ENVIRONMENTAL PROTECTION FROM POLLUTION USING THE TECHNOLOGY OF AIR PURIFICATION OF WASTE GASES AT INDUSTRIAL ENTERPRISES

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Abstract. *This article describes dry and wet methods for purifying exhaust gases to capture dust and neutralize mists. The descriptions given of the equipment for purifying harmful emissions differ from each other, both in design and in the principle of sedimentation of suspended particles. Horizontal rotary scrubbers are proposed for use, which allow effective and targeted spraying of liquid inside the scrubber, which in turn creates favorable conditions for more contact with pollutant particles.*
Keywords*: ammonia, hydrogen, sulphur dioxide, rotary conical basket.*

The most advanced and optimal scrubbers were used for technological processes, which contributes to the most rational use of natural resources, improving the environmental situation in the area where the emission source is located, preserving biodiversity, improving the well-being of the environment and creating favorable living conditions for people.

Environmental protection from pollution includes, on the one hand, special methods and equipment for purification of gas and liquid media, waste and sludge treatment, recycling of heat and maximum reduction of thermal pollution. On the other hand, this involves the development of technological processes and equipment that meet the requirements of industrial ecology, with environmental protection techniques being applied at almost all stages of technology.

Gaseous industrial wastes include unreacted gases (components) of initial raw materials; gaseous products; exhaust air of oxidation processes; compressed (compressor) air for transportation of powder materials, for drying, heating, cooling and regeneration of catalysts; for blowing sediments on filter fabrics and other elements; individual gases (ammonia, hydrogen, sulphur dioxide, etc.); mixtures of several components (nitrogen-hydrogen mixture, ammonia-air mixture, sulphur dioxide and phosgene mixture); gas-dust flows of various technologies; gas-dust streams of various technologies; exhausted nitrogen-hydrogen mixture, ammonia-air mixture, sulphur dioxide and phosgene mixture.); mixtures of several components (nitrogen-hydrogen mixture, ammonia-air mixture, sulphur dioxide and phosgene mixture); gas-dust streams of various technologies; waste flue gases from thermal reactors, furnaces, etc.; and waste gases generated by thermal reactors, furnaces, etc.), as well as waste gases generated during ventilation of workplaces and premises. Besides, all powder technologies are accompanied by intensive emission of gas-dust wastes. Dust formation occurs in the processes of grinding, classification, mixing, drying and transportation of powder and granular bulk materials [1, 2].

Sources of atmospheric air pollution include industrial enterprises, transport, thermal power plants, agricultural production and livestock complexes. Each of these sources is associated with the emission of a large number of specific toxic substances, sometimes not immediately identifiable.

The capture or disinfection of unwanted or hazardous components can occur on various bases. Among the fundamental filtering methods, we note the following:

Mechanical gas purification – physical capture of solid impurities in mechanical dust collectors of fiber, inertial-gravity, electrostatic and other types;

Wet gas cleaning by absorption (scrubbers and absorbers) – absorption of chemically active (gas / aerosol) or mechanical filtrate in a volume of liquid (water or absorbent);

Dry adsorption method and catalytic capture (industrial carbon, zeolite filters) - fine capture of gas and aerosol components in the surface layer of microporous material (adsorbent), in some cases - with the parallel occurrence of chemical / cascade catalytic reactions;

Ion exchange (RIF filters) is the exchange of ions between the filter material and substances that demonstrate electrolytic activity (air purification from vapors of acids, alkalis, saline solutions, ketones, ethers, alcohols and other polar solvents) [2].

Gas purification systems can also be categorized according to other bases. Based on the principle of air purification efficiency, gas treatment units (GPU) can be divided into coarse and fine filtration devices, based on the use of liquid as a filter functor - into dry and wet, and based on the ability to neutralize active inclusions - into chemical and mechanical (non-chemical) [1].

Cyclones are simple, but reliable, durable and unpretentious rotational-gravity dust collectors that show good efficiency in capturing coarse mechanical inclusions (sawdust, shavings) and medium-fine dust.

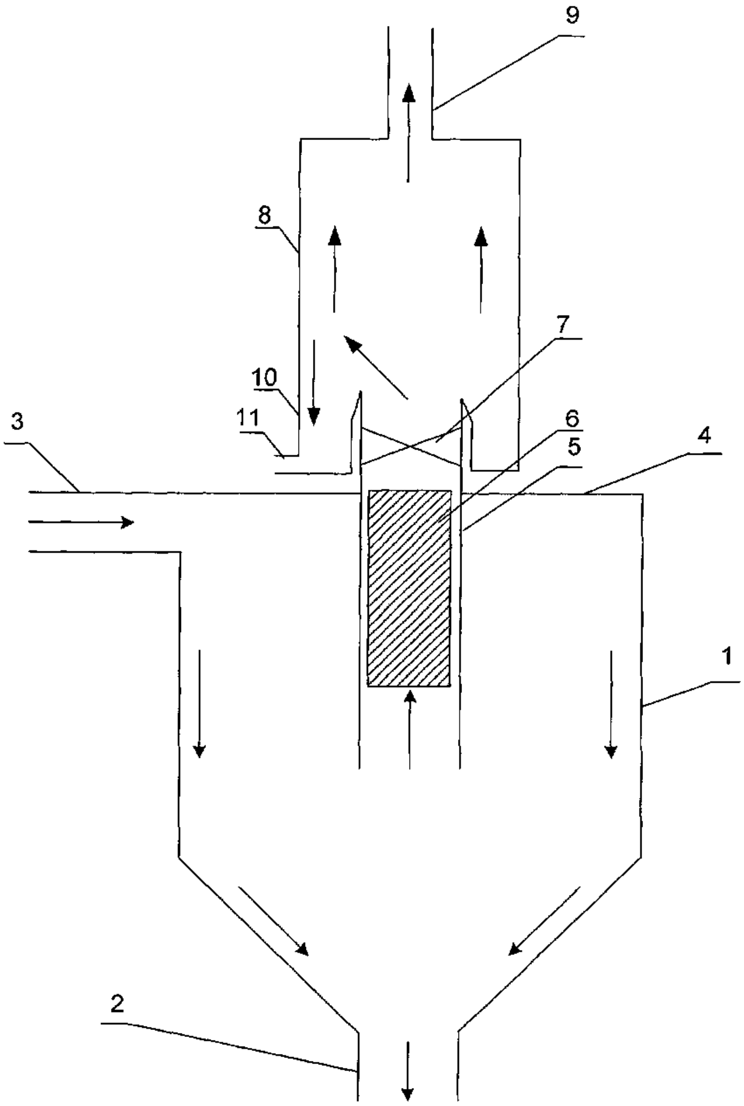
The principle of operation of cyclonic dust precipitators is to pass (and parallel swirl) a dusty flow in a cylindrical-conical (or cylindrical) chamber: the particulate swirling inside the column , due to inertia, is applied to the inner walls of the chamber and, losing its kinetic potential, is discharged into the dust collection bin:

In “traditional” cylindrical-conical counterflow cyclones, sedimentation of the dust suspension occurs under the influence of gravity and In addition, cyclones are widely used in the heat and power sector - as independent ash collectors or as part of gas purification systems (as pre-filters).

To capture dust and neutralize mists, dry and wet methods of cleaning exhaust gases are used. In addition, equipment for treating harmful emissions differs from each other, both in design and in the principle of sedimentation of suspended particles. The operation of dry sedimentation equipment for suspended particles is based on gravitational, inertial and centrifugal sedimentation mechanisms or filtration mechanisms. In wet dust collectors, dust-laden gases come into contact with liquid. In this case, deposition occurs on drops, on the surface of gas bubbles or on a liquid film.

Currently, a large number of different methods for purifying gases from technical contaminants have been developed and tested in industry: NO_x, SO_2, H_2S, NH_3, carbon monoxide, various organic and inorganic suspended substances.

A cyclone is known, containing a vertical cylindrical-conical body equipped with a pipe for removing dust, a pipe for supplying a dusty gas flow located tangentially to the body, a cover, an exhaust pipe, characterized in that it is additionally equipped with a plasma torch installed inside the exhaust pipe, and a gas flow spinner, located above the plasmatron, and the upper part of the exhaust pipe is made with an extension in the form of a cylindrical body, equipped with a pipe for removing purified gas and a circular hopper with a pipe for removing dust (Fig. 1).



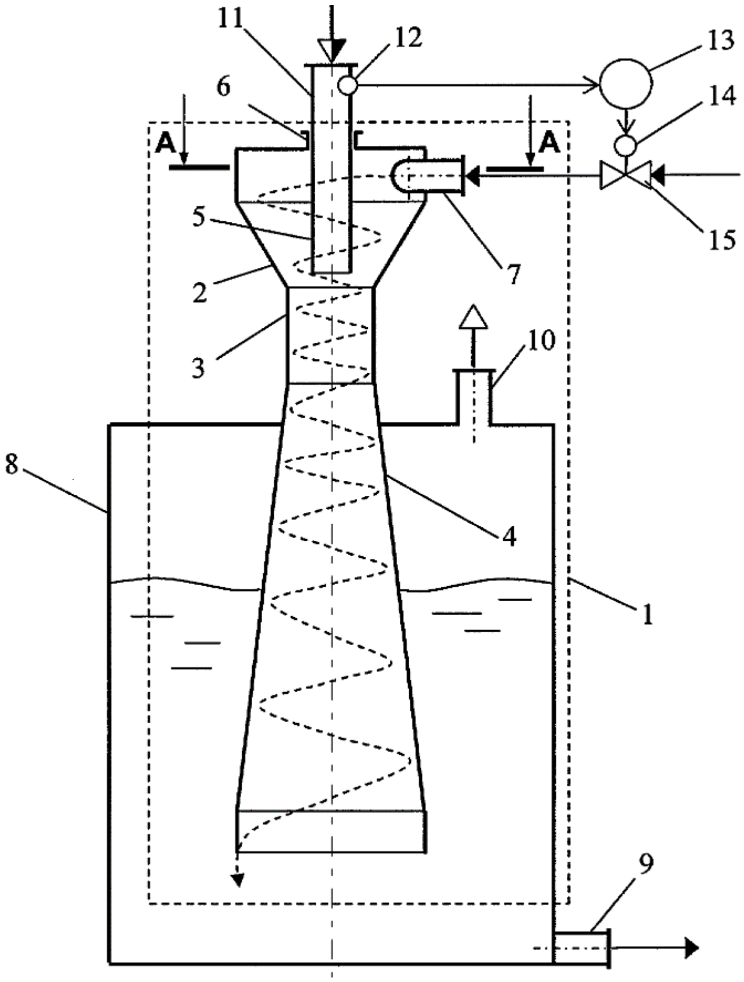
Rice. 1. Cyclone

The utility model is aimed at increasing the efficiency of gas stream purification by removing fine dispersed fractions and harmful emission components without interrupting the purification process.

The specified technical result is achieved by the fact that the cyclone contains a vertical cylindrical-conical body equipped with a pipe for removing dust, a pipe for supplying a dust-laden gas flow to the apparatus, located tangentially to the body, a cover, an exhaust pipe, inside which a plasma torch is installed and a gas flow spinner located above the plasma torch. , and the upper part of the exhaust pipe is made with an extension in the form of a cylindrical body equipped with a pipe for removing purified gas and a circular hopper with a pipe for removing dust.

When this cyclone operates, the dust and gas flow through pipe 3 enters the cylindrical-conical housing 1, passes in a circle around the exhaust pipe 5 and moves spirally downward, ensuring the separation of large particles of the dispersed phase from the dispersion medium (gas). In the lower part of the housing, the flow loses speed and changes its direction, as a result of which large and medium suspended particles are separated and removed through the dust removal pipe 2. Gases purified from large and medium dispersed dust move in an ascending spiral and enter the exhaust pipe 5 The gas flow rises through the exhaust pipe 5 and passes through the plasmatron 6. In the plasmatron 6, electrical discharges periodically occur between the electrodes, causing the decomposition of harmful components of the gas flow into simple components that have a charge. Under the influence of the resulting plasma, the complex components of the ejection are destroyed and particles of the fine dispersed phase are charged. Dust particles with an electrical charge stick together and increase their mass. Next, the gas through the gas flow spinner 7 enters the expanded part of the exhaust pipe made in the form of a cylindrical body 8, where, when the gas flow rotates, particles of a fine dispersed phase are separated from it under the influence of centrifugal forces and gravitational forces. The purified gas flow is removed through the purified gas removal pipe 9, and the dust, under the influence of gravitational forces, flows along the walls of the cylindrical body into a circular dust hopper 10, from where it is removed through the dust removal pipe 11.

The disadvantage of this installation is low productivity and difficulty in manufacturing.



Rice. 2. Vortex scrubber

The vortex scrubber is known (Fig. 2), which includes a body in the form of a Venturi tube, presented in the form of a cylindrical confuser , a neck and a diffuser, a nozzle installed in the body coaxially with it, equipped with a pipe for introducing the dust and gas flow, and having inlet pipes G- shaped, made with the ability to rotate around its axis, and a gas separating tank equipped with outlet pipes for purified gas and liquid with captured particles, characterized in that the inlet pipes are connected to the liquid absorbent supply system, and the nozzle is configured to move axially relative to the body.

A vortex scrubber, characterized in that a dust concentration sensor is built into the dust and gas flow input pipe, connected to a controller connected to the actuator of the control valve installed between the liquid absorbent supply system and the supply pipes.

A vortex scrubber, characterized in that the liquid outlet pipe with trapped particles is made tangential to the gas separation tank.

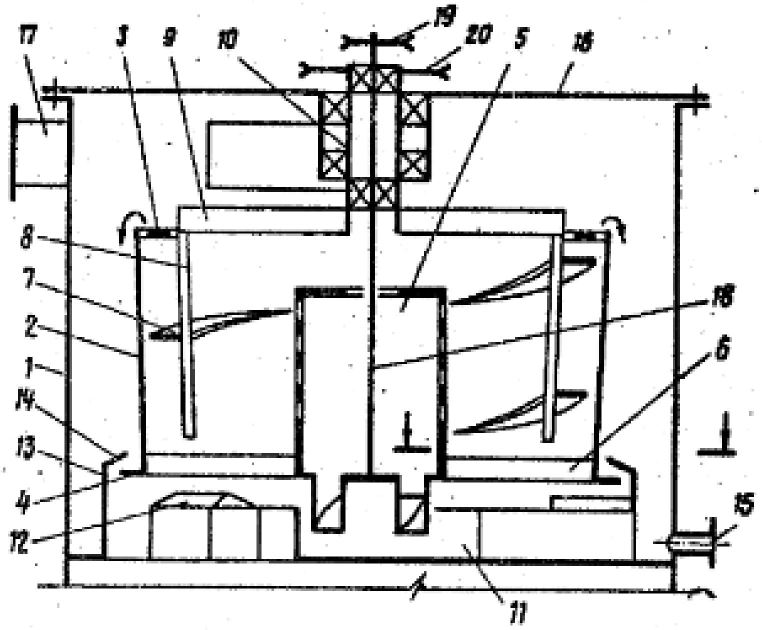
The proposed vortex scrubber works as follows. A liquid absorbent (for example, water) is supplied to the pipes 7 through a control valve 15 from the liquid absorbent supply system under pressure. Passing the elbows of 16 pipes 7, located at an angle to the axis of the body 1, the liquid absorber has a high speed, directed at an angle to the axis of the scrubber body 1 [3]. Therefore, the liquid absorber entering through the nozzles 7 acquires a rotational motion around the axis of the housing 1. Further along the confuser 2 to the neck 3, the circumferential component of the velocity of the liquid absorber increases. In addition, due to the tapering shape of the confuser 2 in the neck 3, the axial component of the velocity also reaches a maximum. Thus, in the area of the entrance to the neck 3, both the axial and circumferential components of the fluid velocity reach their maximum values. In accordance with the law of conservation of energy, the pressure in this zone takes a minimum value, that is, a large vacuum appears at the end of the nozzle 5, the degree of which is regulated by its axial movement relative to the body 1. As a result, near the exit from the nozzle 5 conditions arise (high speed of rotational and axial movement, significant vacuum), facilitating the transfer of impulse and angular momentum from the liquid absorber to the dust and gas flow supplied through pipe 11.

The dust and gas flow acquires a powerful impulse from the rotating liquid and intensively swirls in neck 5, which serves as a mixing chamber, where a three-phase gas-liquid-solid system is formed. Under the influence of large centrifugal forces arising in the rotating flow of a three-phase system, primary phase separation occurs in diffuser 4: particles of the heaviest - solid - phase are thrown towards the wall of diffuser 4, the lightest gas phase forms a rotating cone-shaped cord in the central part of diffuser 4, and the layer liquid is located between the surfaces of the rotating cord and the wall of the diffuser 4 [3, 4].

As the flow moves along the diffuser, the flow expands, as a result of which both the speed of rotation of the flows and the angular momentum decrease. When the three-phase system exits the diffuser 4 into the gas separation tank 8, secondary separation occurs, which consists in separating the gas from the liquid containing the captured particles. Gas in the form of bubbles is bubbled through a layer of liquid in the gas separating tank 8, where it can be further purified from solid particles. The purified gas is removed from the gas separating tank 8 through a pipe 10, which is located in the upper part of the gas separating tank 8, as close as possible to the axis of the housing 1. The liquid with captured particles is discharged through the pipe 9, which can be made tangentially to the gas separating tank 8. Thanks to the tangential connection pipe 9, part of the kinetic energy of rotational motion, which is possessed by the rotating flow leaving the diffuser 4, is converted into potential pressure energy. The liquid with captured particles from pipe 9 can be further supplied for cleaning from captured particles (for example, on a filter), and then returned to the scrubber through pipes 7 using the pump of the liquid absorbent supply system [5, 6].

The main disadvantages of this scrubber are its excessive metal consumption and complexity both in manufacturing and in operation.

A rotary scrubber is known (Fig. 3), which contains a housing 1, a rotary conical basket 2 with an internal perforated flange 3 on a larger base and an external flange on a smaller base. In it, the basket 2 is connected to the sprayer 5 using inclined ribs-jumpers 6. The device for removing sediment in the form of a spiral tape stripper 7 is attached to rods 8, connected by means of inclined ribs-jumpers 9 to the drive hollow shaft 10.



Rice. 3. Rotary scrubber

The transfer channels of the plate 11 are equipped with inclined covers 12, the plate itself has a wall 13 with a conical flange 14. The body of the apparatus is equipped with a pipe 15, a cover 16 and a pipe 17 for gas outlet. The sprayer shaft 18 is equipped with a pulley 19, and the hollow shaft 10 is equipped with a pulley 20. The basket 2 and the stripper strip 7 have the ability to rotate individually.

A rotary scrubber works as follows: dusty air (gas) enters the apparatus from below in the axial direction or tangentially, as in a cyclone, and rises upward. When entering the apparatus tangentially, under the action of centrifugal force, the solid phase is separated from the flow before contacting the sprayer 5, the flow, passing the annular gap between the sprayer 5 and the conical basket 2, is washed from the solid phase by a flow of sprayed liquid. Purified air (gas) goes up and is discharged from the apparatus through pipe 17 or through pipe in cover 16 (not shown). Passing the annular gap, the gas flow is involved in rotational motion, which contributes to a more complete separation of the solid phase.

The jumper ribs 6 and 9 are installed at an angle to the axis of the apparatus and thus play the role of an axial fan. The pulp formed when the gas flow passes through the rotor is thrown onto a conical basket 2, where phase separation occurs. The liquid accumulates near the wall of the basket, flows through the perforated inner flange and is discharged onto the wall of the housing 1, flows down, and then through the overflow channels of the plate 11 is directed for spraying to the center, where. is captured by sprayer 5 and again sent for spraying. The sediment, under the action of the spiral stripper strip 7, moves downwards, is discharged through the smaller base of the conical basket 2 onto the wall 13 and falls down under the influence of gravity. The spiral stripper belt 7 and the conical basket 2 rotate in the same direction, but with different angular velocities, which ensures that the sediment moves downwards. The flange 6 on the smaller base of the conical basket 2 and the conical flange 1 of the wall 13 prevent the passage of air flow. Through pipe 15, the apparatus is refilled with fresh liquid.

The rotational motion of the spiral stripper strip 7 is transmitted from the electric motor through pulley 20, hollow shaft 10, ribs-jumpers 9 and rods 8, to the conical basket 2 - through pulley 19, sprayer 5 and ribs-jumpers 6. The required ratio of the angular velocities of the conical basket 2 and The spiral stripper strip 7 is provided by selecting the appropriate V-belt gear ratio or using a gearbox (not shown). To ensure that the sediment falling down does not fall into the transfer channels of the plate 11, inclined covers 12 are provided.

The spiral stripper strip 7 creates a channel through which the liquid phase moves upward not along the generatrix of the conical basket 2, but in a spiral, which lengthens the residence time of the pulp in the area of centrifugal forces and has a beneficial effect on the efficiency of the phase separation process. The relatively low speed of the spiral stripper belt and conical basket reduces wear on structural elements and reduces specific energy consumption.

A rotary scrubber containing a housing, a hollow drive shaft, a rotary conical basket, a liquid sprayer, a device for removing sediment, characterized in that, in order to increase the efficiency of dust collection, the device for removing sediment is made in the form of a spiral tape attached to rods connected to the shaft by means of inclined ribs-jumpers, the basket is connected to the liquid sprayer by means of additional inclined ribs-jumpers, while the basket and the spiral belt are installed with the possibility of individual rotation.

The disadvantage of this rotary scrubber is its complexity in manufacturing, excessive metal consumption and low productivity. Along with this, when using a liquid with impurities, the probability of clogging the nozzles is very high, which leads to disruption of the technological process, affecting the quality of waste gas purification.

A feature of mechanical rotary scrubbers is the presence of a rotating device (rotor, disk, etc.), which provides spraying and mixing of liquid or rotation of the gas flow.

Depending on the method of supplying mechanical energy, devices of this type are divided into two groups:

– mechanical scrubbers – devices in which the gases being purified are brought into contact with a liquid sprayed using a rotating body (shaft with blades, disk, perforated drum, etc.);

– dynamic gas scrubbers – devices in which energy supplied by a mechanical device is used to rotate the gas flow.

A mechanical scrubber with rotating perforated discs is often used in industry. Technological process for purifying polluted air. Energy and resource saving processes in chemical technology, petrochemistry and biotechnology.

The dust contained in the gases is deposited together with the water in the bath and partially on the disks, from which it is washed off with liquid. Collected dust in the form of sludge is periodically or continuously removed from the bath.

The consumption of washing liquid in mechanical scrubbers is determined by the properties of the gases being purified and the captured product. Since mechanical scrubbers often operate with periodic removal of liquid, the consumption of washing liquid in them is significantly less than in hollow or packed gas scrubbers. The permissible speed of purified gases in mechanical scrubbers is 0.8 - 10 m/s. These devices are suitable for purifying gases (including aggressive and poisonous ones) from suspended particles larger than 7 microns in size, which are not capable of forming solid deposits in the presence of moisture.

The disadvantage of this device is the increase in resistance created by the perforated disks to the passage of the gas-air mixture.

Exhaust gas purification systems at stationary sources of industrial enterprises involve the use of various scrubbers both in design and in the method of capturing certain pollutants contained in these emissions.

The operation of PGOU, in particular scrubbers, is associated with certain requirements for the quality of pollutant capture and productivity.

The proposed horizontal rotary scrubber is distinguished by the fact that instead of perforated disks, blade strips are used, installed perpendicular to the axis and rotated at an angle of 45° relative to the plane of rotation. This arrangement of the blade bar allows for efficient and targeted spraying of liquid inside the scrubber, which in turn creates favorable conditions for more contact with pollutant particles. The greatest contact between the liquid and pollutant particles contributes to an increase in wettability and adhesion, thereby increasing the size and weight of the pollutant particles. An increase in size and weight contributes to the most rapid sedimentation of pollutant particles and their transportation to the storage hopper.

The use of the most advanced and optimal scrubbers for certain technological processes contributes to the most rational use of natural resources, improving the environmental situation in the area where the emission source is located, preserving biodiversity, improving the well-being of the environment and creating favorable living conditions for people.

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