Analysis of Dusty Air Cleaning Technology and Equipment Available in the Cotton Processing Process

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Abstract: One of the biggest problems in cotton processing plants is the loss of dusty air and the lack of harm to the environment. In addition, reducing fiber, lint, fibrous waste, and similar products that are emitted into dusty air is one of the company's most important challenges. This article analyzes the convenience, cleaning efficiency, advantages and disadvantages of dusty air purification technology and equipment available in the cotton processing process. The principle of operation of foreign technologies is also considered. In order to reduce dusty air in the plant, the release of raw materials by adding dust to cyclones, energy consumption and so on, three dust trap device schemes have been developed and high efficiency has been achieved.

Keywords: Cotton, down, seeds, cyclone, dust, dirt, product, raw material, separator, mineral, organic, moisture, cylindrical, conical, cylindrical-conical, auger, fan.

Analysis of dusty wastes generated during cotton processing. The technological system of primary processing of seed cotton consists of the process of transportation of raw materials and finished products on the territory of the enterprise and departments by various means of transport. Pneumatic transport is one of the main means of transporting seed cotton from the warehouses to the production, as well as the transfer from one section to another.

Pneumatic transport is distinguished by the reliability of the system of operation of other transport devices, low losses in the transportation of cotton, compactness, ease of installation in small spaces, high capacity to transport cotton in adverse conditions and extremely simple repair process. This figure is the basis for its widespread use in industry.

Suction pneumatic conveyors are the main equipment for ginning cotton in ginneries. The general scheme of the pneumatic transport device used in ginning enterprises is shown in Figure 1.1.

The cottonseed is transported to the pneumatic transport system through a working pipe by means of a spool-supply RBX. The principle of operation of the equipment is as follows: as a result of the thinning of atmospheric air, air is sucked into the working pipe, which is accompanied by the seed cotton. In the separator, the seed cotton is separated from the air and transferred to the required location by means of a vacuum valve on a screw or belt conveyor, and the dusty air goes to the dust collector and, after cleaning, is released into the atmosphere.

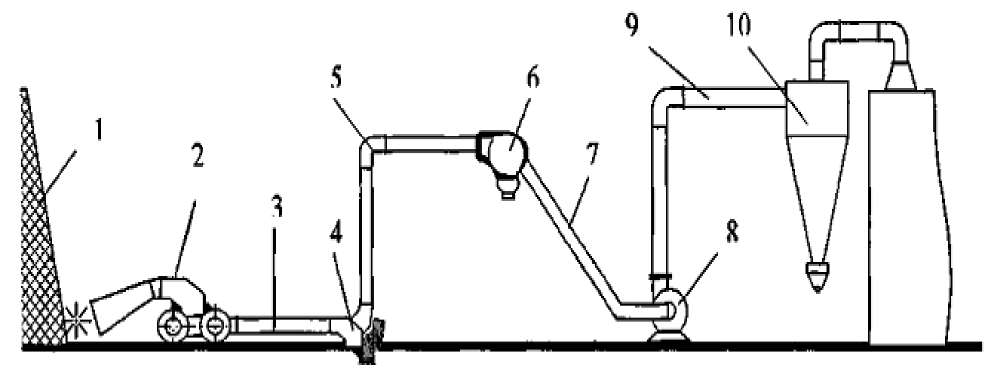


Figure 1; 2-nd spoiler; 3-horizontal working pipe; 4-stone holder; 5-vertical pipe; 6-separator; 7-Suction air duct; 8-centrifugal fan; 9-thrust air duct; 10-dust collector.

Figure 1.1. General view of the pneumatic transport device.

The main advantage of the suction device is the simplicity of changing the layout of the working pipe, depending on the location of large and closed warehouses on the territory of the preparation site of the enterprise.

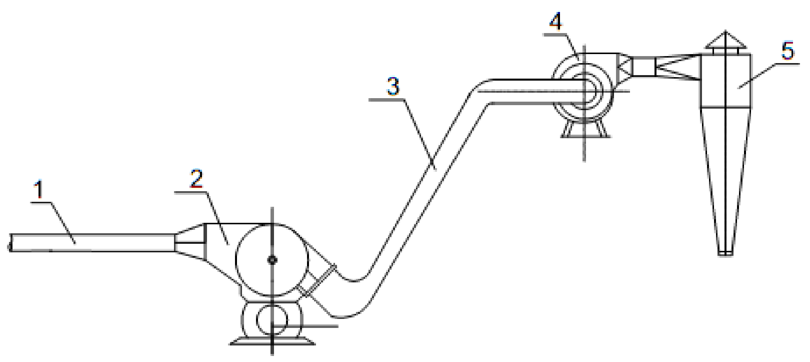
The efficiency of pneumatic transport equipment varies depending on the capacity of the gin. Their average productivity is 15 tons per hour.

The growth of the cotton harvest and the production of seed cotton are putting demands on the ginning industry to increase production capacity, equipment efficiency and finished product quality. The solution to these problems also depends in many ways on the operation of pneumatic conveyors for seed cotton, as it is the first and foremost in the technological process of primary processing of cotton.

Moisture, high levels of pollution and increased production of cotton harvested during the cotton harvest will lead to the expansion of the territory under the enterprise. As a result, the intermediate length of the vehicles within the enterprise increases. Depending on the size of the preparation, the distance can be 200 m or more. Additional, serial, re-transfer units and pneumatic transport devices will be installed to transport cotton seeds from remote cotton fields to production.

SS-15A and SX separators are currently widely used. During operation, a mixture of seed cotton and air enters the separation chamber through an inlet pipe. Due to the large size of the camera, the flow rate decreases sharply. The bulk of the seed cotton or fiber continues to move by inertia and passes through the back wall, sliding off the surface with the help of the vacuum valve blades, while the rest hits the surface of the net. The cotton wool or fiber is separated from the mesh surface by means of elastic scrapers, which are also lowered into the vacuum valve. Incomplete research on waste passing through the mesh surface has not been completed.

In order to separate the cotton product from the air in the pneumatic transport, a separator is used, the brand of which is SS-15A, SX. The inside of the separator has a 2x2 mm mesh surface, which acts as a trap for trapping incoming cotton seeds. The short fibers, fine mineral and organic wastes in the cotton also pass through the fan along with the air, and dust traps are used to clean the air (Figure 1.2).



1,3-pneumatic transport pipeline; 2-separator; 4-fan; 5-dust collector

Figure 1.2. Schematic of the technological process of the dust removal system

Unfortunately, mineral, organic, seed husks, and short-fiber wastes from seed cotton or fiber coming into SS-15A or SX separators pass through the mesh surface and collect in dust collectors.

If the surface area of the mesh is reduced, the aerodynamic drag will increase. It should be noted that if we move from percentages to weights, the average fiber loss when the pneumatic device is 15 t / h, the fiber loss is 4.14 kg / h. reaches

To check this, we first need to know the amount of waste from the pneumatic transport system and the aspiration system installed in the workshops of ginneries.

At the beginning of the technological process of processing cotton in pneumatic conveyors on cotton transport, drying and cleaning machines, up to 80% of fine mineral powders and mainly large organic powders are separated up to 20%. Larger dispersed dusts larger than 50 μm can make up 70% of the total mass. In the process of ginning and lintering, the proportion of mineral fractions of dust decreases, and the organic particles of dust increase to 80-90%. Dust particles are less than 50 microns in size. The level of dust in the exhaust air of the process equipment varies from 800 to 2000 mg / m3. High dust content is 3000-4000 mg / m3.

Dust collectors have been shown to consume a lot of electricity. Therefore, the tendency to shorten cylindrical type dust collectors is widespread.

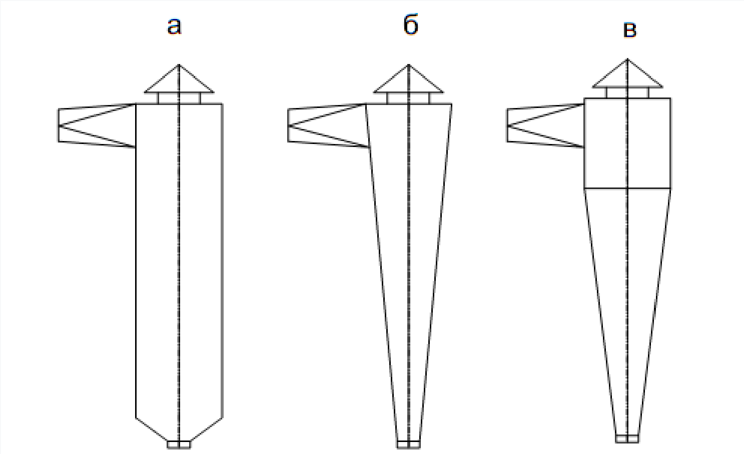
Based on the analysis obtained, we need to first analyze the dust collectors currently used in our industry and abroad in order to capture the fibrous waste emitted by the air from the technological processes of ginneries and to properly regulate the concentration of dust in the atmosphere.

Analysis of types of dust collectors and their processing technology. There are many types of dust collectors available today and they are used depending on the characteristics of the dust. For example, filters are used in fine-grained plants, and electrostatic precipitators are used depending on the nature of the charge. These dust collectors are mainly used in areas where there are relatively few dust particles.

SP-6, SS-6, SL-3, SS-3, VZP-1200, etc. are currently used in cotton gins to clean the air from organic, mineral and other contaminants. Different types of dust collectors are widely used.

Dry dust collectors are widely used in cotton ginning plants to clean the polluted air and release it into the atmosphere. Dry dust collectors include two-flow dust collectors. Nowadays, the most common in the industry are single-flow dust collectors.

There are three types of single-flow centrifugal dust collectors: cylindrical, conical, and cylindrical-conical (Figure 1.3).



a) cylindrical; b) conical; v) cylindrical-conical.

Figure 1.3. Schematic of single-flow dust collectors.

Cylindrical dust collectors are not currently used. This is because the airflow that enters it begins to circulate based on the centrifugal force. As the number of revolutions increases, the airflow slows down and is unable to deliver dust particles to the wall. As a result, the dust particles cannot reach the dust trap wall, which reduces the cleaning efficiency.

Cone dust collectors have SP-3 type dust collectors and their cleaning efficiency is high, but one of their main drawbacks is that when the dust air stream entering the dust collector vertically enters the dust separator chamber, the air flow hits the sloping side of the cone. a certain amount of dust tends to reach the top of the holder. This force prevents the airflow from moving in a spiral, resulting in a loss of power to spiral the separated dusty air and a sharp decrease in the cleaning efficiency of the dust collector.

In general, for static dust collectors to work effectively, the static drop in air pressure must be proportional, which can be seen in the following scientific work. In this case, the change in static pressure depends on the geometric size of the dust collector.

In addition, the speed of the air, as shown in the work, depends on the power consumption of the fan, which creates the air pressure entering the dust collector.

As can be seen from Figure 1.4, the air flow coming in with force P is divided into two forces P1 and P2, which leads to a decrease in the air flow force.

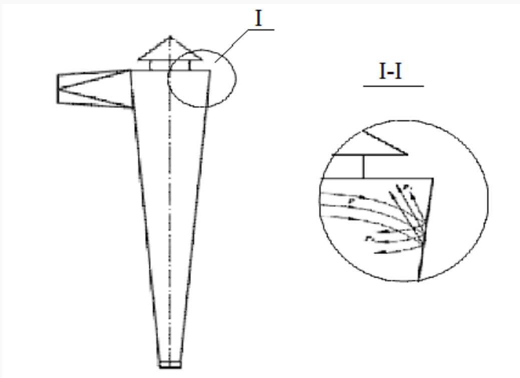


Figure 1.4. Pressure loss in the cone dust collector

As a result, the cleaning efficiency is reduced when the dust particles in the dust trap cannot reach the wall.

$\mathbf{P = P_1 + P_2}$

A study of dust collectors shows that their cleaning efficiency increases when the pressure of the air flow entering the dust collector is applied in the same direction. With this in mind, cylindrical-conical dust collectors have been developed and introduced into the dust collector, which move the air pressure in one direction.

The effectiveness of individual cotton dust collectors also depends on factors such as its diameter, location, and operating mode. The amount of dust released into the atmosphere from dust collectors is often 8-10 times higher than that of PVD. The construction of some dust collectors abroad and at our ginneries is shown in Figure 1.5.

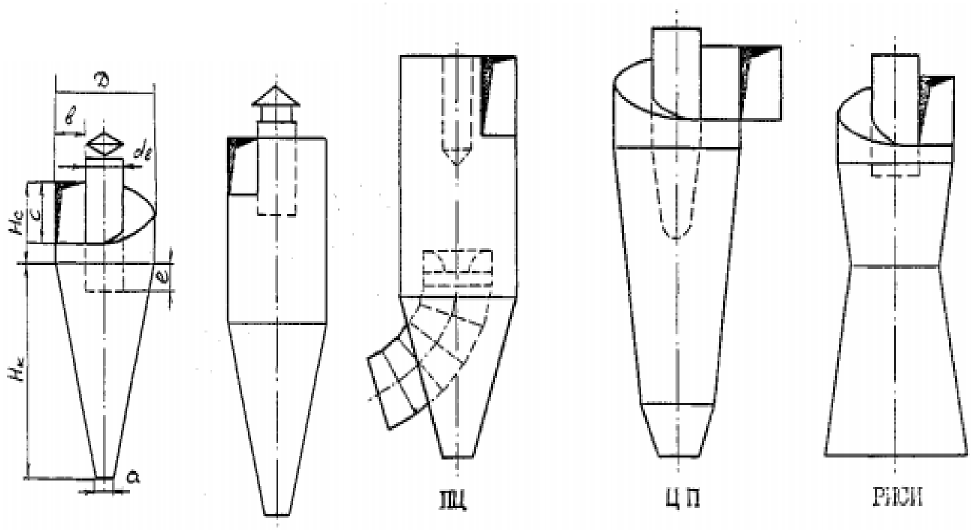


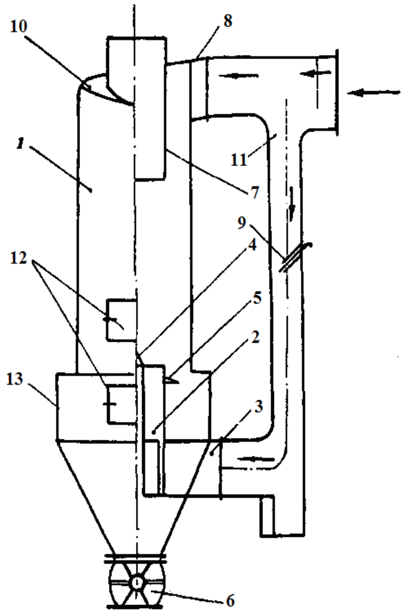
Figure 1.5. Used in foreign and domestic ginneries dust collectors

The SP-3 dust collector has the lowest (520 Pa) UTS dust collector and the highest (1100-1300 Pa) hydraulic resistance. The cleaning rate is high in the UTS-1.5 dust collector (90%) and low in the SP-3 dust collector (75%). Because of this, recommendations have been made for the introduction of a dust collection system in the ginning industry.

Rolling dust collectors are also dry type dust collectors with circulating flow. The VZP dust collector, developed by scientists from the Moscow Textile Academy, is also successfully used in the chemical and other industries. One of their main features compared to other dust collectors is their high efficiency (Figure 1.6). The VZP-800 and VZP-1200 dust collectors consist of a cylindrical body with a tangential slide 2 at the bottom and an inlet pipe 3 to transmit the primary flow of dusty air. There is a cylindrical suction cup on the axis of the rotator.

It is connected to the top of the cone. On the outer surface of the rotator is placed a reflector 5, the shape of which is truncated cone. The bunker part is attached to the 6-hole dust holder vacuum-valve flange. At the top of the dust collector is a pipe 7 for venting purified air. This pipe also circulates the dusty air from the second stream at the same time. A secondary dust air distribution valve 9 is located in the primary dust air inlet pipe (Figure 1.6).

VZP dust collectors operate as follows: Two one-way rotating dust air streams into the mixer or separation zone at the top of the suction pipe and the primary criterion. The centrifugal particles are separated into the wall and flow down the bunker. It is discharged from there through a continuous vacuum valve. As the downward secondary current flows in a spiral along the wall of the equipment, the return washer pushes it upwards and joins the primary current. It goes out of the suction tube with it.



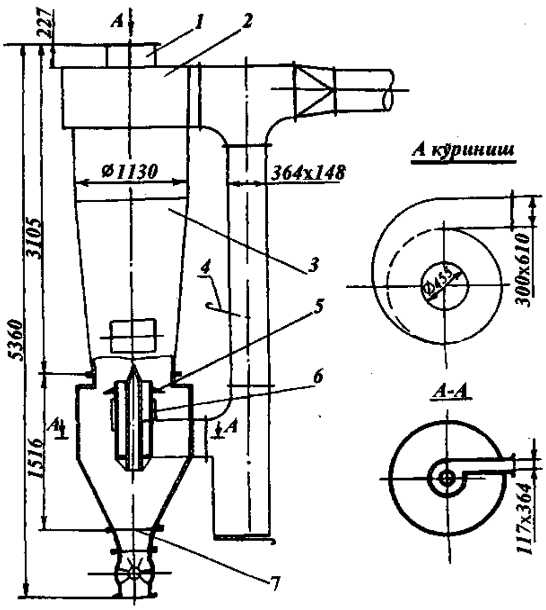
1-separation chamber; 2-downstream vortex; 3- tube; 4-squeezer; 5-return washer; 6-vacuum valve. 7-air outlet pipe; 8-tube; 9-shiber; 10- high flow vortex;

1-supply air duct; 12-observation cover; 13- bunker;

Figure 1.6. Sliding VZP dust collector.

VZP is a unique aerodynamic device. In it, large dust particles from the CC-15A separator are confused by the circulating air flow, which reduces the efficiency of the VZP apparatus. It contains fine particles and mineral impurities and traps small fractions.

Recently, VZP-800 and VZP-1200 whirlpool dust collectors with air efficiency of 3 and 6 m3 / s have been widely used in the ginning industry. These encountering screw dust collectors belong to the group of dry center centrifugal dust collectors and are designed to remove dust from the recycled air (Figure 1.7).



1-dust extraction pipe; 2-high flow vortex; 3 -separation chamber; 4-shiber; 5-return washer; 6-downstream vortex; 7-Dust extraction hole.

Figure 1.7. Sliding VZP-MZ dust collector.

Since both single-stream dust collectors and floating dust collectors are not cleaned properly during one-time cleaning, two-stage cleaning systems have been installed for fiber, lint and linter dust collectors coming from the air from pneumatic vehicles.

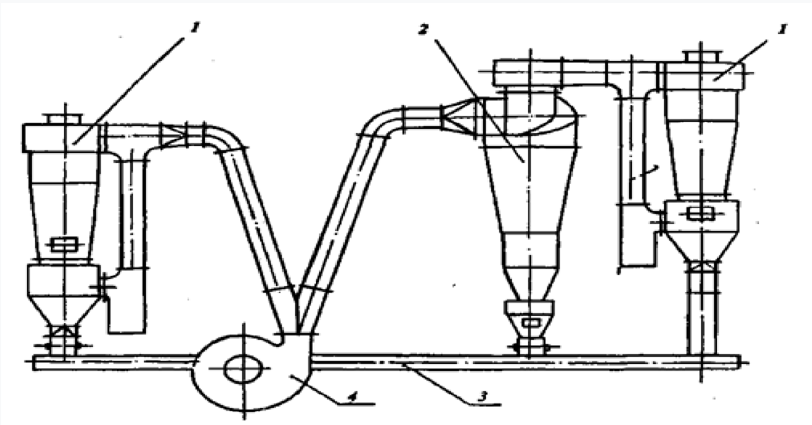
JSC "Scientific Center of Cotton Industry" has created a two-stage chamber equipment for cleaning the air from cotton dryers. Testing of this device revealed the following:

- air consumption, (m3 / s): up to the equipment - 4.8; after the equipment - 6.1;
- hydraulic resistance, (Pa) - 1000 - 1100;
- cleaning efficiency, (%) - 96.1 - 96.4;
- Dustiness of the purified air, (mg / m3) - 29.3 - 40.8;
- total power consumption, (kW) - 21.5

The authors found good results in the use of two-stage 6 dust collectors (air efficiency 6 m3 / s) in the treatment of cotton emissions from the pneumatic transport system. The first stage used two dust collectors with a capacity of 3 m3 / s, and the second stage used four UTSV dust collectors with a capacity of 1.5 m3 / s. However, such a two-stage device consumes a lot of metal and electricity.

The two-stage dust collector device has a high dust holding efficiency.

In cooperation with JSC "Scientific Center of Cotton Industry" MTA (Moscow Textile Academy) developed three high-efficiency dusting equipment (Figure 1.8). It is designed to clean the exhaust air of the air transport system for cotton.



1 VZP-MZ dust collector; 2 UTSV-ZM dust collector; 3rd set screw; 4-fan.

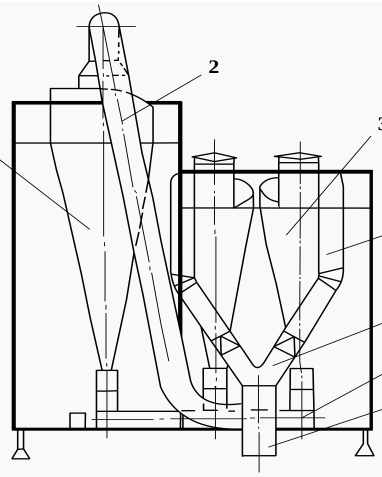
Figure 1.8. General drawing of the dust collector.

The high humidity of the air in the system and the humidity of the moving dust particles in it increase the likelihood of clogging of the air purifiers and can lead to a loss of reliability.

The two-stage dust collector is shown in Figure 1.9. The dust in the dust trap with a capacity of 6 m3 / s falls into the dust trap with a capacity of 6 m3 / s. It captures the bulk of coarsely dispersed dust, including fibrous fractions. The air transport flow does not reduce the operating radius of the dust collector and the air pressure in the dust collector in the dust collector pipe of the first cleaning stage can be adjusted. At 14 kW) № 9 is sucked using the S6-46 series fan 7. The air then enters through two non-clogged tees 5 and pipe 4 into two dust traps, each with a capacity of 3 m3 / s. The dust pipes of the dust collectors are connected to the hopper by means of augers 6.

Dust from the dust collectors to the nozzles: zero static pressure can be applied to the nozzle of the vacuum cleaner - with a cover on the suction side of the fan № 9 S6-46, from each of the three cubic dust collectors - by moving the deflector. The curvature of the hopper allows it to be quickly inspected and cleaned when the dust collector is clogged.

The high dust content of the device (96-97%) is explained by the presence of large dispersed fractions of cotton leaves and stalks. A fine fraction of dust, consisting of fine mineral particles, binds large particles and the cotton itself to the moisture of the cotton.



1 - 6 m3 dust collector; 2-air ducts; 3 - 3 m^3 dust collector; 4 - air duct; 5 - flange; 6 - auger; 7 - fan.

Figure 1.9. Schematic of a device with three dust collectors

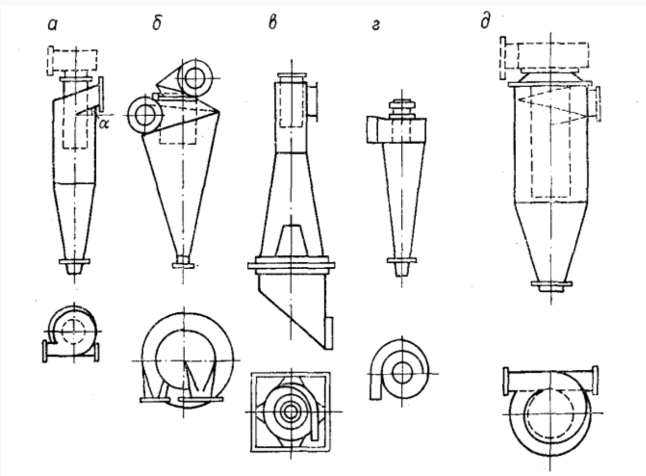
It is known that in the technological process of primary processing of cotton there is a separation of dust, consisting of mineral, dirty (cotton stalks, stems, leaves) and fibrous fragments. Different types of dust collectors are used to clean the dusty air before it is released into the atmosphere: dust collector, wet dust collector, cloth filters and others.

Their use in the cotton industry is explained by a number of specific properties of fibrous powders (ductility, stickiness, etc.).

The first devices used to capture fibrous dust were dust collection chambers. Their advantage is the simplicity of construction. However, they are not used due to their large size, low efficiency and fire hazard

Dust traps of various designs are currently used in foreign industry. The most common dust collectors of NIOGas are SN, SKTI and VSNIIOT, LIOT and SIOT dust collectors, the diagram of some of which is shown in Figure 1.10.

Along with the creation and improvement of inertial dust collectors, a number of new inertial dust collectors have been created in gas cleaning techniques in recent years.



a) NIIOGas (SN-11, SN-15, SN-24, α-angle 110, equal to 150); b) SIOT; v) VSNIIOT; g) SDK – SN – 33 and SK – SN – 34; d) LIOT.

Figure 1.10. Scheme of dust collectors used abroad

One of the promising types of inertial dust collectors is the Confused Diffusion (KDP) dust collector. The built-in two-stage dust collector is in the form of a round cross-section (nozzle) diffusion channel with a small nozzle in the diffuser section. Based on the calculations of the trajectory of the particles in the dust trap, the authors concluded that particles larger than 3 μm in the dust are trapped. Ventilated air enters the dust collector at a speed of 22 m / s and a suction coefficient of 10%, hydraulic resistance of 550 Pa. The degree of purification of the air from fine dust particles of 0-8 microns is 80 ÷ 84%, and the degree of purification from coarse particles of 0÷20 microns is 92 ÷ 94%.

Scientific studies have shown that the reduction in hydraulic resistance improves the degree of purification. Simple, high-efficiency dust collectors are widely used to clean dusty air from dust particles larger than 6 microns.

As mentioned above, dust trapping in dust collectors is based on the use of particle inertia (centrifugal forces).

Under the influence of centrifugal force, the dust particles are pushed out of the air stream into the dust collector body. As the dust collector body approaches, the airflow is diverted and moves upwards towards the exhaust pipe in an internal rotating spiral

One of the functions of rotary dust collectors is to partially remove the air phase from the hopper and transfer fresh air to the central zone of the equipment. Such dust collectors are promising in trapping finely dispersed dust.

The efficiency of air pollution treatment can be increased, especially through the passage of highly dispersed dust through barriers and the use of other filtering materials.

When studying foreign dust collectors, it is necessary to compare them with our own dust collectors and, based on this, to introduce the efficiency of a dust collector with a high cleaning efficiency.

The performance and efficiency of the dust collectors analyzed above show that the cleaning efficiency of these dust collectors is much lower, mainly due to the uncertainty of how the composition of the dust air being cleaned is related to the dust collection cleaning efficiency.

To do this, it is necessary to study the physical, mechanical and chemical properties of the dust being cleaned, taking into account both the theoretical and practical study of dust collectors, resulting in the creation of devices based on resource-saving technology.

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