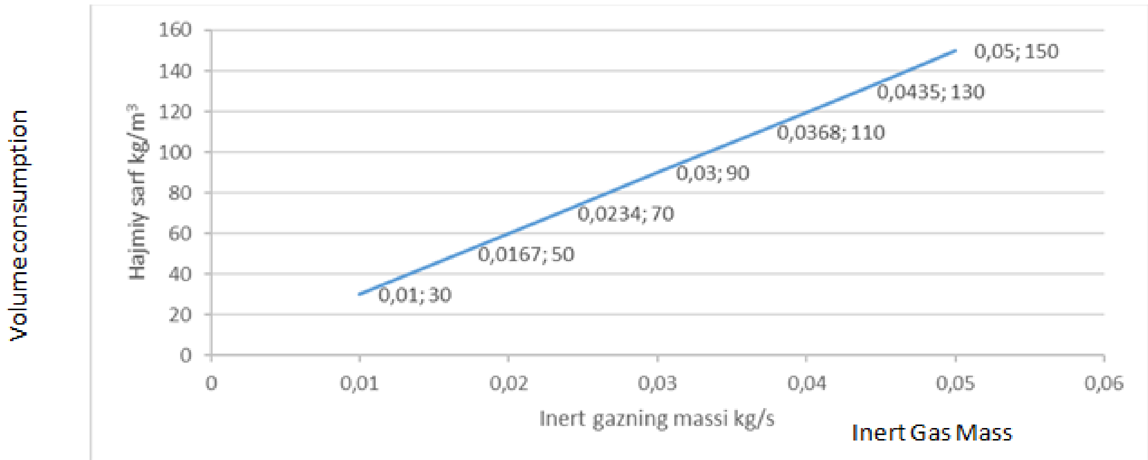

Figure 3. Change in mass of inert gas as a result of volume consumption

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGY

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 8 | Aug 2023

As can be seen from Figure 3, the amount of inert gas increases with the increase in volumetric consumption. It was found that the amount of inert gas increased from 0.01 kg/s to 0.05 kg/s when the volumetric consumption increased from 30 m3/h to 150 m3/h. The flow of inert gas depends on the type and properties of the absorbent, the parameters of the absorption process, and the effect of the surface layer of the liquid.

The interaction process between the phases in the tubular absorber depends on various factors. In the proposed experimental device, liquid and gas interact in a direct direction. To calculate this process, an ideal compression model was chosen and the calculations were carried out on this basis.

During the experiments, the force driving the absorption process was calculated. The ideal compressive strength in the absorbent was determined by the following formula:

$$\overline{Y_{o'r}} = \frac{\triangle\overline{Y_{kat}} - \triangle\overline{Y_{kıch}}}{2.3\lg\left(\frac{\triangle\overline{Y_{kat}}}{\triangle\overline{Y_{kıch}}}\right)}, \qquad (11)$$

here, $\triangle \overline{Y_{kat}}$ - a large driving force at the entrance to the absorber kg/kg,

$\triangle \overline{Y_{kıch}}$- small driving force at the exit of the absorbent kg/kg.

The following formula was used to find the unknown values. The driving force at the entrance to the absorber:

$$\triangle \overline{Y_{kat}} = \overline{Y_b} - \overline{Y^*_{X_{ox}}} \qquad (12)$$

her, $\overline{Y^*_{X_{ox}}}$ - concentration of oil in the gas leaving the system at equilibrium.

$$\triangle \overline{Y_{kıch}} = \overline{Y_{ox}} - \overline{Y^*_{X_b}} \qquad (13)$$

$\overline{Y^*_{X_b}}$- concentration of oil in the gas entering the equilibrium system.

In the process of absorption, the concentrations of substances change in a state of equilibrium. By changing the concentration of the gas sent to the absorber, the change in the concentration of substances in the equilibrium state was studied (Table 2).

Table 2. A change in the concentration of substances in an equilibrium state with a change in the concentration of flue gas

$\bar{Y}_b$ (kg/m^3)	$Y_{o'r}$ kg/kg)	$\triangle \overline{Y_{kat}}$ (kg/kg)	$\triangle \overline{Y_{kıch}}$ (kg/kg)
0.02	0.0029	0.0057	0.0055
0.03	0.008	0.0138	-
0.04	0.0149	0.022	0.0055
0.05	0.0225	0.03	0.0055
0.06	0.03	0.0388	0.0055

As can be seen from Table 2, the average value of the driving force changed from 0.0029 to 0.03 when the concentration of oil in the smoke gas entering the absorber was changed from 0.02 kg/m3 to 0.06 kg/m3.

Discussion and analysis

Calculations carried out on the basis of the experiments show that the yield of the absorbent during the absorption process and the concentration of the absorbent are related to the volume consumption of the gas supplied to the

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

absorber. When constant pressure and absorbent concentration is 0.06 kg/m3. It was taken as the optimal volume consumption for the absorption process, because at 30 m3/h, the gas absorber yield is equal to 0.01 kg/s. This value was found to be the maximum value of the absorber yield.

Since the absorption process is driven by an ideal compressive force, the values of internal friction and internal resistance forces are calculated. These forces depend on the concentration of inert gas in the absorbed gas. The smaller the absorbent concentration, the smaller the force that moves the substance. When the concentration of the absorbent is equal to 0.06 kg/m3, it was determined that the force moving the substance is 0.03 kg/kg. This value is considered optimal for these parameters.

Conclusion

The results of the experiment on cleaning the air from oil smoke gases show that when the volume consumption of oil smoke gas is changed in the range of 30÷150 m¬3/h, the yield of the absorbent changed in the range of 4.78*10-4÷2.37*10-3 kg/s. It was found that when the volumetric consumption of the absorber increases from 30 m3/h to 150 m3/h, the absorbent increases from 0.000478 kg/s to 0.00237 kg/s, respectively. It was determined that with the volume consumption of flue gas increasing from 30 m3/h to 150 m3/h, the amount of inert gas increased from 0.01 kg/s to 0.05 kg/s. When the concentration of oil in the flue gas was changed from 0.02 kg/m3 to 0.06 kg/m3, the average value of the driving force was found to change from 0.0029 to 0.03. From this it can be concluded that the absorption efficiency changes in connection with the change in absorbent consumption

REFERANCES

1. C. Shrubsole, S. Dimitroulopoulou, K. Foxall, B. Gadeberg, A. Doutsi, IAQ guidelines for selected volatile organic compounds (VOCs) in the UK, Build. Environ. 165 (2019) 106382, https://doi.org/10.1016/j.buildenv.2019.106382.
2. S. Wang, H.M. Ang, M.O. Tade, Volatile organic compounds in indoor environment and photocatalytic oxidation: state of the art, Environ. Int. 33 (2007) 694–705, https://doi.org/10.1016/j.envint.2007.02.011.
3. N. Blommaerts, F. Dingenen, V. Middelkoop, J. Savelkouls, M. Goemans, T. Tytgat, S.W. Verbruggen, S. Lenaerts, Ultrafast screening of commercial sorbent materials for VOC adsorption using real-time FTIR spectroscopy, Separ. Purif. Technol. 207 (2018) 284–290, https://doi.org/10.1016/j.seppur.2018.06.062.
4. C. Mandin, M. Trantallidi, A. Cattaneo, N. Canha, V.G. Mihucz, T. Szigeti, R. Mabilia, E. Perreca, A. Spinazz`e, S. Fossati, Y. De Kluizenaar, E. Cornelissen, I. Sakellaris, D. Saraga, O. Hanninen, ¨E. De Oliveira Fernandes, G. Ventura, P. Wolkoff, P. Carrer, J. Bartzis, Assessment of indoor air quality in office buildings across Europe – the OFFICAIR study, Sci. Total Environ. 579 (2017) 169–178, https://doi.org/10.1016/j.scitotenv.2016.10.238.
5. 5. Khairov G.B. Modern environmental problems in the oil industry of Kazakhstan // Oil and gas. - 2001. - No. 3. - S. 93-98.
6. Chervyakova O.V. Mechanochemical synthesis of magnetic adsorbents based on quartz-containing mixtures: Cand. …cand. chem. Sciences: 01.04.17. - Almaty, 2003..
7. B. Pejcic, P. Eadington, A. Ross, Environmental monitoring of hydrocarbons: a chemical sensor perspective, Environ. Sci. Technol. 41 (2007) 6333–6342.
8. R. Angelucci, A. Poggi, L. Dori, G.C. Cardinali, A. Parisini, A. Tagliani, M. Mari asaldi, F. Cavani, Permeated porous silicon for hydrocarbon sensor fabrication, Sens. Actuators A 74 (1999) 95–99.

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

https://journals.researchparks.org/index.php/IJOT e-ISSN: 2615-8140 | p-ISSN: 2615-7071

Volume: 5 Issue: 8 | Aug 2023

9. Okonsky, I.S. Processes and apparatuses of oxygen and cryogenic production / I.S. Okonsky. - M., Mashinostroenie, 1985. - 256 p.
10. Kalinin, N.V. Air supply systems for industrial enterprises / N.V. Kalinin, I.A. Kabanova, V.A. Galkovsky, V.M. Kostyuchenko. - Smolensk, Smolensk branch of MPEI (TU): 2005. - 122 p.Старк, С.Б. Воздуходувные машины и вакуумные установки в черной металлургии / С.Б. Старк, Л.Н. Белянчиков. – М., Металлургия: 1971. – 264 с.
11. A.N. Planovsky, P.I. Nikolaev. Processes and devices of chemical and petrochemical technology. – M.: Chemistry Publishing House, 2007, 493 p.
12. M.A. Adlivankina, M.N. Greyhounds. Calculation of absorption plants. Uch. settlement, GOUVPO "MGUS". - M, 2006, 65 p.
13. Hurmamatov A. M., & Boyto’rayev S. B. (2023). Analysis of Oily Dusts Emitted During Metal Surface Treatment in Laboratory Conditions. International Journal on Orange Technologies, 5(7), 10-15. Retrieved from https://journals.researchparks.org/index.php/IJOT/article/view/4589

Copyright (c) 2023 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/