OIL REFINERY CATALYST

IMPROVING THE PROCESS OF CLEANING THE AIR FROM DUSTS

Davron Hamidov[1], Fazilat Akhmedova[2], Zafar Uralov[3]

[1]Associate Professor at the Karshi State Technical University

[2]Lecturer at the Karshi State Technical University

[3]Master's student at the Karshi State Technical University

Abstract. The aim of the project is to develop an effective technology for the capture of catalyst dust used in the reforming process at oil refineries. It involves studying the physicochemical properties of catalyst dust emitted into the atmosphere, studying the hydrodynamics of catalyst dust deposition processes in a centrifugal force field, and developing effective devices.

Keywords: *Oil, catalyst dust , centrifugal force, dust settling, finely dispersed solid dust.*

Introduction. In industry, cleaning large amounts of air emissions from various impurities is a difficult hydromechanical process, the difficulty lies in the fact that the dust emitted into the atmosphere is very small. In manufacturing enterprises, single-stage dust removal devices are mainly used. Dust from technological processes is fed to dust removal devices through a fan, and the cleaned dust is discharged into the atmosphere. In industry, cyclone devices with low efficiency are used as dust removal devices. The efficiency of these cyclone devices used as dust removal devices in manufacturing enterprises ranges from 54.5 to 86.6%. The results of studies on dust removal indicate that the cleaning efficiency of devices for particles of 5 μm is 7.9–38.0%, in some cases not more than 12.5%, and for particles of 5–10 μm, the efficiency is 10.1–45%. As can be seen from these results, a large part of the dust released into the atmosphere without being captured is very dangerous for the human body. It can

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also be noted that large-diameter cyclone devices are not suitable for cleaning fine dispersed dust [1; pp. 32–34]. Sedimentation in a centrifugal force field. This method of separating inhomogeneous dust and gas systems is much more effective than gravitational sedimentation, therefore it is used to separate smaller (up to 5 μm) dust particles [2; pp. 309–310].

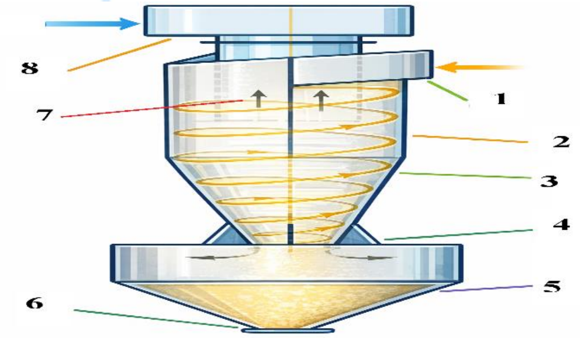

Figure 1. 1 - air inlet pipe; 2 - cylinder part; 3 - cone part; 4 - retained dust outlet pipe; 5 - hopper; 6 - solid particles outlet pipe; 7 - purified air outlet pipe; 8 - snail

Cyclones have been used in industry since the 1980s. Currently, they are one of the most widely used devices for dust removal equipment due to their simplicity of design, small size, and reliability [3; p. 34]. The principle of operation of a cyclone is based on the separation of dust particles from a gas flow under the influence of centrifugal forces arising from the rotation of the flow in the device [4; p. 168].

The most common cyclones in technology are cyclones that change the main direction of the gas flow, which are called reverse flow. In these cyclones, air enters the cyclone through a tangential pipe 1 and has a circular motion, being blown against the inner walls of the cylinder 2 and the cone 3

moves downwards in a spiral along [5; p. 21]. In the central zone, the circulating air flow, cleaned of dust, moves from bottom to top and is discharged from the cyclone through the coaxially located cleaned air outlet pipe 7 and the snail 8. A small part of this flow, in which the main mass of the discharged dust is collected, enters the bunker 5 through the retained dust outlet pipe 4, where the particles settle. Part of the flow, freed from the particles accumulated in it, exits the bunker through the central zone of the dust outlet 4. Having caught. The remaining powder is removed from the hopper 5 through the discharge pipe and discharge device 6 [6; p. 27]. Due to the intensive circulation of gas in the cyclone shell, static pressure shifts from its edge to the center. This situation is also observed in the dust hopper. It follows that the hermeticity of the hopper should be ensured not only in the cyclone suction devices, but also in the fans . Failure to comply with this condition leads to a sharp decrease in dust separation in the cyclone and even its complete failure [7; 25-27 -p.]. The turbulent flow formed in the cyclone is also formed in the bunker located in the section. At the same time, in the center of the turbulent flow, the spiral movement of the gas is directed upwards. Disturbance of the rotational movement of the gas in the bunker inevitably leads to a significant decrease in the degree of purification. Therefore, the degree of purification in a group of cyclones with a common shell is slightly lower than in a single apparatus [8; p. 251].

Experimental results and their discussion. The main factors polluting atmospheric air are: sulfur oxides, nitrogen, carbon, hydrogen sulfide, hydrocarbons, tetraethyl lead and mechanical impurities. They have a harmful effect on the human body and the environment. The main factors polluting air are stationary (petrochemical plants, oil refineries and power plants) and mobile (internal combustion engine vehicles). The share of stationary factors in atmospheric air pollution is 60%. The evaporation of hydrocarbons is a major stationary factor in air pollution. Almost all oil refining enterprises have a significant impact on the atmosphere. This is the evaporation of oil and oil products in open-surface treatment facilities. The release of hydrocarbons from the flanges of devices, pumps and especially compressors also has a negative impact on the atmosphere. Technological condensates from AT and AVT devices, cooling waters from vapor mixing condensers, and wastewater from barometric condensers have a significant impact on atmospheric hydrogen sulfide pollution [9; 270-273-b,11; 196-201-b]. For the model device, a conical cyclone device was taken as a model for cleaning the air from fine dispersed dust. The dimensions of the cyclone device were calculated based on the volume of dusty air. The capacity of

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the experimental sample of the cyclone device is Q=0.05 m3/s, the outer diameter of the conical part is 0.29 m. Figure 2 shows the dimensions of the improved cyclone device relative to its outer diameter. The dusty air flow rate in the inlet pipe was determined as follows [10; 624-b, 11; 196-201-b]

$$\omega_{cp.} = \frac{V}{3600\frac{\pi d^2}{4}} = \sqrt{\frac{2\Delta P}{\rho \zeta}} \quad (3.1)$$

where, V is the volume of air entering the device, m3/s; d is the dusty air inlet pipe diameter, m; P - hydraulic resistance of the device, Pa; p - medium density, kg/m3; - ζ hydraulic resistance coefficient. Device diameter [10, 329 p, 11; 196-201-p]

$$D = \sqrt[4]{\frac{4^2}{3600^2 \pi^2 \cdot 2}} \cdot \sqrt[4]{\frac{V^2 \rho \zeta}{\Delta P}} \quad (3.2)$$

According to the centrifugal force formula, $(C = \frac{m\omega^2}{R})$ the cleaning efficiency can be increased by increasing the air flow velocity of the device, reducing its diameter, or using cyclones connected in series [10, 329-330 b, 11; 196-201-b]. The design dimensions of the cyclone device were determined and improved based on the properties of the RG-482, 582-1.2 catalyst dust from the reforming process. An improved cyclone device (see Figure 2) is presented. Taking into account the fine dispersion of catalyst dust, i.e. up to 20 µm, a circulation pipe was installed in the dusty air inlet pipe of the cyclone device. The function of this pipe is to transfer dust particles up to 5 µm in size, which are mixed with the purified air flow inside the

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device and released into the atmosphere, back to the dusty air inlet pipe.

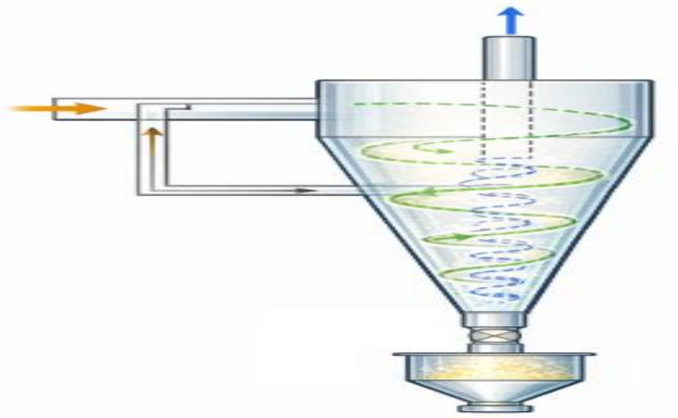

Figure 2. Improved cyclone device As a result of calculations, the optimal structural dimensions of the proposed device were determined: the outer diameter of the cylindrical part of the cyclone is 1.15 m, the total height is 1.6 m, the height of the cylindrical part is 1.15 m, the height of the conical part is 0.45 m, the diameter of the dusty air inlet pipe is 0.065 m, the diameter of the cleaned air outlet pipe is 0.090 m, the diameter of the circulation pipe is 0.01 m.

Conclusion. In industry, cleaning large amounts of air emissions from various impurities is a difficult hydromechanical process, the difficulty is that the dust emitted into the atmosphere is very small. In manufacturing enterprises, single-stage dust cleaning devices are mainly used. The exhaust from technological processes is sent to dust cleaning devices through a fan, and the cleaned dust is discharged into the atmosphere. In industry, cyclone devices with low efficiency are used as dust cleaning devices. Centrifugal force field sedimentation. This method of separating inhomogeneous dust and gas systems is more efficient than gravitational sedimentation, therefore it is used to separate smaller (up to 5 μm) dust particles. The main air pollutants are: sulfur oxides, nitrogen, carbon, hydrogen sulfide, hydrocarbons, tetraethyl lead and mechanical impurities. They have a harmful effect on the human body and the environment. The main air pollutants are stationary (petrochemical plants, oil refineries and power plants) and mobile (internal combustion engine vehicles). A conical cyclone device that purifies the air from fine dispersed dust

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was used as a model device for the model device. The dimensions of the cyclone device were calculated based on the volume of dusty air.

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