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Methods and Devices for Reducing Air Dust Concentrations

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Introduction

The goals of environmental protection policies are the wise use of natural resources, the avoidance of negative impacts that society's economic activities have on the environment and public health.

Ensuring the transition of water to low and closed technological processes in industrial production, as well as developing and introducing waste-free technological processes, cost-effective methods of cleaning industrial and household waste water, air, and solid waste are crucial to reducing environmental pollution.

The technological process of primary cotton processing is accompanied by large dust discharge from technological and transport machineries into industrial buildings and into the atmosphere. Dust deposition pollutes production buildings and the manufacturing environment, creating adverse working conditions for people and equipment.

The amount of dust in the air in the cotton cleaning enterprise's production facilities does not exceed 10 mg/m^3, and the waste air released into the atmosphere is 150 mg/m$^{3.}$

Production facilities and individual dust producing devices are cleaned of dust to create normal sanitary and hygienic conditions. Before it is released into the atmosphere, the dusty exhaust air is also cleansed.

Methods Before being discharged into the atmosphere, dust and unclean air extracted from dust sources, as well as air utilized in pneumatic transport equipment, must be deducted. Dust removal can be classified as large, medium, or small. Dusty air is cleansed of dust larger than 100 m during huge dust cleaning; the amount of dust in the air after such cleaning is greater than 150 mg/m^3..

Results The tendency of suspended particles to maintain their initial direction of motion when the direction of the gas flow changes is the basis for inertial and centrifugal dust collection. Dust collectors with a large number of holes are common inertial devices**.** Gases are cleaned of particles, exit through holes, and change direction of travel; the gas speed at the device's entrance is 10-15 m/s. The device's hydraulic resistance ranges from 100 to 400 Pa (10 to 40 mm mercury column). Dust particles with diameters smaller than 20 μm are not captured by the slits.

The degree of purification ranges from 20 to 70%, depending on particle dispersion. The inertial approach is only suitable for clearing big amounts of dust. This method's downside, in addition to its low efficiency, is slot blockage. [4].

Conclusion Air pollution with dust emissions from cotton processing enterprises in Uzbekistan is of great importance and poses a serious environmental threat to the environment, as well as human health and life. Dust particles 10 microns or smaller are the most dangerous when released into the atmosphere. In most cases, the dust collection equipment used in enterprises is morally and physically outdated and cannot provide the required level of dust removal in accordance with the current environmental standards in the field of atmospheric air protection. In addition, such modernization of existing dust collection systems of cotton processing plants is often

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complicated by the lack of space required to accommodate new dust collection plants. Thus, cotton mills continue to use outdated inefficient dust collectors, which has serious environmental consequences. In addition, there is a need for mechatronic devices for determining and monitoring the concentration of dust in cotton processing enterprises. Because the existing devices are made only to determine the concentration of dust in the air in laboratory conditions. Therefore, the creation of mini-stations for continuous monitoring of the amount of dust in the enterprise is one of the most urgent issues.

At the beginning of the technological process, mainly mineral dust is released and pollutes the air during the transportation and weeding of cotton raw materials, and at the end of the technological process, especially during ginning and linting, dust of organic origin is released.

Dust in the exhaust air of the pneumatic transport system of cotton raw materials contains 10-20% organic and 80-90% mineral particles. At the end of the technological process in linters, when waste air is removed from condensers, the content of the organic fraction of dust reaches 80-90% [2].

The amount of dust in the air emitted from the technological equipment in production shops depends on the type, humidity and contamination of raw cotton; Dust emissions are the strongest during the processing of low-grade cotton raw materials. Table 1.2 shows the approximate composition of dust emitted by air during pneumatic transportation of cotton raw materials (grade III hand-picked, standard moisture and contamination from 1.3 to 3.5%).

Table 1. Disperse composition of dust

The size of the particles, mkm	0-50	50-70	70-90	90-160	160-190	190-250	250-500	500-1000	1000 And bigger than that
The composition of particles of a certain size in dust,%	3	12	9	5	4	11	12	9	3

Data on the amount of exhaust air and dust content released by the main technological equipment are presented in Table 2.

Table 2. The amount of dust emitted from the main technological equipment

Name of equipment	The amount of air released into the atmosphere,m^3/s	Dust air, mg/m^3
Pneumatic transmission device	4,5-7	4000-12000
2 Jin machine	3,2	500-2000
4 x Jin machine	6,4	500-1500
2 linters 4 linters	5,0 7,0	800-2000 800-2000
Pneumatic seed cleaner	1,5	300-800

Dust and dirty air drawn from dust sources, as well as air used in pneumatic transport devices, must be dedusted before being released into the atmosphere. Dust removal can be large, medium and small dust removal. Dusty air is cleaned of dust larger than 100 μm during the cleaning of large dusts, after such cleaning, the amount of dust in the air is more than 150 mg/m^3.

During average cleaning, dust with a size of 10 μm and above is removed, the amount of dust in the air after cleaning should not exceed 150 mg/m3. Such air can be released into the atmosphere [3].

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During fine cleaning, dust smaller than 10 μm is captured, and the amount of residual dust in the air should not exceed 2-3 mg/m^3 [2].

According to the basic principle, cleaning methods can be divided into mechanical cleaning, electrostatic cleaning and ultrasonic coagulation cleaning.

Mechanical cleaning of gases includes dry and wet methods. Dry methods include:

1) gravity settling of dust;

2) collection of dust based on inertial and centrifugal force;

3) filtering.

In many industrial production plants, several methods of gas purification are combined and differ in the construction of purification devices.[2].

Gravitational deposition of dust is based on the settling of suspended particles under the influence of gravity when the gas moves at low speed without changing the flow direction. The process is carried out in gas channels and dust deposition chambers. To reduce the settling height of the particles in the sedimentation chambers, many horizontal shelves are installed at a distance of 40-100 mm, which divide the gas flow into flat streams. The performance of settling chambers is determined using expression 1.1 [2];

$M = SV$ (1.1)

here

S - the area of the horizontal part of the chamber, m^2;

V is the sedimentation speed of particles, m/s.

Gravitational sedimentation is effective for large particles with a diameter of more than 50-100 microns, and the degree of purification is not higher than 40-50%. This method can be used only for initial, large-scale purification of gases [3].

Inertial and centrifugal dust collection is based on the tendency of suspended particles to retain their original direction of motion when the direction of the gas flow changes. Among inertial devices, dust collectors with a large number of holes are often used. Gases are cleaned of dust, exit through the holes and change the direction of movement, the gas velocity at the entrance to the device is 10-15 m/s. The hydraulic resistance of the device is 100 - 400 Pa (10 - 40 mm mercury column). Dust particles with a diameter of less than 20 μm are not caught in the slits. The degree of purification is 20-70%, depending on the dispersion of the particles. The inertial method can be used only for cleaning large dust. In addition to low efficiency, the disadvantage of this method is clogging of slots [3].

A conical cyclone device is widely used by dust collectors to clean dusty air before it is released into the atmosphere. Figure 1

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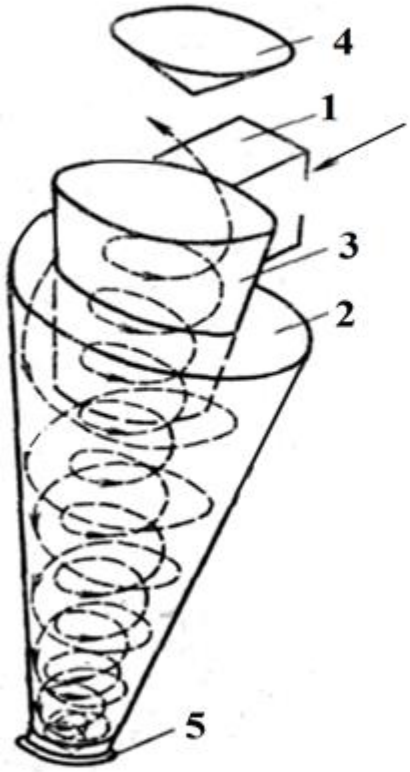

Figure 1. Conical cyclone device.

Conical (Centrifugal) dust collectors are used for cleaning large dusts (more than 50 µm in size). When the air stream rotates inside the cyclone, the centrifugal force increases, due to which the dust particles are separated from the air and thrown to the outer wall. Conical cyclones are widely used in the cotton industry.

Figure 1 shows the device of a conical cyclone, which consists of an inlet pipe 1, an outer hollow cut cone 2, an inner hollow cut cone 3, a separator cover 4 and a dust tube 5. After the dust enters the cyclone, the centrifugal force pushes the dust particles to the inner wall of the outer cone, the dust particles roll along the wall, roll into the dust extractor and are released into the atmosphere.

Under the influence of the airflow, it also loses its rotation and speed, moves to the inner cone at the bottom and goes out into the atmosphere. At the bottom of the cyclone, at the transition point of the outer air flow to the inner cone, there is a dust tube that prevents dust from escaping. Dust is sucked into the cyclone through the outer air dust pipe and released into the atmosphere through the inner cone together with the cleaned air

For the normal operation of the cyclone without external air intake, it is necessary to create an airlift at the outlet by adjusting the separator cover, which can reduce the vacuum at the bottom of the cyclone to some extent. The complete elimination of suction in the cyclone is carried out by adjusting the dust pipe, as well as by installing a hopper or a sluice. Even a small suction of air from the bottom of the cyclone will significantly reduce the dust retention efficiency. If 10-15% of the air is absorbed, the efficiency of its cleaning becomes insignificant. As the air velocity increases at the entrance to the cyclone, the effect of dust retention increases. However, with increasing speed, the resistance of the cyclone also increases. The optimal speed of air in cyclones is considered to be 14-18 m/s [3].

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Conical cyclones capture dust depending on the properties of dust and the size of its particles.Figure 2 shows how the particle size of the dust retention effect of the cyclone depends on the volume and size of the dust particles coming out of the pneumatic conveyor device. About 35% of the dust in the production area was taken. In this case, dust retention is 60-65%. The experience of cotton cleaning enterprises shows that the efficiency of dust retention reaches 94-97% when the exhaust air containing a lot of fibrous mass is cleaned with cyclones. This is explained by the fact that air and dust fall along the inner surface of the outer cone and the dust changes the direction of the air flow near the tube. When changing the direction of the air flow, small dust particles are ejected from the cyclone into the atmosphere together with the air.

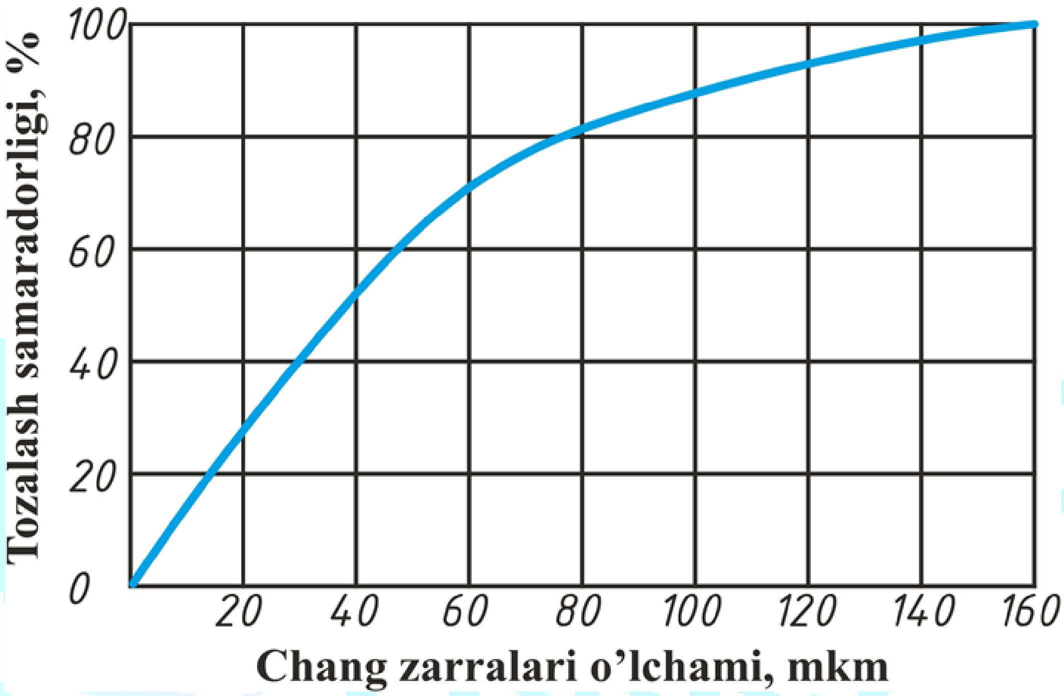

Figure 2. Graph of dust retention effect of cyclone (D = 1800 mm) depending on the size of dust particles

Normal operation of cyclones during the processing of low-grade cotton raw materials during linting can theoretically capture dust particles up to 76 mg/m^3 to 95-97%. The same type of dust can be retained in the air cleaning process during cotton ginning up to 97%. In cyclones of this type, the air flow resistance is 460-650 N/m2 at an air inlet speed of 14 m/s.

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