UDC 66.01: 66.011 **Progressive Chemical Technologies**

INDUSTRIAL AIR TRIBOELECTROSTATIC FILTER

Y.S. IVKINA, S.I. KUZNIETSOV, O.O.VENHER
Kherson National Technical University

A large number of production processes in the light, textile and food industries are associated with the formation of dust that pollutes the air of the working area.

When inhaled, the upper respiratory tract of a person traps dust particles larger than 10 microns and they do not enter the lungs. But the main danger is fine dust, which can penetrate the human body and cause harm to health. These are particles less than 8-10 microns in size, invisible to the naked eye, which can linger in the alveoli of the lungs. It is estimated that 10% of dust inhaled by a person reaches the alveoli, and 15% is swallowed with saliva. Dust smaller than 0.25 microns practically does not settle, and are in the air in a suspended state [1].

Particles with a charge of 2-8 times more are actively retained in the respiratory tract. In addition, identically charged particles remain in the air of the working area longer than differently charged particles, which agglomerate and settle faster [2].

Therefore, special attention is paid to the problem of fine dust capture.

The purpose of the research was to develop a design of a triboelectrostatic filter capable of effectively capturing fine dust of any origin. The design of a multi-disc triboelectrostatic dust collector has been developed, which has high productivity, high efficiency and low cost. To create an electric field in the filter, the tribo effect is used, which occurs as a result of the friction of dielectrics, and eliminates the need to use a high-voltage power source [3].

The design of the triboelectrostatic dust collector [4] consists of a number of parallel disks - electrodes 2, fixed on a common shaft 3. The shaft with the disks fixed on it is driven to rotate by the electric motor 7 through the reducer 6. The disks are in contact with stationary brushes 4. A system of rotating disks with with brushes can have an open design, when the polluted gas is fed into the electrostatic filter forcibly. In any case, a hopper 5 is installed in the lower part of the filter to collect the captured dust.

Any dielectrics can be used as a material for the production of discs [5]. The most suitable for this purpose are polystyrene, organic glass, polyvinyl chloride, fiberglass, fluoroplastic and other materials that have a high ability to electrify from friction. Brushes can be made of felt, nylon yarn, fiberglass, bristles, cloth, fur, etc.

When the discs rotate and rub against stationary brushes, static electricity is generated on the surface of the discs, and an electrostatic field is created between the discs. Dust particles are forcibly directed or freely enter the device and fall into the electric field. As a result of the effect of polarization and direction of charges, dust is attracted by the surface of the oppositely charged discs, settles on them and with the help of brushes 4 are cleaned into the hopper - dust collector 5.

An electrostatic field is created by electric charges stationary in space and constant in time, while there is no electric current. It is a special kind of matter that transmits the actions of charges to each other.

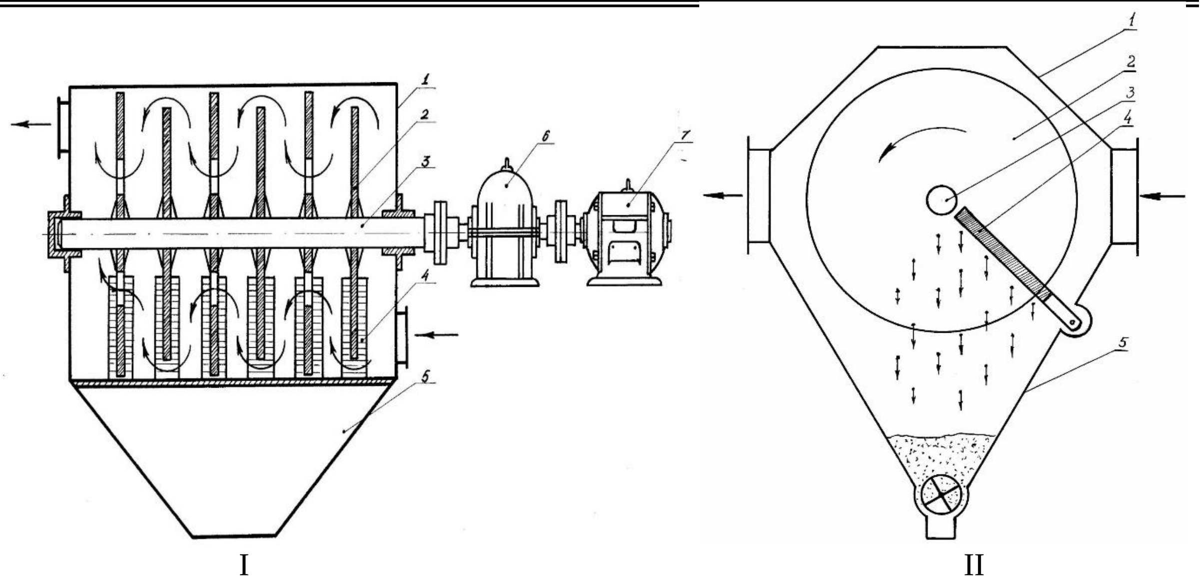

Fig. 1. Multi-disc triboelectrostatic dust collector: 1 – body; 2 - electrode discs; 3 – shaft; 4 – brushes; 5 - dust hopper; 6 – reducer; 7 - electric motor.

Electrostatic discharge occurs at very high voltage and very low current. A voltage of tens of thousands of volts with a current measured in thousandths of an ampere cannot be felt by touch. It is the low current values that prevent the static charge from harming a person, which is a great advantage of the tribo-electrostatic dust collector.

To prevent the charges from flowing off the surface of the discs, the shaft must be made of a dielectric or have insulating devices.

The device can be connected to the gas pipe in two ways. The flow of dusty gas can pass: I - perpendicularly and II - along the axis of rotation of the discs. In the second case, dusty gas is supplied through a side fitting. The gas passes through the radial gap between the first (in the direction of the gas) disk and the casing, then moves from the periphery to the center between the first and second disk. The gas then passes through the central holes in the second disc and is directed from the center to the periphery between the second and third discs. Thus, the gas passes successively through the gaps between all the discs and is discharged from the opposite end of the device through the side fitting. To ensure the movement of gas through the dust collector in all paired disks, holes are made in their central part for the passage of gas, and the gap between these disks and the filter casing should be minimal. Unpaired disks are made solid, and the gap between the disk and the casing should ensure the unhindered passage of gas.

With the cover removed (Fig. 2), the dust collector can be installed in an open, dusty room or at the source of dust emission. In this case, the particles are attracted to the discs from a distance of 3 - 5 m.

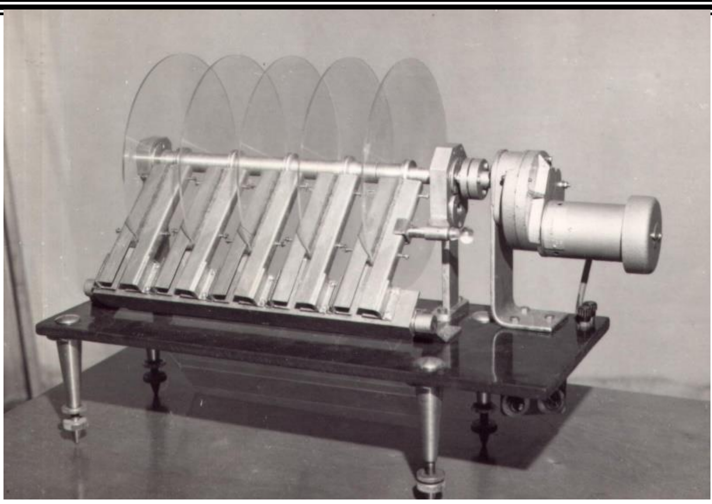

Fig. 2. Triboelectrostatic dust collector of open type

The conducted tests showed that the device of the described design intensively captures dust of various substances of organic and inorganic origin. From organic substances, cotton, hemp and jute dust, particles of other textile fibrous materials, as well as flour, sugar, oxalic acid, urea, sulfosalts, etc. are well captured.

The triboelectrostatic dust collector is able to effectively clean gases from extremely light and small particles, the size of which can be less than 0.01μm, to safely capture flammable, explosive, conductive dust at low gas pressure.

The working parts of the dust collector are not subject to corrosion from the action of acids, alkalis and other aggressive environments, as they are made of non-metallic materials, and electromagnetic fields dangerous to human health do not arise in it.

References

1. Torghabeh A., Pradhan B., Jahandari A. Assessment of geochemical and sedimentological characteristics of atmospheric dust in Shiraz, southwest Iran. *Geoscience Frontiers*. 2019. P. 26–32.

2. Виробничий пил, його дія на організм людини. URL: https://te.dsp.gov.ua/vyrobnychyj-pyl-jogo-diya-na-organizm-lyudyny/

3. Мала гірнича енциклопедія : у 3 т. / за ред. В.С. Білець-кого. - Д. : Донбас, 2004. - Т. 1 : А - К. - 640 с. - ISBN 966-7804-14-3.

4. Патент на корисну модель №120641 Україна, МПК A47L 9/10, (2006.01), B04C 3/04 (2006.01). Трибоелектростатичний пиловловлювач / Кузнєцов С.І. (Україна); Заявл.22.04.11; Опубл. 11.11.17, Бюл. №21, 2017.

5. Кузнєцов С.І., Венгер О.О., Семенченко О.О., Безпальченко В.М., Івкіна Є.С. Дослідження впливу деяких факторів на рівень електризації діелектриків. Науково-практичний журнал Екологічні науки №45 - С. 95-99.