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EXPERIMENTAL STUDIES ON POLYPROPYLENE FILTER RESISTANCE ACCORDING TO DSTU EN 143-2002

Purpose. To determine maximum dust holding capacity with the set dust-catching efficiency of two successively adjusted filtering elements made of polypropylene material when being dusted with coal dust.

Methodology. To define resistance of filters and their dust holding capacity, a gravimetric method was used according to DSTU EN 143-2002 requirements. The calculation methods consist of two stages. At the first stage the diameter of pre-filter fibres is calculated on the basis of maximum dust holding capacity for the set ultimate pressure and dust particle target size. At the same time, thickness and density of fibre packing of a filtering layer are selected by reference to conditions of the technological process of its formation while producing filtration fabric. At the second stage the radius of the main filter based on the set dust-catching efficiency is calculated.

Findings. It has been established that dust deposit on polypropylene filtering elements of respirators occurs in the front layer. It has been defined that dust holding capacity and protective power time of respirators can be increased while filtering coal dust with a system of two successively adjusted filtering elements with the following parameters: packing density of 55 and 27 g/cm^2; a fibre radius of 2–4 and 6–10 microns and a thickness of a filtering layer of 4 and 3 mm, respectively. This allowed creating an anti-aerosol two-layer polypropylene filter RPA-TD 1.2 which meets the DSTU EN 143-2002 requirements and can be used for protecting people's respiratory organs at the site of intensive coal dusting including stoping face, coal transloading, dressing plants and others.

Originality. Dust holding capacity of filters depends on generation of self-filtering dust layer, which can develop on the work surface at speeds below 0.04 m/s.

Practical value. Rational parameters of the two successively adjusted filtering elements of polypropylene fabrics were defined with the protective power time of the proposed system increased by 25 % compared to the used filtering elements for RPA respirators.

Keywords: *respirator, filter, dust holding capacity, pressure drop, air flow resistance, airflow rate*

Introduction. Nowadays, mine air dust content during the main technological process at mining enterprises exceeds maximum allowable concentration, which necessitates use of respiratory protective equipment (RPE). In stoping and development faces dust content in the work area achieves 1000 mg/m^3, while technically achievable levels of residual dust content are within the range of 300–400 mg/m^3 [1, 2]. Such high levels of dust content cause short service lifetime of filtering elements of respirators. Under these conditions regarding highly intensive work of miners, running time of respirators with even a large filtering area up to 1000 cm^2 will make only a few hours. That is why enhancing service lifetime of filters and their dust holding capacity at site of intensive coal dusting, such as working faces of coal mines, is a topical task.

Analysis of the recent research. Many scientists have been working upon solving the task of enhancing service lifetime of fibrous filters and, consequently, their dust holding capacity. Among them are A. A. Kirsh, I. B. Stechkina, V. A. Rirsh, B. I. Ogorodnikov, A. A. Ennan, V. N. Kyrychenko, Yu. L. Yurov, O. V. Hryhorieva, and others. Design engineers distinguish three major requirements to filters: low initial resistance, maximum dust holding capacity and compactness. The first two requirements are provided by low speeds of filtration, which can be achieved through increasing a filtering sur-

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face. At the same time, the third one reduces itself to a filter work surface which being unfolded volumetrically has a compact form [3].

According to certain researchers, increase in dust holding capacity can be achieved in two ways. The first one involves pleating of filtering surface [4], while the second one implies variable packing density and variable fibre radius through the thickness [5]. At the present time the second method is difficult to provide while manufacturing filtering materials. It is easier to produce filters consisting of two and more layers: the first (prefilter) layer is spongier, while the last (main) one is more compact. Use of a spongy layer with low initial resistance and filtering efficiency will allow increasing the dust holding capacity of a filter and the following compact layer will provide the necessary dust-catching efficiency [6]. The latter was studied by B. I. Ogorodnikov and his collaborators in order to develop high efficiency filter systems of "Shelter" Object [7, 8]. However, his works study the parameters of Petrianov's filtering materials (FM) only, which are limited in use and are not applied for producing respirator filters.

Unsolved aspects of the problem. It is possible to improve dust holding capacity of a filter as well as respirator service lifetime by combining the two methods described above. Thus, it is necessary to produce pleated filter elements with different densities of fibre packing which are adjusted successively. However, solution of the similar task requires extension studies to define the parameters of both the pre-filter, which will provide the most dust holding capacity at the least increase in resistance, and the main filter, designed to provide the set filtration efficiency.

Objectives of the article. The work aims to define the parameters of the system of two successively adjusted filtering elements, which are able to provide maximum dust holding capacity simultaneously achieving its limit value at the set filtration efficiency.

Theoretical research. Theoretical studies in this field have allowed developing a method for identifying effective radii of fibres of the main and preliminary stage of fibrous filters [5]. Calculation methods consist of two stages. At the first stage the diameter of pre-filter fibres is calculated on the basis of maximum dust holding capacity for set ultimate pressure and dust particle target size. At the same time, the thickness and density of the packing of the filtering layer fibres are selected based on conditions of the technological process of its formation while producing filtration fabric. At the second stage the radius of the main filter fibre is calculated based on the set dust-catching efficiency.

The dependence of pressure drop Δp on the filtering layer, which consists of polypropylene fibres on its dust holding capacity, can be expressed as follows [4]

$$\Delta\eth = \Delta\eth_{\hat{\imath}} + \frac{kd\rho_l\varphi}{6F_0}\left[\left(F_a^2 + \frac{4DF_a}{d\rho_l\varphi}\right)^{3/2} - F_a^3\right],$$

where Δp_0 is pressure drop on a pure filtering layer, pascal; d is a fibre diameter, m; ρ_l is loose density of dust particles, kg/m^3; φ is the coefficient which considers mass variation for a dust layer on the surface of a fibre depending on its size-consist; $F_a = {}^{4\beta H}\!/_{d}$ is the surface area of fibres, m^2; H is a filtering layer thickness, m; β is the density of particle-particle packing; F_0 is the area of pure filtering material, m^2; D is dust holding capacity, kg/m^2; k is the proportionality factor, which depends on filtration speed (for polypropylene fibres), m^4/s^2; here v is the filtration speed, m/s.

Fig. 1 shows a set of curves $\Delta p(D)$ which were calculated for typical filtration conditions with different radii of fibres.

According to Fig. 1, with the same thickness of a filtering layer and density of packing the dust holding capacity increases along with fibre diameter increasing, since more time is required for achieving the resistance which corresponds to the limit pressure drop.

It is well known that the bigger the fibre diameter is, the smaller the efficiency of filtering material is [5]. That is why it is necessary to define the dust aerosol concentration after the preliminary stage of cleaning in order to estimate an increase in pressure drop on the last filtering layer (the finishing filter) over time and to determine contribution of each stage to the overall increase in pressure drop. For pre-filters with small fibre diameter, pressure drop increases rapidly due to growing resistance of a layer of deposited particles on its surface. At the same time if the fibre diameters is very big, the pre-filter lets very many particles and rapid growth of pressure drop at the final stage is essential. Thus, we can conclude that there exists an appropriate fibre radius of the pre-filter which provides a proportional in time increase in pressure drop at both stages of cleaning.

Having defined the size of fibres of the preliminary stage of cleaning, it is necessary to determine the efficiency of its dust catching (filtration)

$$E = 1 - K = 1 - \exp\left(-\frac{\beta H}{\pi d}\eta_z\right),$$

where K is the coefficient of penetration of aerosol through the filtering layer, %; η_z is the overall coefficient of capture of aerosol particles.

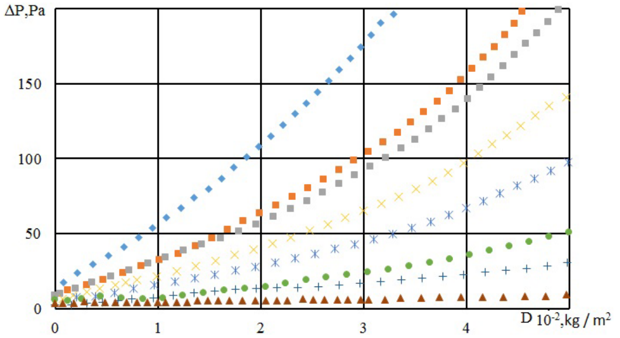

Fig. 1. Dependence of pressure drop Δp on dust holding capacity D of a filtering layer. The curves are calculated with:

v = 1.5 m/s; β = 0.05; H = 6 mm; and fibre diameters d = = 2 microns (◆); 2.5 (■); 3 (■); 3.5 (×); 4 (✳); 4.5 (●); 10 (+); 15 microns (▲)

The efficiency of capturing aerosol particles decreases with increasing fibre diameter (Fig. 2), that is why after defining the dust holding capacity of the filtering layer, it is necessary to check if filtration efficiency is provided.

The concentration of the dust aerosol after the filtering *Ca* can be calculated by the formula, mg/m^3

$$C_a = KC_b,$$

where C_b is the concentration of the dust aerosol before the filter, mg/m^3.

The dust holding capacity of the filtering layer over the time t, with the known airflow rate Q and dust aerosol concentration C_b, can be defined using the formula, mg/m^2

$$D = \frac{C_b Qt}{F_0}.$$

Thus, having been given the dust concentration in the air of the working area we can define the dust holding capacity of the preliminary layer over the time t. According to Fig. 1 we find the fibre diameter of the pre-filter, which will provide the most dust holding capacity. Afterwards, having defined the density of packing and filtering layer thickness (for polypropylene filters $\beta = 0.05$; $H = 6$ mm), we calculate dust-catching (filtration) efficiency and dust aerosol concentration after the preliminary layer. The fibre diameter of the finishing layer is found based on the given dust-catching efficiency, while dust holding capacity of the finishing filter is calculated over the same period of time t on the basis of the diameter value calculated from conditions of the maximum efficiency. At the same time it is essential to select the fibre diameter of the preliminary stage of cleaning so that pressure drop increase for both filters is virtually equal (Fig. 3).

Thus, the suggested methods will allow calculating effective fibre radii of multilayer filtering materials intended for respiratory protective equipment; this will be done as the first approximation without considering the distribution of coal dust over fractions. Their application at coal enterprises in stoping faces will allow increasing filter service lifetime with lower impacts on respiratory organs.

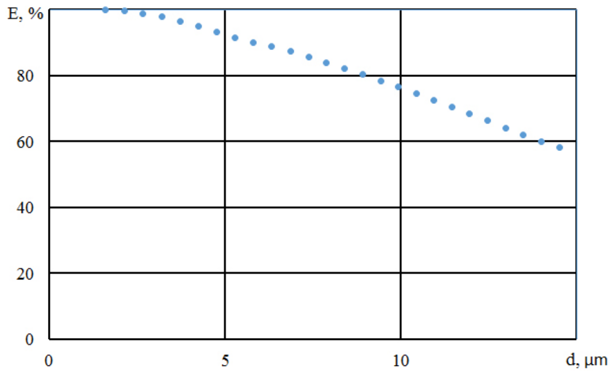

Fig. 2. Dependence of filtration efficiency E of a layer of the filtering material on the fibre diameter d

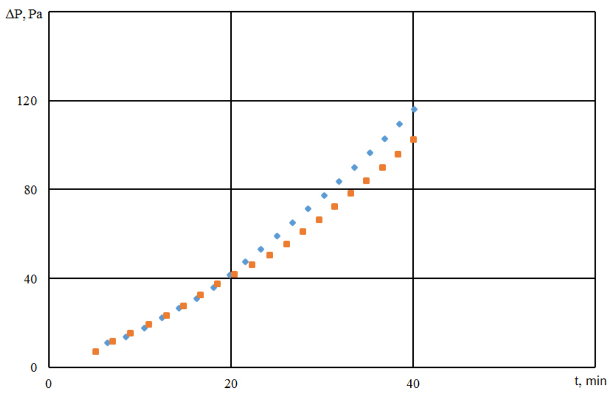

Fig. 3. Dependence of pressure drop increase Δp on time t in a two-layer filter:

◆ — pre-filter; ■ — the main filter

Experimental studies. To study the parameters of multilayer filters, a special universal stand was used (Fig. 4). Its part which provides preparation of newly generated dust is of particular interest; this sets the stand apart from other gears of similar purpose, since it imitates the real process of dust formation preserving all its properties of newly generated dust (surface maturity, no conglomerates, humidity, or electric charging, etc.). In this case modes of dispersion of dust-producing materials and blowing off particles are of importance; they will provide repeatable dust supply of the required size-consist and concentration range.

The unit works in the following way. The pressurised air is supplied from the compressor through the cleaning filter *1* to the pressure regulator *3*, which provides constant pressure controlled with a manometer *2*. The amount of air supplied to the unit is regulated with a valve *4* and is controlled with a micromanometer according to the pressure drop on the calibrated diaphragm *5*. Further, to create dust aerosol, part of the pure air is supplied with the help of a valve 6 through the flow-meter (rotary meter) to the vibrational chamber of dust supplier *9*, which is designed as a steel split-type glass with inlet and outlet fittings. The other part of the

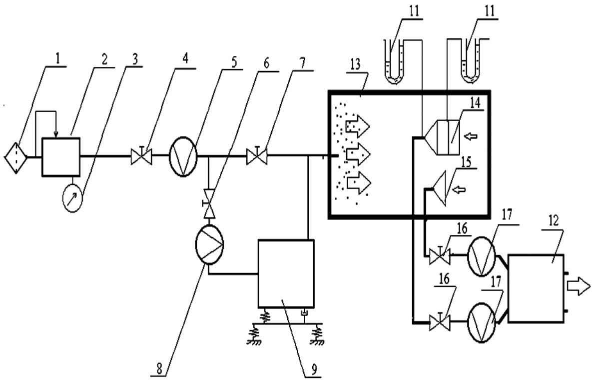

Fig. 4. The diagram of the unit for testing RPE and controlling dust content of the air:

1 — preliminary cleaning filter; 2 — manometer; 3 — pressure regulator; 4, 6, 7, 16 — control valves; 5 — diaphragm; 8, 17 — rotary meter; 9 — dust supplier; 11 — micromanometer; 12 — two-channel aspirator; 13 — testing chamber; 14 — holder of the tested filters; 15 — holder of AFA filters pure air is supplied through a valve *7* to the testing chamber *13* along with the tested product placed in it. The filters were adjusted successively into the portafilter *14*. Immediately before the testing chamber, the dusty air coming from the dust supplier is dispelled with the pure air to provide the required dust concentration. At the same time, it is controlled through the gravimetric method and the sampling is done to the AFA *15* filters.

The dust concentration in the air supplied to the testing chamber is calculated on the basis of the mass of the dust settling into the filter of the tested product and the volume of the air passing through it. Dust accumulation in the tested product is estimated according to an increase in its pressure resistance, which is defined based on the readings of a micromanometer *11* of MKB 150 type. The readings were taken every 20 minutes within the accuracy of ± 1 mm. Streaming the air through the filters at a rate of 30 l/min was provided by an aspirator *12* with rotary meters *17* and control valves *16*.

To form the required aerosol, preliminarily crushed pieces of dust-forming material (for example, coal) are loaded into the vibrational chamber; their mass makes about 100 g. With that intensive self-grinding of these pieces into particulate form occurs resulting from vibration of the chamber. To accelerate the grinding, loading of steel balls with a diameter of 10...15 mm into the chamber is available. Blowing off the dust from the chamber is provided by supplying the air through the inlet fitting. The airflow regulation with the valve *6* allows obtaining aerosol with different size-consist, while the required concentration is gained with the valve *7* due to dilution of dusty air with the pure air.

To obtain the similar or close to it distribution of the size-consist of the dust, there were selected four modes of operation of the unit whose parameters are given in Table 1.

The modes corresponded to the volume flow rate of dm^3/min. At the same time, created limiting concentrations depended on the flow rate of the air passing through the dust generator and changed approximately from 350 mg/m^3 at the volume rate of 1 dm^3/min to 1600 mg/m^3 at the rate of 4 dm^3/min. Lower values of dust concentrations could be obtained by increasing the pure air supply. Test samples of the size-consist were taken from the dust settling on the filter of the tested respirator and were analysed using the Coulter device. Selected results of the size-consist analysis are given in Table 1.

Polypropylene filters for RPA respirators of FFP2 brand with different packing density and fibre radius (the parameters are given in Table 2) were stidued. The main characteristics of the tested filters were defined according to DSTU EN 143 requirements and the results are given in Table 3.

The area of the filters made about 500 cm^2. The air was blown off with the volume of 30 l/min. The coefficient of penetration was defined by test-aerosol of paraffin oil with a particle diameter of 0.08–1.8 microns, with the mean weighted diameter of 0.6 microns.

The dust concentration in the testing chamber was defined by formula [9], mg/m^3

$$C = 1000\frac{M_1 - M_2}{Qt},$$

where M_1 is the mass of the dust filled quantitative AFA filter paper, mg; M_2 is the mass of the pure AFA filter, mg; Q is the rate of airflow through the filter, dm^3/min; t is the time of filter dusting, min.

The coefficient of penetration of the dust aerosol of the filter was defined by the formula [9]

$$K_d = \frac{M_{1f} - M_{2f}}{M_1 - M_2},$$

where M_{1f} and M_{2f} stand for the mass of dust filled and clean AFA filters after testing the samples, mg.

The results of studying the successively adjusted filters are presented in Figs. 5–8.

The analysis of the obtained data shows that given the equal density of fibre packing of both filters, almost all the dust settles on the first one, which results in its increasing resistance. As for the latter, the pressure drop kept stable (Fig. 5). In the second experiment, at the beginning of the dusting process the main filter resistance increased by 15 % within 60 minutes, and then kept constant till the end of studies. At the same time, pressure drop at the pre-filter was increasing constantly; however, by the end of the studies total resistance of the filter system was by 10 % lower than that in the first case. This is explained by the fact that part of the dust penetrated into the main filter and, therefore, dust load in the pre-filter, which mainly contributed to the resistance, decreased. It is worth noting that generation of dust on the pre-filter surface resulted in increasing its filtration efficiency and, thus, decreased the flow of aerosol particles to the following filter.

An interesting result was obtained in the third series. The increase in resistance both in the first and second filters was proceeding practically simultaneously for two hours. Afterwards, the change of pressure drop in the main filter started slowing down, while in the pre-filter, conversely, it began increasing faster (Figs. 9, 10). This id explained by formation of a self-filtering dust layer on the pre-filter surface; this dust layer enhanced its efficiency and, thus, decreased the dust flow to the main filter. Many researchers also point out a possibility of its formation [10, 11]. With the aerosol flows through the filtration fabric, disperse particles settle on the fibres. In the process of aerosol deposition the disperse particles accumulate as dendrites between fibres occluding pore channels. On the surface of the filtration fabric there is formed a layer of aerosol particles, the so-called autofilter, which is a highly effective filtering environment almost completely catching disperse particles out of the aerosol flow. Its formation features low filtration speed up to 0.04 m/s, which occurs when respirators are used taking into account the area of filters of 500 cm^2 and airflow rate of 30 dm^3/min. Further increase in filtration speed results in increasing response rate of a particle and in weakening electrostatic and diffusive mechanisms of catching aerosol and, therefore, in fewer prerequisites to formation of dust self-layer.

Table 1

Characteristics of the unit operation mode

Unit operation mode	Rate of airflow through the dust generator, dm^3/min	Dust concentration in the chamber, mg/m^3 during air supply of 60 dm^3/min	Dispersive particle size, micron (mass fraction of particles in samples at different modes of blowing off, %)				Mean median size of dust, micron
			below 5	5–10	10–30	over 30	
1	1	300–350	9	12	49	30	21
2	2	500–550	8	11	48	33	22
3	3	850–900	4	8	45	41	27
4	4	1500–1600	3	5	30	62	36

Table 2

Parameters of filtering materials for producing filters

Number of the sample	Area density of samples, g/cm^2	Filtering layer thickness, mm	Mean fibre radius, micron
The pre-filter			
1	50	5	2–4
2	40	4	3–5
3	27	4	5–9
4	17	3	6–10
The main filter			
1	55	4	2–4

Table 3

The main characteristics of filters

Factors	Values of filters with the density of packing, g/cm^2			
	50	40	27	17
Coefficient of penetration by paraffin oil, with the air volume of 30 l/min	0.5	3	12	35
Pressure drop at the filter, Pascal, with the air volume of 30 l/min	27.5 ± 1.5	22.6 ± 2.4	13.7 ± 1.9	6.1 ± 1.7

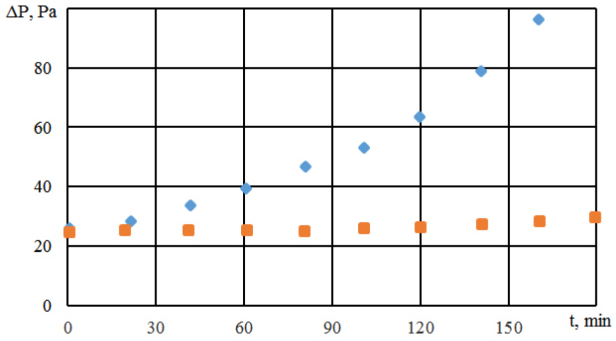

Fig. 5. Change of pressure drop when dusted by coal dust with concentration of 300 mg/m^3:

◆ – in the main filter with density of 55 g/cm^2; ■ – in the pre-filter with density of 50 g/cm^2

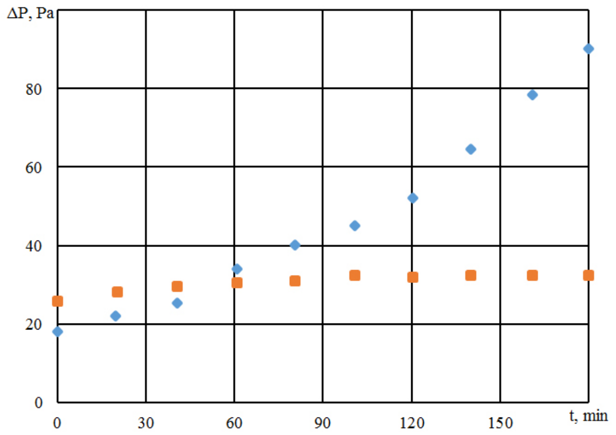

Fig. 6. Change of pressure drop when dusted by coal dust with concentration of 300 mg/m^3:

◆ – in the main filter with density of 55 g/cm^2; ■ – in the main filter with density of 40 g/cm^2

Let us note that the overall resistance of the filter system was by 20 % lower than that in the first case, which indicates higher dust holding capacity of the system. For example, comparing the figures of pressure drop change of this filter system with similar figures of a filter with a density of 55 g/cm^2, we can see that despite higher initial resistance of the two-stage system, the operational lifetime resource is by 25 % higher. This is explained by the increasing resource of the main filter due to elimination

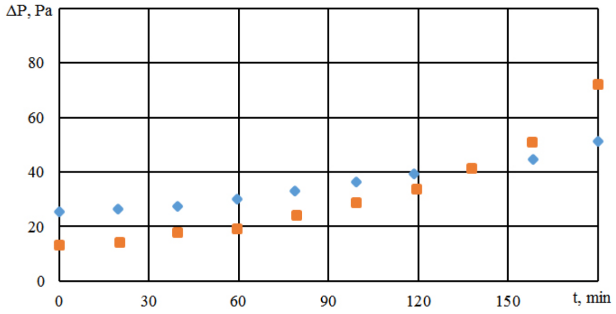

Fig. 7. Change of pressure drop when dusted by coal dust with concentration of 300 mg/m^3*:*

◆ *– in the main filter with density of 55 g/cm*^{2}*;* ■ *– in the pre-filter with density of 27 g/cm*^{2}

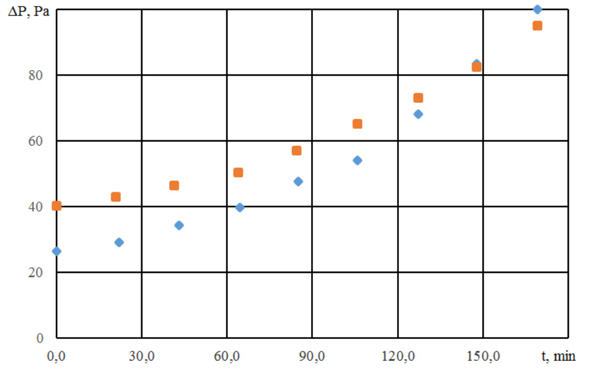

Fig. 9. Comparison of pressure drop change when dusting:

■ *– a single-layer filter with packing density of 55 mg/m*^{2}*;* ◆ *– a two-stage system with packing density of a pre-filter of 27 mg/m*^{2} *and that of the main filter of 55 mg/m*^{2}

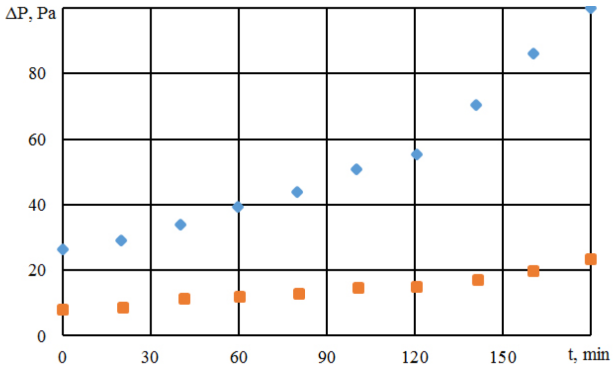

Fig. 8. Change of pressure drop when dusted by coal dust with concentration of 300 mg/m^3*:*

◆ *– in the main filter with density of 55 g/cm*^{2}*;* ■ *– in the pre-filter with density of 17 g/cm*^{2}

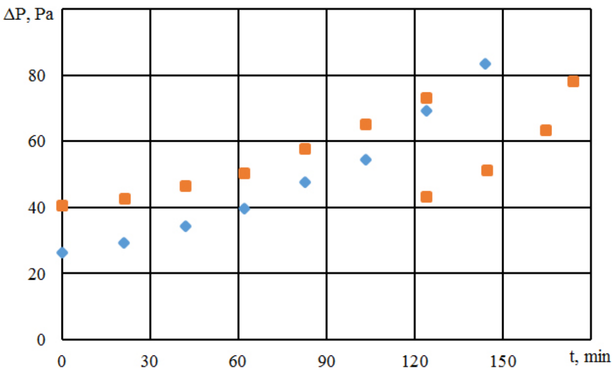

Fig. 10. Comparison of pressure drop change when dusting:

◆ *– a single-layer filter with packing density of 55 mg/m*^{2}*;* ■ *– a two-stage system with packing density of a pre-filter of 27 mg/m*^{2} *and that of the main filter of 55 mg/m*^{2} *with the pre-filter removed after 120 minutes*

of coarse fraction dust getting on it and uniform distribution of aerosol particles inside the filtering layers apart from the surface. Moreover, after achieving the critical value of resistance, it is possible to decrease it for the two-stage system by removing the pre-filter and, therefore, to increase the resource of protective power time.

The analysis of the parameters of dust filled filters testifies that the ratios of the density of packing of the main filter and pre-filter of 55 and 27 g/cm^2 correspondingly, have the smallest increase in resistance; at the same time the amount of dust was 40 to 60 %; (experiment 3).

The parameters of dust filled filters are given in Table 4.

Conclusions.

The experiments conducted allow making the following conclusions:

Table 4

Dust accumulation and resistance increase in filters

Number of experiment	Filter	Density of the material, g/cm^2	Dust mass, g	Amount of the dust settling into filters, %	Increase in resistance, times
1	The main filter	55	–	–	0
	Pre-filter	50	6.8	100	4.1
2	The main filter	55	0.4	6	1.2
	Pre-filter	45	6.5	94	4.0
3	The main filter	55	2.9	40	2.6
	Pre-filter	27	4.3	60	3.5
4	The main filter	55	5.7	80	3.4
	Pre-filter	17	1.6	20	2.5

- dust accumulation in polypropylene filters mainly occurs in the front layer, that is why to increase dust holding capacity and protective power time it is essential to adjust a pre-filter consisting of coarse fibres with low packing density;
- filtration of the air flow containing coal dust while using the system consisting of two successively adjusted filters in an RPA respirator allowed defining maximum dust holding capacity with the following parameters for the filters: packing density of 55 and 27 g/cm^2; the fibre radius of 2–4 and 6–10 microns and the filtering layer thickness of 3 and 4 mm, correspondingly. This result was achieved due to generation of a self-filtering dust layer, which can be formed on working surface at the speed below 0.04 m/s;
- application of the main filter and pre-filter, correspondingly, allowed designing an anti-aerosol two-layer polypropylene filter RPA-TD 1.2 which meets DSTU EN 143-2002 requirements and can be used to protect workers' respiratory organs at sites of intensive coal dusting including stoping face, coal transloading, dressing plants and others;
- the resource of the suggested filter system increases by 25 % compared to filters used for RPA respirators.

Further studies on the parameters of polypropylene fabrics within a wider range of packing densities are required to use them as filtering elements while designing filters for respiratory protection from mine coal dust.

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Експериментальні дослідження опору поліпропіленових фільтрів відповідно до вимог ДСТУ EN 143-2002

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Мета. Визначення максимальної пилоємності при заданій ефективності пиловловлювання послідовно встановлених двох фільтруючих елементів із поліпропіленових тканин при запиленні їх вугільним пилом.

Методика. Визначення опору фільтрів і їх пилоємність виконувалося гравіметричним способом відповідно до вимог ДСТУ EN 143-2002. Методика розрахунків складається з двох етапів. На першому – розраховується діаметр волокон попереднього фільтра виходячи з максимальної пилоємності для заданого граничного тиску й заданого розміру часток пилу. При цьому товщина й щільність упаковки волокон фільтруючого шару вибирається виходячи з умов технологічного процесу його формування при виробництві фільтрувальної тканини. На другому етапі – розраховується радіус волокна основного фільтра, виходячи із заданої ефективності пиловловлювання.

Результати. Встановлено, що основне накопичення пилу на поліпропіленових фільтруючих елементах до респіраторів відбувається в лобовому шарі. Визначено, що пилоємність і час захисної дії респіраторів можна збільшити при фільтрації вугільного пилу за допомогою системи із двох послідовно встановлених фільтруючих елементів з параметрами: щільністю упаковки 55 і 27 г/см^2; радіусом волокон 2–4 і 6–10 мкм та товщиною фільтруючого шару 4 і 3 мм відповідно. Це дозволило створити протиаерозольний двошаровий поліпропіленовий фільтр РПА-ТД 1,2, що відповідає вимогам ДСТУ EN 143-2002, який можна використовувати для захисту органів дихання персоналу в місцях інтенсивного утворення вугільного пилу, таких як очисні вибої, перевантаження вугілля, на збагачувальних фабриках і інших.

Наукова новизна. Пилоємність фільтрів залежить від утворення автофільтруючого шару пилу, що може формуватися на робочій поверхні при швидкостях нижче 0,04 м/с.

Практична значимість. Встановлені раціональні параметри двох послідовно встановлених фільтруючих елементів із поліпропіленової тканини, при цьому час захисної дії запропонованої системи підвищується на 25 % у порівнянні з фільтрами, що використовуються для респіраторів типу РПА.

Ключові слова: *респіратор, фільтр, пилоємність, перепад тиску, опір повітряному потоку, витрата повітря*

Экспериментальные исследования сопротивления полипропиленовых фильтров в соответствии с требованиями ДСТУ EN 143-2002

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Цель. Определение максимальной пылеёмкости при заданной эффективности пылеулавливания последовательно установленных двух фильтрующих элементов из полипропиленовых тканей при запылении их угольной пылью.

Методика. Определение сопротивления фильтров и их пылеемкости производилось гравиметрическим способом в соответствии с требованиями ДСТУ EN 143-2002. Методика расчетов состоит из двух этапов. На первом – рассчитывается диаметр волокон предварительного фильтра исходя из максимальной пылеёмкости для заданного предельного давления и заданного размера частиц пыли. При этом толщина и плотность упаковки волокон фильтрующего слоя выбирается исходя из условий технологического процесса его формирования при производстве фильтровальной ткани. На втором этапе – рассчитывается радиус волокна основного фильтра, исходя из заданной эффективности пылеулавливания.

Результаты. Установлено, что основное накопление пыли на полипропиленовых фильтрующих элементах к респираторам происходит в лобовом слое. Определено, что пылеёмкость и время защитного действия респираторов можно увеличить при фильтрации угольной пыли с помощью системы из двух последовательно установленных фильтрующих элементов с параметрами: плотностью упаковки 55 и 27 г/см^2; радиусом волокон 2–4 и 6–10 мкм и толщиной фильтрующего слоя 4 и 3 мм соответственно. Это позволило создать противоаэрозольный двухслойный полипропиленовый фильтр РПА-ТД 1,2, соответствующий требованиям ДСТУ EN 143-2002, который можно использовать для защиты органов дыхания персонала в местах интенсивного образования угольной пыли, таких как очистные забои, перегрузки угля, на обогатительных фабриках и других.

Научная новизна. Пылеёмкость фильтров зависит от образования автофильтрующего слоя пыли, который может формироваться на рабочей поверхности при скоростях ниже 0,04 м/с.

Практическая значимость. Установлены рациональные параметры двух последовательно установленных фильтрующих элементов из полипропиленовой ткани, при этом время защитного действия предложенной системы повышается на 25 % по сравнению с использующимися фильтрующими элементами для респираторов типа РПА.

Ключевые слова: *респиратор, фильтр, пылеёмкость, перепад давления, сопротивление воздушному потоку, расход воздуха*

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