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DEVELOPMENT OF A FIBER FILTER FOR DUST CHAMBERS

Purpose. Development of a new design of the dust chamber for dedusting the air of aspiration systems equipped with a modular fiber filter.

Methodology. In the development, a complex method was used, which provided for the critical analysis and synthesis of literature, security documents for inventions and utility models regarding the types and designs of dust chambers for purification of aspiration air from industrial dust, as well as a theoretical rationale for electrostatic dust collection in a fiber filter that is based on the laws of physics and aerodynamics.

Findings. Research studies on various types and designs of dust chambers have shown the feasibility of developing a new design of the dust chamber equipped with a modular fiber filter to increase its efficiency. Such a design of the dust chamber for the purification of aspiration air will improve the state of sanitary and hygienic working conditions of workers of mining and processing plants and mines.

Originality. Ways of increasing the efficiency of dust collection of industrial dust by dust chambers due to the placement of different dust precipitation elements are considered. A new dust chamber design has been developed for dedusting air of aspiration systems. The chamber is equipped with a modular fiber filter that operates in interchangeable dust deposition and regeneration modes depending on dust load.

Practical value. To improve the efficiency of dust collection in aspiration systems on the basis of theoretical justification and experimental tests, a new design the dust chamber has been developed equipped with a modular fiber filter that operates in interchangeable dust deposition and regeneration modes, which ensures effective dedusting of air from ventilation emissions.

Keywords: *dust chamber, fiber filter, aspiration system, aspiration air, dust catching, coagulation*

Introduction. The extraction of iron ores of the Kryvyi Rih basin is carried out underground (PJSC "KRYVYI RIH'S IRON-ORE COMBINE", PJSC "SUHA BALKA", mine management of PJSC "ARCELORMITTAL KRYVIY RIH") and open (PJSC "PivnHZK", PJSC "CENTRAL HZK", mining and processing production of PJSC "ARCELORMITTAL KRYVIY RIH", PJSC "PivdHZK", PJSC "INHULETS HZK") methods [1, 2].

The process of processing the rock mass at the crushing and sorting complexes of mines and crushing and concentrating complexes of plants includes technological operations of large, medium and small crushing, classification of iron ore by size, transportation, overloading, grinding, and enrichment. All these operations are accompanied by the formation of a large amount of industrial dust.

Depending on the composition, the dust may have a fibrogenic, irritant, toxic and allergenic effect on the body. Of paramount importance for the development of pulmonary diseases of the lungs (chronic dust bronchitis, pneumoconiosis, bronchial asthma, pulmonary emphysema, pulmonary insufficiency, etc.) is the mineralogical composition of dust, especially the content of silica. Production dust can affect the organs of vision, lead to inflammatory processes in the conjunctiva (conjunctivitis). Dust, getting on the skin, can cause allergic reactions and can either penetrate directly into the skin or into the orifices of the sebaceous and sweat glands. When the sebaceous glands are blocked, inflammatory processes can occur, which are accompanied by reddening and skin tenderness. Clogging with dust of these glands leads to a decrease in sweating ability of the skin, which is a protective mechanism of the organism against overheating.

In order to prevent the spread of dust in industrial premises or on industrial sites, dust extraction sites are localized by means of aspiration shelters with the removal of aspiration air into the dust treatment plants.

According to the research conducted at the mining and ore-dressing enterprises of Kryvyi Rih, the dust content in the aspiration air can fluctuate over a wide range: from 150–400 mg/m^3 (with screens and dry magnetic separators) up to 1000–5000 mg/m^3 (during operation of crushers and unloading of rock mass from them).

According to the technical characteristics of dust treatment plants used for cleaning the aspiration air of mining and processing plants and crushing and sorting complexes of the mines of Kryvbas, the efficiency of cleaning at the first stage (cyclones of different design, gravel filters, and so on) should be 85–95 %, at the second (hoses, electric filters, etc.) – 97–99 %. Industrial studies have shown that the actual total efficiency of the two-stage cleaning system does not exceed 70–80 %, resulting in air pollution of production shops, industrial sites and the territory of industrial enterprises of Kryvbas, worsening the sanitary and hygienic working conditions of their workers.

Cases of occupational diseases of dusty etiology among workers of the basic occupations of the mining enterprises of Kryvbas make approximately 90–100 per 10,000 employees of the total number per year. The incidence of dust bronchitis is also observed among workers in the auxiliary professions (20–25 % of the total). These categories of workers do not take direct part in the processing of the rock mass, but throughout their working time are in the area contaminated with dust at a concentration greater than the maximum permissible.

Literature review. Research studies and publications of a number of domestic and foreign authors are devoted to the solution of the issue of aspiration air purification, which is removed from the shelters of technological equipment for processing of rock mass, such as M. I. Birger, A. Yu. Waldberg, V. P. Aleksandrov, V. N. Uzhov, A. V. Sheleketin, I. I. Afanasiev, O. Ye. Lapshyn, O. V. Kalmykov, K. G. Rudenko, V. I. Muliavko, A. M. Kirichenko, A. A. Nemchenko, S. M. Panova, Andrew B. Cecala, Andrew D. O'Brien, Joseph Schall, Jay F. Colinet, William R. Fox, Robert J. Franta, Jerry Joy, Wm. Randolph Reed, Patrick W. Reeser, John R. Rounds, Mark J. Schultz, and others.

The analysis of the literature has shown that the choice of the method for trapping dust for the purification of aspiration air depends on the physico-chemical properties (dispersed composition, hygroscopicity, tendency to coagulate, ability to cement, flammability, electrical properties) and the value of the industrial dust being captured; the content of dust fractions in the purified air and the limits of its change, and so on.

According to the basic environmental and hygiene standards and regulations (TRGS 900, BGI 5047, EN ISO 14001: 2004, etc.) managed by EU and US industrial companies, gravity dust collectors, dry and coating cyclones (TGL, SGA, SHA, etc.), bag filters (with mechanical dust shaking, backwash, impulse backwash, cartridges), wet dust collectors (Venturi scrubbers, with barrier, irrigated with water droplets) and industrial electric filters can be used to clean aspiration air [3–5].

At enterprises of Ukraine and CIS countries for the extraction and processing of minerals for the purification of air aspiration systems there are used gravitational dust collectors (dust chambers), louvered dust collectors, single and group cyclones (type CN, SKCN, SIOT, LIOT, CVP), battery cyclones (type BC, PBC, CB, CBR), rotoclones, scrubbers (injectors, Venturi, nozzles, centrifuges), fabric filters (hoses, eyelids, rolls, etc.), granular filters (gravel, Rashig rings, granules, etc.), electrostatic precipitators (type UG, EGA, UV, etc.) [6, 7].

Unsolved aspect of the problem. The problem of increasing the reliability of the work of aspiration systems and purification of aspiration air in dust collecting devices for improvement of sanitary and hygienic working conditions of employees is urgent and has not been completely solved by this time.

The decrease in the efficiency of aspiration air purification in dust-collecting plants of enterprises is caused, as a rule, by the unsatisfactory work of the first stage of purification – cyclones. The inconsistency of the actual efficiency of air purification by cyclones with their technical characteristics is caused by a number of organizational and technical reasons, which are completely eliminated under the conditions of operation of these existing devices, which is very problematic:

1. Highly abrasive dust generated during crushing and grading of rock mass, entering the cyclone at high speed (from 8 to 22 m/s at the inlet and from 1.7 to 4.5 m/s at the working part), causes it to erase, resulting in the need to overhaul or replace the cyclone. The need for frequent repairs or replacement of cyclones results in the fact that they are in most cases in poor condition with poor cleaning efficiency.

2. Frequent failure to observe the discharge schedule of the cyclone bins causes them to be filled and the cleaning efficiency drops to zero.

3. The technical implementation of the unloading part of the cyclone bins in many cases leads to significant air leaks (when the suction value is 6–8 %, the cleaning efficiency is reduced to zero).

4. They are very sensitive to the decrease in the velocity of the dusty flow at the inlet to the cyclone, which inevitably arises in the operation of aspiration systems due to the wear of the fan parts, increase in the aerodynamic resistance of the air ducts from the suction points to the cyclones as a result of the accumulation of dust on the horizontal and weak sites, as well as unproductive suction in areas from cyclones to fans.

For these reasons, the actual efficiency of cyclone air purification is reduced to 45–50 % of its nominal value.

Low efficiency of catching dust by filtering installations of the first stage of cleaning adversely affects the work of filtering installations of the second stage (bag filters, electro filters, rotoclones, bubbling filters), as they get large abrasive particles leading to their premature wear and failure of the entire installation of dust collectors aspiration system.

Purpose. A critical analysis of the existing design solutions of dust chambers, by which the aspiration air is purified, was carried out in order to determine the possibilities of their further improvement and development of a new design of a dust chamber equipped with a modular fiber filter, for improvement of sanitary and hygienic working conditions of workers of crushing and sorting complexes of mines and crushing and concentrating complexes of plants.

Methods. The research was performed by critically analyzing and generalizing various literary sources, security documents for inventions and utility models on existing types and designs of dust chambers for purifying aspirated air from industrial dust, and based on the results of industrial studies of fiber curtains in the conditions of a crushing and screening plant mine "Rodina" of PJSC "KRYVYI RIH'S IRON-ORE COMBINE" and pilot operation in the conditions of the case of medium-shallow crushing of the crushing plant and processing plant No. 1 of PJSC "Ferrexpo Poltava Mining".

Results. All common methods of extracting dust from aspiration air can be divided into the following:

1. Dry (gravity dust: hollow, with shelves; inertial: chamber, louver, cyclone, vortex, rotary; filtration: fabric, fibrous, granular, mesh, spongy; electric: single-zone, double-zone, tubular, lamellar; combined: electrocyclones, filter cyclones).

2. Wet (inertial: chamber, condensing, cyclone, rotary, scrubber, shock; filtration: mesh, fibrous, foam; electric: single-zone, double-zone, tubular, lamellar; combined: cyclone-foam).

Wet dust trapping methods have several drawbacks (high energy costs and the cost of cleaning the air from dust, runoff, the need to protect dust-cleaners from corrosion and the removal of deposits on the walls of the apparatus and pipelines, the need for warming or supplying hot water at low ambient temperatures) which limit their widespread use; therefore, dry methods of dusting are preferred.

When choosing a specific dust collector to clean the aspiration air, in addition to the above, you should additionally consider:

- volume of aspiration air;
- pressure value in the ventilation unit;
- ways to remove trapped dust.

Dust (dust deposition) chambers are the simplest dust collectors, in which dusty air moves at low speed, resulting in the gravitational deposition of dust particles.

For practical use, dust cameras have several advantages, namely:

- simplicity of construction and operation;
- reliability and durability;
- possibility of arrangement with other elements of aspiration systems and possibility of application both in stationary and in mobile installations;
- low hydraulic resistance (up to 200 Pa), allowing the use of low-pressure fans;
- relatively small capital and operating costs;
- changes in the aerodynamic parameters of the aspiration systems, which tend to reduce the amount of aspiration air, do not reduce the cleaning efficiency, as in cyclones, and vice versa increase it, since it is inversely proportional to the velocity of dusty air in the chamber;

- because of the low velocity of dusty air in the chamber, the abrasiveness of the dust has little effect on its service life;

- they do not require insulation while reducing the ambient temperature, as this reduces the density of dusty air, resulting in reduced resistance of the environment to the deposition of dust particles and increases the efficiency of air purification.

However, the presence of significant drawbacks inhibits the mass use of dust chambers (low efficiency of deposition of fine dust fractions; large overall dimensions at high air flow; capture of predominantly heavy and large particles).

At the same time, simple variants of dust chambers are used as elements of basic technological equipment (for example, cold heads of rotary kilns and drying drums are equipped with dust chambers that capture large particles of dust, which reduces the likelihood of their deposition in aspirated ducts and reduces the dust load on highly efficient dust collectors). Therefore, it is advisable to install dust chambers as the first stage of dusty air purification for the deposition of large and heavy dust particles.

However, there are various ways to increase the dust collection of dust chambers, which can significantly approximate it to the efficiency of cyclones while guaranteeing the stability of dust collection.

The performance of dust chambers depends on a number of parameters relating to the aerodynamics of dusty air flow, its physical state, physico-mechanical properties of dust, geometric shapes and dimensions of the chamber. Changing these settings can actively influence the dust chamber's performance.

In stationary air, gravity forces a suspended particle in gravity seeking to reach the vertically limiting surface of the dust-limiting surface at a velocity determined by Stokes law, which takes into account the size of the dust particle, acceleration of free fall, density and dynamic air clarity.

In the laminar mode of the air flow, the deposition time of the dust particle will be the same, but it will move horizontally to the distance determined by the speed of the flow. In order for the dust particle to remain in the chamber, this distance must not be greater than the length of the chamber.

In the turbulent mode of motion of the dusty air stream, the dust deposition velocity is affected by the transverse component of the flow pulsation rate, which causes the dust deposition conditions to deteriorate sharply. Therefore, in order to increase the efficiency of the dust chamber, the mode of air movement in it should be as close as possible to the laminar.

A characteristic parameter that determines the flow regime is known to be the Reynolds number, which takes into account the flow velocity, the characteristic linear size of the channel along which the flow moves, and the kinematic viscosity of the air flow. The smaller the value of the Reynolds number is, the closer the mode of motion is to laminar. We practically cannot influence the magnitude of the kinematic viscosity. Reducing the velocity of the dusty air stream at a given flow rate can only be achieved by increasing the cross-sectional area of the chamber by increasing the linear dimensions, which is undesirable since this will increase the value of the Reynolds number. In addition, increasing the width of the dust chamber leads to an increase in the usable space occupied by the camera, and an increase in height leads to an increase in the distance of deposition of dust particles.

Therefore, the efficiency of deposition of dust particles by gravity forces in dust chambers can be increased by reducing the distance from any dust particle to the surface of its deposition plane. This is achieved by placing it in the cavity of a dust chamber of horizontal or inclined plates (shelves), which converts it into a group of small parallel chambers (patent of Ukraine for utility model No. 1204) and reduces the required time of finding dust particles within the length of the chamber.

Reducing the height of fall (deposition) of dust particles is also achieved by placing vertical partitions or special guide plates in the middle of the dust chambers to direct the dusty air flow to the bottom of the dust chamber and by reducing its speed (patents of Ukraine for utility model No. 95132 and No. 104741). By reducing the speed of movement of the air stream and its deflection down, the dust particles, due to the collision with the guide plates and with each other, coagulate to form aggregates that are better deposited by gravity.

In some dust chambers, in order to increase their dust efficiency, it is envisaged to install chain or wire curtains and partitions, vertical or horizontal screens (patent of Ukraine for utility model No. 97725). Due to this, the mechanism of inertial deposition of dust particles is added to the mechanism of gravitational deposition by the flow of air from various obstacles.

For purification of the polluted air from dust under the influence of both gravity and electric field forces inside the dust chambers, the deposition and corona electrodes are installed (patent of Ukraine for utility model No. 114271).

One way to increase the efficiency of coagulation of dust particles is to place in the path of the dusty flow of various obstacles that can create an electrostatic effect in the air flow, promote mechanical coagulation of the particles, as well as the deposition of dust due to the loss of energy of the dust particle moving in the dust chamber, for example, fiber curtains (fiber filter) [8, 9].

Industrial research studies on a fiber filter for aspiration shelters of nodes of overloading of bulk materials (on the design of which patents of Ukraine for utility model No. 52371 and No. 78881 were obtained) in the conditions of the crushing and sorting factory mine "Rodina" of PJSC "KRYVYI RIH'S IRON-ORE COMBINE" and the experimental operation of this filter in the conditions of the case of medium-shallow crushing of the crushing plant and concentrating plant No. 1 of PJSC "Ferrexpo Poltava Mining" showed that the filter efficiency, depending on the degree of tightness of the cover, can reach 92–93 %.

Therefore, it is advisable to equip the dust chamber with a modular fiber filter, which will increase the efficiency of its dust deposition.

The mechanism of dust trapping by a fiber filter is the deposition of dust particles on the fibers as a result of Brownian motion (diffusion), inertial collision, contact (engagement), the action of gravitational and electrostatic forces (Fig. 1).

Dust particles accumulating on the surface of the fibers completely cover the fibers and further settling occurs on a layer of previously settled dust particles. The accumulation of dust deposits on the fibers causes a change in the structure of the filter medium and the conditions of filtration, resulting in the formation of enlarged particle aggregates, which become an auxiliary filter medium. The formation of auxiliary filter layers inside the fibers increases hydraulic resistance and increases the efficiency of dust deposition on the fibers.

According to filtration theory, all dust particles that touch the fiber surface are retained on it, but in some cases, when

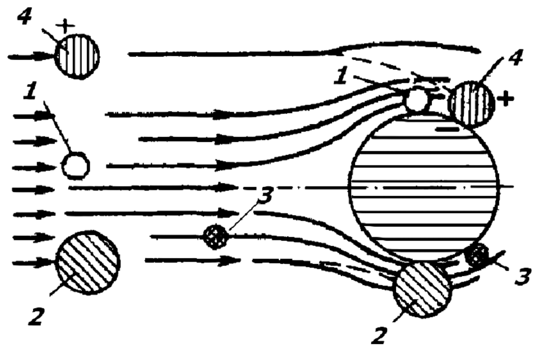

Fig. 1. Scheme of mechanisms of dust capture by fiber:

1 – due to contact (engagement); 2 – due to inertial collision; 3 – due to Brownian motion (diffusion); 4 – due to the action of electrostatic forces dust particles hit the surface of the fiber, their reflection due to elastic impact is possible and the greater the likelihood of the lower the adhesion or autogression forces acting on particles.

In order to retain dust particles after contact with the surface of the fiber, it is necessary that the energy of the adhesion forces (autogenesis) should be greater than the kinetic energy of the particle obtained by the elastic impact. According to experimental studies, we can conclude that for dust particles smaller than 1 micron, the probability of reflection from the fiber surface is very small and can be ignored. As the size of the dust particles increases, their kinetic energy increases and this increase is proportional to the size of the cube. The area of contact of the dust particles with the surface of the fiber or the individual contact between the particles changes only in proportion to the square of the particle size. Therefore, as a result of the increase in the size of the dust particles, the probability of reflecting the particles after contact with the fiber surface increases.

The value of the kinetic energy of the dust particles after the contact depends on the elastic-plastic properties of the dust particles and fibers: the higher the elasticity of the dust particles and fibers is, the greater the probability of reflection of the particles from the fiber surface is.

The values of kinetic energy and the probability of reflection are determined not only by the size of the particles, but also by the speed of their motion in the air stream. The probability of reflecting dust particles is highest with some average particle speed. At relatively low speeds, the dust particles have little kinetic energy and are subjected to a relatively small aerodynamic force that seeks to tear away and extract these particles.

At high speeds of motion the magnitude of the kinetic energy of the dust particles is considerable, and when they contact, they can develop a momentum of force, which may exceed the elastic limit of the material in the contact zone. The plastic deformation that occurs in the contact zone contributes to the approximation of dust particles (or dust particles and fibers) and the increase in the contact surface, which in turn leads to an increase in the forces of autogeny (adhesion). If the dust particles or fibers have sufficiently plastic properties, then the increase in adhesion forces (autogenesis) will be significant enough to ensure their secure attachment to the surface of the fibers. Thus, at sufficiently high speeds of movement of dust particles, the probability of their reflection is very low.

Let us dwell in more detail on the electrostatic deposition of dust particles, since the presence of electrical charges on the fibers increases the overall dust efficiency by 20–30 %, which is confirmed by the results of repeated laboratory and practical studies.

Most synthetic fibers create an electrostatic effect in the flow of dusty air moving through them.

Some types of synthetic fibers and dust particles can accumulate electrical charges, leading to electrostatic interaction that is sufficient to move dust particles to the fibers and touch their surface. Electrostatic interaction forces are widely used to increase the efficiency of dust trapping in filtering devices for respiratory protection [10] and for aspiration air purification. In this case, the charging of dust particles and fibers can occur due to triboelectricity when the particles strike one another and when rubbing on the surrounding surfaces (housings of technological equipment, covers of aspiration shelters, aspiration ducts, collectors), and so on.

There are different naturally occurring processes of electrification of bodies that can occur simultaneously. Static electrification can include the following physical phenomena:

- contact electrification, which occurs at the contact of two bodies and is caused by the transition of electrons across the interface, which in turn is caused by the difference in the position of the electronic energy levels;

- electrification of friction resulting from the contact or collision of the dry surfaces of two solids and their subsequent separation (typically, the surfaces of two heterogeneous bodies or two solids with different concentrations of the same ions);

- homogeneous or symmetric charge separation, which occurs when the relatively small solids are separated from one another. This creates particles that carry different in magnitude opposite to the sign of charge, while the system as a whole remains neutral;

- electrification caused by electrostatic phenomena in gases in contact with solids is associated with the formation of ions and electrons. Moreover, opposite charges are separated by mechanical forces as a result of the movement of masses of gases or solids in the presence of electric fields or in the absence thereof.

The polarity, the value of the charges, and the rate of their loss are influenced by the chemical composition of the fibers and dust particles and the conditions of dust formation.

As a result of experimental studies, it was determined that iron ore, which is formed during the extraction and processing of iron ore at the mining and mining enterprises of Kryvyi Rih contains approximately 55 % of particles with a positive charge, 37 % – particles with a negative charge and 8 % – neutrally charged particles.

The action of electrostatic interaction forces leads to the aggregation of dust, as well as to the formation of dust aggregates with many branches on the fibers (the so-called "dendrites"). Coagulated dust particles are more easily deposited on the fiber, and dust particle aggregates formed on the fibers increase the efficiency of dust retention from the air stream.

The effect of the electric field on the process of deposition of dust particles on the fiber can be roughly divided into weak and strong. The weak influence of the electric field is considered to be the one that cannot change the trajectory of motion of the particles. Due to the strong influence of the electric field, the motion of particles near the fiber and their adhesion (autogenesis) are determined mainly by the presence and magnitude of the electric field.

As experiments show, electrically charged fibers over time lose their charge. Even in normal relative humidity (40–50 %) after 80–90 minutes after pointing the charge on the fibers, its density decreases by 45–60 %. However, under the influence of constant factors leading to the formation of charges on the fibers (the presence of electrically charged dust or dust, which when interacting with the fiber forms an electric charge), they can be stored for a long time.

The deposition of dust particles on the fiber is uneven. The maximum size and number of dust particles that settle on the fiber decreases as the contact angle φ increases to 90° (Fig. 2). At a touch angle close to zero, the flow velocity is minimal and therefore the probability of dust particle detachment due to aerodynamic force is minimal.

When the side surfaces of the fiber are wrapped, the tearing force increases due to the increase in the speed of the dust flow. Under the influence of air flow, not so much individual particles as their aggregates can come off. The probability of separation of sediment particles and their aggregates from the fiber may increase due to the fact that, in addition to the hydrodynamic forces of the dusty stream, they are affected by kinetic energy due to the oblique impact of particles moving in

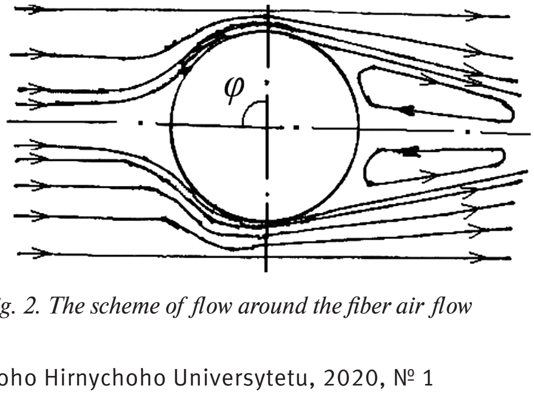

Fig. 2. The scheme of flow around the fiber air flow

the air stream. As a result of the combined effect of these factors, the separation of particles and aggregates can occur at lower flow rates compared to dustless airflow.

On the back of the fiber, adhesion (autogenesis) increases due to turbulent eddies, especially for small dust particles. The deposition of dust particles on the front and back sides of the fiber has a different mechanism and depends on the size of the particles and the direction of air flow.

Based on the above for the purification of aspiration air, the authors propose a dust chamber equipped with a modular fiber filter (Fig. 3), consisting of a housing *1*, in the middle of which are insulated impermeable partitions section *2*, inlet branch for supplying dusty aspirated air *3* and exhaust branch for removal of purified air *4*. In the middle of the insulated sections *2* there are mounted coaxially arranged cylindrical nets *5*, rigidly fixed to their bottoms, inside of which there are freely suspended on solid inverted plates *6* negatively and positively charged fiber curtains of modular fiber filter *7*, which passes pre-charging in the chamber.

An electrostatic field is formed around the fibers of the modular fiber filter. By entering the field of appropriate polarity, dust particles from the stream of dusty air passing through the filter, gather directional motion to the surface of the fiber and settle on it, forming a loose dust layer, which is removed mechanically. With the loss of fibers of the charge on them the electrostatic mechanism of capture is weakened and deposition occurs, mainly due to inertial and gravitational forces.

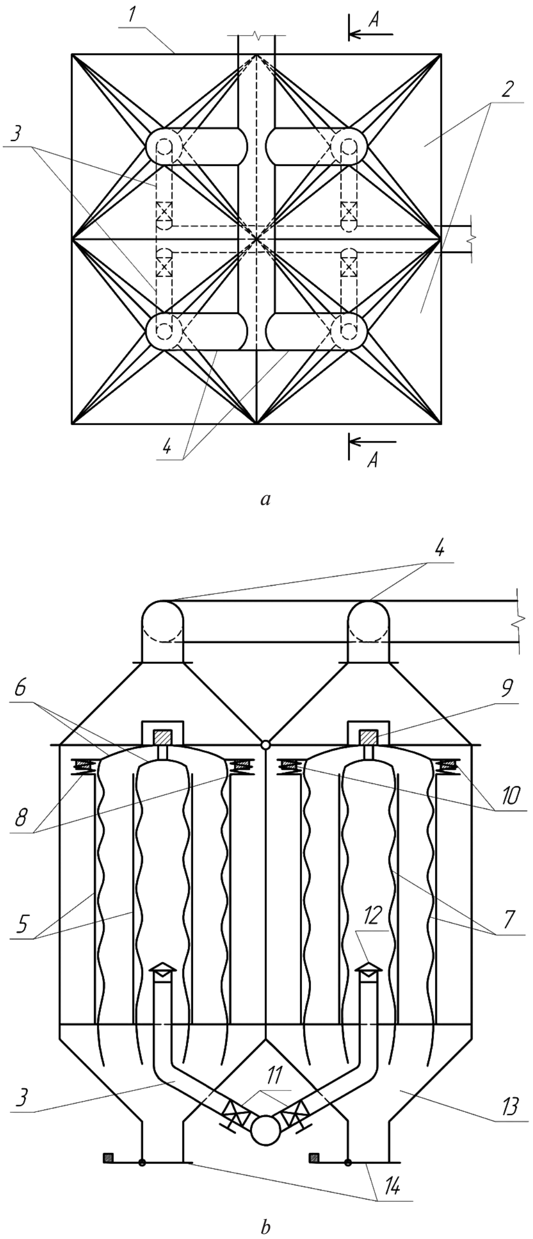

Fig. 3. Dust chamber with a modular fiber filter:
a – top view; b – section along the line A-A

Inverted plates 6 rely on springs *8*, which are secured to the nets *5*, for the regeneration of the modular fiber filter with the help of the electric vibrator *9* mounted on the top inverted plate. In addition, the inverted plates *6* are equipped with electrical sensors *10* for the automatic activation of the vibrator *9*. Branches for supplying dusty aspirated air *3* are equipped with latches with mechanical actuator *11* and protective visors *12*. The bottom of the insulated sections *2* forms a hopper *13* to collect the trapped dust, which is equipped with a flashing shutter *14*.

A dust chamber with a modular fiber filter works as follows. The flow of dusty aspirated air through the inlet nozzles *3* vertically enters inside the insulated sections *2* and is reflected from the bottom solid inverted plate 6, which leads to the redirection of air flow in the horizontal direction with the formation of radial flows. Then the dusty air passes through the rows of negatively and positively charged curtains of the modular fiber filter *7*, which are stabilized by coaxially arranged cylindrical nets *5*, where it is cleared of dust and through the nozzles to remove the purified air *4* is discharged into a common air collector.

For the regeneration of the curtains of the modular fiber filter *7* by means of an electric vibrator *9* mounted on the upper inverted plate, the solid inverted plates *6* rely on springs *8* which are secured to the nets *5*. The vibrator *9* is automatically activated due to the fact that the inverted plates 6 are equipped with electrical sensors *10*, which are triggered when the inverted plates are lowered under the weight of the sediment in the modular fiber dust filter. In order to prevent dust from entering the inlet nozzle *3* during regeneration of the modular fiber filter *7*, a protective visor *12* is installed at its end. Shattered dust falls into the hopper 13, which is equipped with a flashing shutter *14*.

By increasing or decreasing the dust load on the dust chamber, as well as during repair work, the insulated sections *2* are switched on or off by means of mechanical actuator latches *11*. If the worn curtains of the modular fiber filter *7* are replaced, the upper part of the insulated section *2* opens and the plates *6* with worn modular fiber curtains are replaced with a new fiber filter by means of a hoisting mechanism. Replacement of the worn curtains of the modular fiber filter is made when it is determined by appropriate tools and techniques that, with constant aerodynamic parameters, the dust filter efficiency is reduced inside the dust chamber.

To maximize dust efficiency, additional rows of modular fiber filter curtains can be placed in the middle of the insulated sections, and the dust chamber can be assembled from any number of sections, arranged in series or in parallel.

Conclusions. Thus, on the basis of analytical research studies of the existing structures of dust chambers, a new design of a dust chamber of high efficiency was developed with a modular fiber filter placed in the body of the chamber for purification of aspiration air in order to improve the sanitary and hygienic working conditions of workers of mining and extraction enterprises. In the future, the authors plan to conduct research on a deeper study of the influence of electrostatic forces on the mechanism of formation and destruction of the dust layer on the fibers, which affects the quality of the filter regeneration process, as well as the development of devices for the electrification of dust particles and curtains modular fiber filter, which is equipped with a dust chamber, during camera operation.

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Розробка волоконного фільтра для пилових камер

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Мета. Розробка нової конструкції пилової камери для знепилення повітря аспіраційних систем, обладнаної модульним волоконним фільтром.

Методика. При розробці використовувався комплексний метод, що передбачав критичний аналіз і узагальнення літературних джерел, охоронних документів на винаходи та корисні моделі щодо типів і конструкцій пилових камер для очищення аспіраційного повітря від промислового пилу, теоретичне обґрунтування електростатичного пилоуловлення у волоконному фільтрі, що базується на законах фізики та аеродинаміки.

Результати. Проведений аналіз різноманітних типів і конструкцій пилових камер показав доцільність розробки нової конструкції пилової камери, обладнаної модульним волоконним фільтром задля підвищення ефективності її роботи. Така конструкція пилової камери для очищення аспіраційного повітря дозволить покращити стан санітарно-гігієнічних умов праці робітників гірничо-збагачувальних комбінатів і шахт.

Наукова новизна. Розглянуті способи підвищення ефективності пиловловлення промислового пилу пиловими камерами за рахунок розміщення в них різних пилоосаджувальних елементів. Розроблена нова конструкція пилової камери для знепилення повітря аспіраційних систем. Камера обладнана модульним волоконним фільтром, що діє у змінних режимах осадження й регенерації в залежності від пилового навантаження.

Практична значимість. Для підвищення ефективності уловлення пилу в аспіраційних системах на основі теоретичного обґрунтування та експериментальних випробувань розроблена нова конструкція пилової камери, обладнана модульним волоконним фільтром, який діє у змінних режимах пилоосадження й регенерації, що забезпечує ефективне знепилення повітря вентиляційних викидів.

Ключові слова: *пилова камера, волоконний фільтр, аспіраційна система, аспіраційне повітря, уловлювання пилу, коагуляція*

Разработка волоконного фильтра для пылевых камер

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Цель. Разработка новой конструкции пылевой камеры для обеспыливания воздуха аспирационных систем, оборудованной модульным волоконным фильтром.

Методика. При разработке использовался комплексный метод, предусматривающий критический анализ и обобщение литературных источников, охранных документов на изобретения и полезные модели относительно типов и конструкций пылевых камер для очистки аспирационного воздуха от промышленной пыли, теоретическое обоснование электростатического пылеулавливания в волоконном фильтре, которое основывается на законах физики и аэродинамики.

Результаты. Проведенный анализ разнообразных типов и конструкций пылевых камер показал целесообразность разработки новой конструкции пылевой камеры, оборудованной модульным волоконным фильтром для повышения эффективности ее работы. Такая конструкция пылевой камеры для очистки аспирационного воздуха позволит улучшить состояние санитарно-гигиенических условий труда работников горно-обогатительных комбинатов и шахт.

Научная новизна. Рассмотрены способы повышения эффективности пылеулавливания промышленной пыли пылевыми камерами за счет размещения в них разных пылеосадительных элементов. Разработана новая конструкция пылевой камеры для обеспыливания воздуха аспирационных систем. Камера оборудована модульным волоконным фильтром, который действует в сменных режимах осаждения и регенерации в зависимости от пылевой нагрузки.

Практическая значимость. Для повышения эффективности улавливания пыли в аспирационных системах на основе теоретического обоснования и экспериментальных испытаний разработана новая конструкция пылевой камеры, оборудованной модульным волоконным фильтром, который действует в сменных режимах пылеосаждения и регенерации, что обеспечивает эффективное обеспыливание воздуха вентиляционных выбросов.

Ключевые слова: *пылевая камера, волоконный фильтр, аспирационная система, аспирационный воздух, улавливание пыли, коагуляция*

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