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EFFECT OF FILTERING BOX PARAMETERS ON THE PROTECTIVE ACTION OF GAS FILTERS

Purpose. To determine the dependence between the design parameters (diameter and height) of a filtering box, the gas filter resistance and the protective power time.

Methodology. The calculation results of the filter sorption capacity for the specified organic compound are obtained involving classic statements of the theory of monomolecular adsorption. Experimental studies of gas filters were carried out according to DSTU EN 13274-3:2005 "Respiratory protective devices. Testing methods".

Findings. It is shown that in terms of the similar sorbent volume and dimensions of the outlet of a filtering box with the exhale valve, the increasing filter area reduces considerably the breathing resistance; however, that results in the reduced protective time of a gas respirator. It has been determined that in this case an increased filter area causes nonuniform distribution of the filtration rate over the filter area and, as a result, nonuniform use of the filter sections. A section in front of the outlet experiences the greatest load in terms of sorption of the harmful gases.

Originality. It has been specified that the increase in the outlet diameter relative to the filter diameter prolongs the protective time of a filter in terms of the same sorbent volume.

Practical value. Dimensions of a filtering box have been identified to provide uniform use of the sorbent and maximum protective time.

Keywords: *gas filter, respirator, activated carbon, breathing resistance, protective power time*

Introduction. Different methods can be used to reduce impurity of the working zone air — equipment pressurization, industrial ventilation, application of cyclones, dust catchers or electric filters and others. However, those measures may be not enough to preserve the workers' health, so respiratory protective equipment (RPE) is required to be used. Relatively light and cheap filtering gas respirators are often used to protect against aerial contamination in a gaseous state.

Current international legislation, i. e. Directive of the Council of the European Union 89/686/EEC of 21 December, 1989, contains a set of requirements for an employer aimed at preventing the development of chronicle occupational diseases and acute intoxications in the workers operating under harmful conditions [1, 2]. Thus, an employer is required to provide the workers only with the certified RPE. In this context, respiratory organs should be protected properly under conditions that:

1. An effective filter is selected correctly.

2. A mask or half-mask with high insulating properties is applied.

3. It is provided that the RPE is used constantly within the whole period of the harmful factor exposure.

It should be noted that the latter is the most important and hard-to-accomplish condition since it depends on the resistance of filtering boxes and loads which a person experiences while breathing. Highly efficient filters (especially, gas ones) are characterized by the considerable pressure difference as they contain sorbents to provide the specified sorption capacity to catch different harmful gases at the expense of physical and chemical absorption. Activated carbon saturated with silver, copper, chromium, and triethylenediamine is the most popular sorbent today. Practice shows that the sorbent amount is determined mainly by the technical conditions and qualification of an engineer. In this context, sorbent density and granule size affect the breathing resistance greatly, which determines breathing heaviness and operating time with the corresponding influence on the period of its application. In most cases, during air cleaning to get rid of aerial contaminations with the help of gas filters, absorption of harmful impurities with the granular sorbent located in the case is applied. Molecules of the impurities, characterized by greater mobility, collide with the sorbent surface and "stick" to it forming not very stable bond; when special chemical substances are added to react with the impurities, the bond is more stable. Along with its saturation, the sorbent loses gradually its ability to absorb impurities making it possible for the contaminated air to move further to new sorbent layers; thus, concentration of the harmful substances in the cleaned air increases gradually exceeding the boundary admissible concentration of harmful substances in the air in the under-mask area. The gas filter should be replaced not later than that moment. Its service life depends on

chemical composition (compound) of the aerial contaminations and their concentrations, on the conditions of its use (air consumption, its temperature and humidity), and on the filter properties (its shape, amount and properties of the sorbent). Moreover, under certain conditions, the caught molecules of harmful substances may be partially liberated (in terms of their dissoluble bond with the sorbent) and come into the air passing through the filter (desorption). Increasing concentration of the contaminations in the cleaned air may provoke the reaction of the sense organs— smell, irritation of the mucous membrane of the respiratory organs, eye and skin irritation etc. Earlier, such "preventive" features were the main method to determine the necessity of filter replacement. However, since 1996, American Occupational Safety Standard regulating the selection and organization of PRE application by an employer prohibited to use subjective reaction of the sense organs while filter replacing [3], and similar EU Standard also claimed (some time later) to use more reliable methods [4]. An American employer is obliged to replace filters either on schedule elaborated on the basis of specification of their service life under specific conditions or according to the End of Service Life Indicators (ESLI) shown on the filter. While elaborating the schedule, it is possible to use the results of laboratory tests of a filter with the simulation of industrial conditions or a manufacturer's recommendations as for the application conditions. At the same time, that is not always convenient and connected with certain difficulties to reproduce the work environment during the laboratory tests. Consequently, the task of searching for more accurate methods for determining the protective time of gas filters is rather topical.

Unsolved aspects of the problem. Recently, to determine the protective power time of a respirator, methods of mathematical modeling of sorption processes have being applied; the methods may be described conveniently and quickly with the help of computer programmes taking into account the information concerning operating conditions as the initial data. However, due to the airflow nonuniform distribution because of the airflow displacement relative to the box (due to the differences in inlet and outlet dimensions), some filter sections turn to be overloaded with further faster exhausting their life span. Thus, to determine the sorbent volume for gas filters, it is important to study the effect of the filtering box parameters: diameter and height, which have minimum effect on the filter efficiency.

Literature review. There are numerous publications in the open access concerning the evaluation of filter resistance depending on the air consumption, properties of the activated carbon (granule diameter, package density) [5], and filter thickness. That issue is rather well-analyzed. It is determined that in most cases interrelation between the growth of breathing resistance and air consumption is linear. However, some studies indicate that deviations from the currently accepted dependences are possible (e.g. in terms of the pulsed flow) [6]. It is known that the filter resistance increases along with the growing sorbent volume and granule size under the action of temperature [7], gas filtering rate [8], air contamination [9], and growing relative humidity [10]. However, effect of the filtering box dimensions is not mentioned among the listed parameters. Recent studies are aimed at analysis of the problem of uniform sedimentation of aerosol particles on the filter fibers [11]. Great attention is paid to the calculation of the density of multi-layered filter package. The research concerning changes in filter resistance during sedimentation of polydisperse particles is also of considerable interest. The authors of paper [12] have found that the filtering box structure affects the value of pressure difference. To decrease the breathing resistance, it is necessary to design the rear wall of a filtering box in the form of confusor, which hill help reduce the number of stall zones and nonuniformity of the flow velocity distribution. Study on protective anti-gas filters is important in the context to provide safety of miners during conventional mining, while

improving efficiency of information measurement system of coal mine air gas protection [13] as well as new recently developed technologies of unconventional mining [14] and during energy-chemical complex creation [15].

Airflow velocity is affected by the ratio of the inlet and outlet dimensions inside a filtering box as well as the place of their location relative to each other. In this context, there occurs the nonuniformity of aerosol catching on some filter segments while others are not involved in the sorption process at all. Thus, the filtering box structure results in the nonuniform use of the sorbent over the filter area. In its turn, that causes the deterioration of its protective functions.

Purpose. The objective of the paper is to determine the dependence between structural parameters (diameter and height) of a filtering box on the gas filter resistance and the protective time.

Materials of the study. To calculate the time of harmful vapour breakthrough, we may use the equation proposed by Dubinin and improved by Wheeler-Jonas

$$t_b = \frac{W_e \rho_b}{C_0}\left[\frac{H_f}{V_l} - \frac{1}{k_v}\ln\left(\frac{C_0 - C}{C}\right)\right], \qquad (1)$$

where t_b is breakthrough time, min; W_e is equilibrium sorption capacity, g/g of carbon; C_0 is concentration of contaminations in the air being cleaned, g/cm³; ρ_b is cubage capacity of the sorbent, g/cm³; k_v is the coefficient of adsorption velocity; C is breakthrough concentration, g/cm³; H_f is filter thickness, cm; V_l is airflow velocity, cm/s.

To calculate sorption capacity of the specified organic compound while catching with the common absorption mechanism, it is possible to use Radushkevich equation

$$W_e = W_0 d_l \exp\left[-\left(\frac{RT}{\beta E_0}\right)^2\left(\ln\left(\frac{p_s}{p}\right)\right)^2\right], \qquad (2)$$

where W_0 is the volume of micropores of the activated carbon, m³/g; E_0 is basic adsorption energy, kJ/mole; d_l is adsorbent density, g/m³; p_s is pressure of the vapour in terms of temperature T, K, which is in the unabsorbed state, Pa; R is universal gas constant (8.314 · 10⁻³ kJ/(mole · K)); β is the coefficient of affinity.

It should be noted that to obtain sorption capacity W_e (g/g of coal) in each separate gas/coal combination, it is required to carry out experimental measurements under corresponding conditions (concentration, air consumption, and humidity).

The coefficient of the adsorption velocity of organic substances while catching them with activated carbon k_v is quite well defined in papers by Loderick. It depends on linear filtration velocity V_l (cm/s) and the diameter of activated carbon granules d_p (cm)

$$k_v = 48\beta^{0.33}V_l^{0.75}d_p^{-1.5}.$$

The coefficient of affinity (similarity) was defined with the help of molecular polarizability P_e (cm³/mole)

$$\beta = 0.086P_e^{0.75}.$$

Taking into consideration the fact that air consumption may be expressed in terms of filtration velocity and cross-section area, and breakthrough time depends on the sorbent thickness, formula 1 may be transformed to be as follows

$$t_{1\%} = C_0^{-1}V_l^{-1}W_e\rho_b\left(H_f - \frac{V_l}{k_v}\ln\left(\frac{C_0 - C}{C}\right)\right). \qquad (3)$$

Equation (3) combines the adsorption efficiency and filter dimensions, filtration rates, and concentration of a harmful substance. While setting those parameters, it is possible to select the parameters of a filter being designed with the mini-

mum breathing resistance. In the assembled condition, a filter usually consists of a certain container where there is some sorbent amount for gases (as a rule, that is activated carbon) and chemical saturants which decontaminate the substances being poorly absorbed. Both the amount and type of the absorber depends on the contamination type and on the (admissible) breathing resistance as well as on the filter dimension and shape. Due to that, gas filters may be of large dimensions; they may also limit the range of vision and become contaminated rather fast. Generally, technical specifications for the development of the respiratory protective equipment indicate the contamination load and air consumption (chemical composition, concentration) as well as minimum period of its protective effect. Having applied those parameters to equations (3, 4), we obtain the equation with two unknowns − cross section (since the consumption depends on the linear velocity and area) and filter thickness. That helps calculate the required filter thickness and sorbent volume − for different cross sections. Analysis of the reduced formula tells about the multiple variants of the filter design (area, thickness, volume) with similar sorption properties.

It is important to select the filter design, which will be of small size and provide uniform use of the absorber in terms of minimum breathing resistance. Thus, the objective was set at stage one of the research to determine pressure difference during the air movement through filtering boxes filled with the sorbent. To do that, five one-type cylindrical samples (Fig. 1) with different dimensions were used (box diameter D_f, cover diameter D_k, filter thickness H_f, and box thickness with cover H_k) to provide similar volume of the activated carbon (Table 1).

Box diameters varied from 7 up to 15 cm; box thicknesses varied from 1.5 up to 4 cm. Outlet hole diameter d_v for all the boxes was 3 cm. Its value depends on the inhalation valve dimension (the diameter is within the range of 2.7−3.2 cm). The filters were made from the activated carbon of CKT-6A grade with the density of 356 g/dm^3 and particle size of 1−1.5 mm.

Pressure difference was measured according to DSTU EN 13274-3:2005 "Respiratory protective devices. Testing methods. Part 3. Determination of breathing resistance". Essence of the method is to measure the differences of static pressures
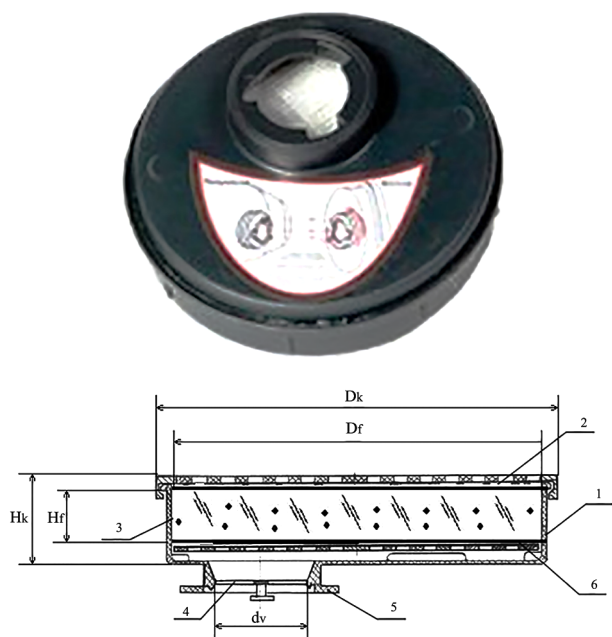
Table 1

Dimensions of the filters used to analyze hydraulic resistance

Filter	Thickness, H_f, cm	Diameter D_f, cm	Area, cm^2	Volume, cm^3
1	1.1	14.5	123	134
2	1.6	10.1	80	128
3	2.5	8.0	50	125
4	2.8	7.5	44	123
5	3.2	7	39	123

in front of and behind the filtering box in terms of the specified air consumption. In this context, the box is located in the special clamp to exclude air suction near the filter. Air was inhausted by means of electric aspirator with the receiver for the flow stabilization. Air consumption was controlled with the help of rotameter. The studies were carried out in terms of changes in air consumption from 20 up to 150 l/min (Fig. 2).

Stage two of the experimental studies involved assessment of the protective effect of the manufactured filters with the use of a respirator with a half-mask of ПР-7 type (its prototype is respirator РУ-60М with the displaced outlet hole in the filtering box). The respirator was put on a dummy head located within the special chamber which was further filled with the gas-air mixture (GAM) containing control toxicant − cyclohexane. GAM was obtained with the help of special dynamic plant where cyclohexane from a cylinder was supplied with constant flow into the stable flow of the gas carrier (purified from the foreign matters and dried air) (Fig. 3).

To obtain stable flow of the gas carrier, a preparation unit was used; that unit contained an oil-free compressor, a receiv-
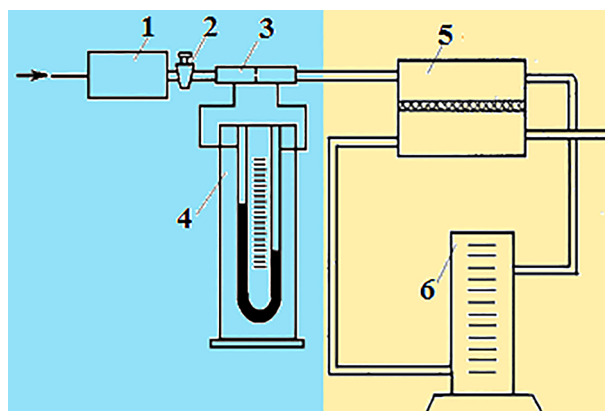

Fig. 2. Scheme of a plant to determine pressure difference on the filtering boxes:

1 − pressure stabilizer; 2 − vent; 3 − membrane; 4 − manometer; 5 − device to fix boxes; 6 − micromanometer

Fig. 1. View of the design of a filtering box with the gas filter:

1 − case of a filtering box; 2 − cover of a filtering box with the inlet holes; 3 − gas filter; 4 − hole of the inhalation valve; 5 − flange to attach a filtering box to the half-mask; 6 − grille to fix a gas filter and gap formation at the rear wall of the box
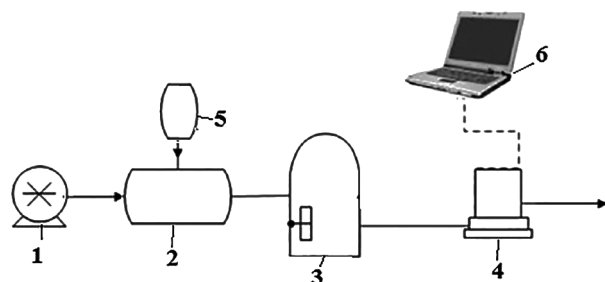

Fig. 3. Scheme of the experimental plant:

1 − compressor; 2 − evaporator; 3 − chamber with cyclohexane; 4 − test chamber; 5 − measuring device; 6 − PC

er equipped with the reference pressure gauge and pressure controller, and systems of filter-absorbing devices to clean the air from dust, water vapours, impurities of basic and acid gases. Constant consumption of the gas carrier was provided by the continuous control of gas pressure in the receiver.

The prepared GAM containing the control toxicant (CT) was inhausted by means of electric aspirator with constant flow rate through a filtering box with the gas filter along with the determination of the time in which the toxicant was detected by the indication means within the under-mask area. Cyclohexane was detected in the GAM within the under-mask area with the help of low inertial electrochemical sensor with time constant less than 2 s installed immediately within the under-mask area. Statistic processing of the measurement results was performed according to the recommendations in [16, 17].

Results. Stage one of the research dealt with the assessment of the effect of filter dimensions on the filter resistance. The obtained results were the expected ones (Fig. 4). It is seen that the thickness decrease and diameter increase of the filter make it possible to reduce pressure difference in terms of the sorbent volume preservation to be constant (e. g. in case of filters 1, 3 and 5).

Stage two involves determination of the fact how changes in the filter parameters will influence the time of protective effect. For instance, let us consider such substance as cyclohexane (molecular mass is 86.18 g/mole; polarizability is 51.5 cm³/mole) (Table. 2). To calculate sorption capacity, equation 2 was used; it was defined that We for cyclohexane was 0.00972 g/g. Then, in terms of the specified concentration, filter diameter, filter thickness, and air consumption, it is possible to calculate the protective time. Table 2 represents the results. To confirm the obtained results, an experiment to determine the protective time was carried out. The experiment showed that the experimental values are by far lower than the calculated ones (from 50 up to 80 %).

The obtained result (Table 3) may be explained by the nonuniform distribution of the airflow velocity over the filter area due to the outlet displacement relative to the center of a filtering box. Theoretical calculation meant uniform filtration process over the whole filter area. During the experiment, in terms of the filter share located in front of the outlet hole, airflow velocity was most likely much higher than the velocity
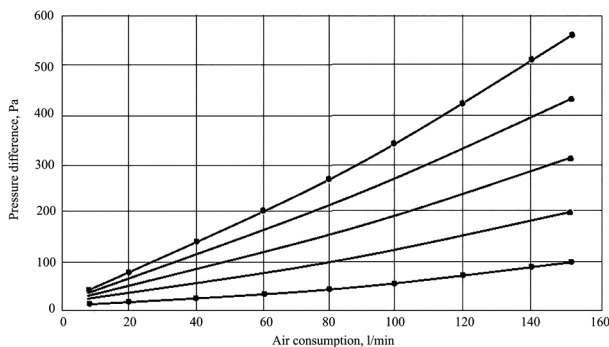
Results of calculations and experimental studies of the time of protective effect of the filtering boxes for different filter designs

Concentration, mg/dm³	Diameter, cm	Thickness, cm	Consumption, l/min	Protective time of the filtering boxes $t_{1\%}$, min	
				Calculated	Experimental
17.5	14.5	0.83	30	84	37
	10.1	1.70		84	46
	8.0	2.72		84	55
	7.5	3.10		84	61
	7	3.56		84	72

within the rest of the filter. That favored faster saturation of the granules with the adsorption gas within that area and beginning of the breakthrough phase. In this context, the rest of the filter has not exhausted its life span so far.

Such filter state during the saturation process is explained by the fact that to reach the outlet hole displaced relative to the outlet center of the box, peripheral air filaments should overcome aerodynamic resistance of the gap between the filter and box case. Besides, while colliding with the rear wall of the box, peripheral filaments change their movement direction; when the filaments move along the gap, we can observe the intermixing of the filaments with different rates and movement directions. It results in the pressure loss in terms of local resistances and within the gap between the filter and box case, which increases the motion resistance with corresponding decrease in the movement velocity (Fig. 5). The farther the peripheral filaments are from the outlet hole, the higher resistance they should overcome.

To confirm that assumption, the airflows were modeled with the help of the system of partial differential equations of the first order with Eulerian variables, which, along with the equation of the low continuity, makes it possible to obtain interrelation between kinematic and geometrical parameters of the filter and density of the dust-laden flow.

$$\begin{cases} \dfrac{1}{r}\rho V_r + \dfrac{\partial \rho}{\partial r}V_r + \dfrac{\partial V_r}{\partial r}\rho + V_z\dfrac{\partial \rho}{\partial z} + \dfrac{\partial V_z}{\partial z}\rho = 0 \\ V_r\dfrac{\partial V_r}{\partial r} + V_z\dfrac{\partial V_r}{\partial z} - \dfrac{V_\theta^2}{r} = k_p \cdot V_r - \dfrac{1}{\rho}RT\dfrac{\partial \rho}{\partial r} \\ V_r\dfrac{\partial V_\theta}{\partial r} + V_z\dfrac{\partial V_\theta}{\partial z} + \dfrac{V_rV_\theta}{r} = k_p \cdot V_\theta \\ V_r\dfrac{\partial V_z}{\partial r} + V_z\dfrac{\partial V_z}{\partial z} = k_p \cdot V_z - \dfrac{1}{\rho}RT\dfrac{\partial \rho}{\partial z} \end{cases}$$

where V_r, V_θ, V_z are projections of the velocities along the coordinate axes, m/s; ρ is airflow density in a filtering box, kg/m³;

Fig. 4. Dependence of the pressure difference on the air consumption through the filters with axial air flow

Values of the parameters used for calculations

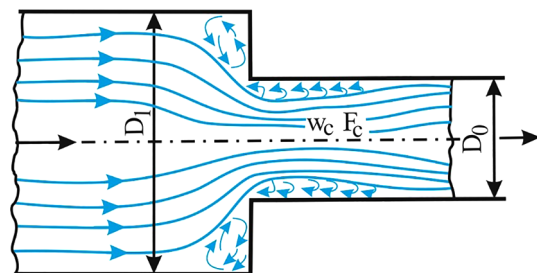| Designation	Numerical value	Measurement unit
Density, ρ_b	0.6548	g/cm³
Concentration, C	17.5	mg/dm³ under atmospheric pressure (101.3 hPa)
Air consumption, Q	30	l/min
K_v	3447	1/min

Fig. 5. Scheme of the air movement and formation of vortexes in terms of the abrupt narrowing of the flow

k_p is the coefficient of penetration, 1/s; R is universal gas constant, J/(kg · K); T is temperature of the airflow, K.

The system is solved involving the least square method, finite element method, and method of local variations with the help of SolidWorks software for the filtering box dimensions indicated in Table 1. As a result, we obtain the interaction between the airflow velocity distributions over the filtering box in terms of its specified geometrical parameters.

To solve the problem, the whole surface of the box was covered with the grid of squares with Δr, Δz dimensions (Fig. 6), which were further divided into triangles with the help of the diagonal for more accurate calculation of the obtained results. Their number depended on the calculation accuracy of the obtained results; the number was specified by the value of an error. The iterations stop if the value of variation becomes less than the specified admissible error. The calculation should be started with the setting of the initial approximation — value of the airflow velocities along Vx, Vy, Vz axes within the nodes of the mesh. Average velocities were calculated according to the sectional area of the filter and air consumption in a filtering box. The described algorithm converges irrespective of the selection of the initial approximation. The calculation was considered to be complete, if the required calculation accuracy was achieved or the specified number of iterations was performed. As a result of modeling, epures of the distribution of aerodynamic indices over the specified calculation zone were obtained (Fig. 7).

As a result of modeling, the interaction between the geometrical parameters of the filtering box and filtration velocity has been obtained. The latter has certain effect on the nonuniformity of the filtration velocity distribution. Thus, the model confirms that in terms of the filter section located in front of the outlet hole, a filtering layer is saturated with the harmful vapours faster; that results in the accelerated development of dangerous breakthrough concentration behind the filter.

Analysis of the design of different-type filtering boxes makes it possible to conclude on the fact that their resistance is 50 % dependent on the availability of the rigid perforated baffle plates and gaskets on the cover and rear wall of the box installed to provide uniform airflow distribution. To reduce nonuniformity of the distribution of the average filtration velocity over the filter area, it is expedient to increase the gap between the filter and filtering box casing immediately owing to the location of the aforementioned plates. To simplify the design and reduce resistance of a filtering box from the filters, it is possible to remove additional baffle plates, if the internal wall of the box is made in the form of cone (Fig. 8). That will help increase gradually the airflow velocity on the way to the inhalation valve along with the decrease in sectional area of the cone favouring uniform flow of the whole filter area.
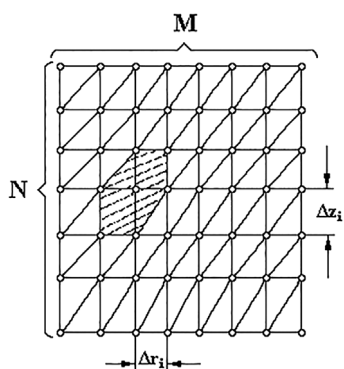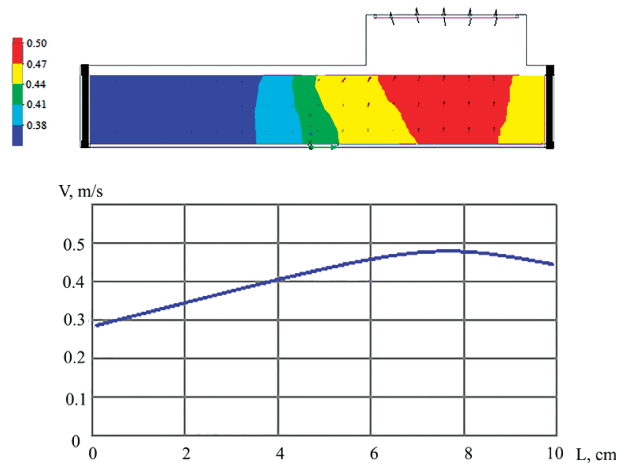

Fig. 7. Modeling of the air movement in the filtering box: changes in the average filtration velocity within the filter sections

Compared to the prototype, such airflow distribution in the specified design provides inconsiderable growth of breathing resistance on the filter during dusting and prolongs the protective time of the respirator. Increase in the valve dimensions and, correspondingly, input diameter as well as the improvement of the filtering box design with a gas filter will favour better distribution of the airflow velocity over the filter area making it possible to provide the required time of protective effect of the filtering boxes in terms of the decreased breathing resistance.

Nonuniform density of the filter filling with the sorbent as well as the fluctuations in thickness and porosity of the filter may be another reason for the reduced protective power time of the filters with the diameter of 10−15 cm. That may happen due to the defects in the filter manufacturing technology or during transportation and setting of the filters in a filtering box. It is obvious that these processes will have far less effect on the protective time of the filters with small diameter and greater thickness.

As a result of the study, the method to calculate parameters of filtering boxes for different working conditions was ob-

Fig. 6. Division of the filtering box into the finite triangular elements:

N, M − dimensions of the section under analysis, Δr, Δz − layout of the section
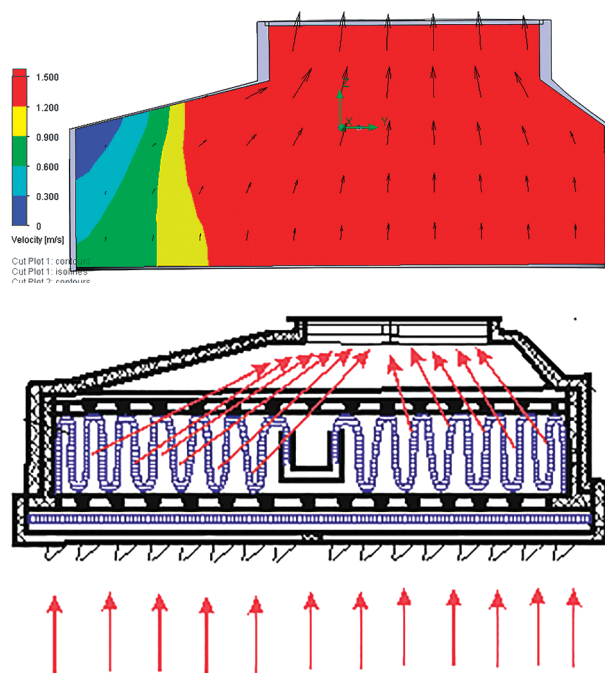

Fig. 8. Scheme of air movement in the filtering box with the rear wall in the form of confusor

tained. Further studies will be aimed at reducing resistance of a filtering box, and increasing the protective power time and coefficient of gas respirator protection taking into consideration working and environmental conditions.

Conclusions. The effect of design parameters of a filtering box on breathing resistance and protective power time of the gas filter saturated with the granulated activated carbon has been studied. It has been demonstrated that in terms of constant sorbent mass, increasing filter area reduces breathing resistance considerably; however, decreased sorbent thickness results in the shortened time of the filter protective effect. In terms of similar dimensions of the output holes of a filtering box with the exhalation valve, increasing filter area results in the nonuniform distribution of the filtration velocity and exhausting of the filter sections. The section in front of the output hole experiences the highest load as for the harmful gases sorption. The more the filter diameter is compared to the outlet diameter, the longer the protective power time is in terms of the similar sorbent thickness. Under condition of uniform filtration velocity, it is possible to determine the protective time of the filter with activated carbon granules using the obtained equation (3), which helps design respirators meeting the specific requirements.

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Вплив параметрів фільтруючої коробки на захисну дію протигазових фільтрів

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Мета. Визначення залежності між конструктивними параметрами (діаметром і висотою) коробки, що фільтрує, опором протигазового фільтра та часом його захисної дії.

Методика. Результати розрахунку сорбційної ємності фільтрів для заданої органічної сполуки отримані з використанням класичних положень теорії мономолекулярної адсорбції. Експериментальні дослідження протигазових фільтрів проводили відповідно до ДСТУ EN 13274-3:2005 «Засоби індивідуального захисту органів дихання. Методи випробування».

Результати. Показано, що збільшення площі фільтра за однакових обсягів сорбенту й розмірів вихідного отвору коробки, що фільтрує з клапаном видиху, істотно знижує опір диханню, однак це призводить до зменшення часу захисної дії протигазового респіратора. Встановлено, що у цьому випадку збільшення площі фільтра призводить до нерівномірного розподілу швидкості фільтра-

ції по площі фільтра та, відповідно, до нерівномірного відпрацювання ділянок фільтра. Найбільше навантаження по сорбції шкідливих газів відчуває ділянка навпроти вихідного отвору.

Наукова новизна. Встановлено, що збільшення відношення діаметра вихідного отвору до діаметра фільтра підвищує час захисної дії фільтра за одного й того ж обсягу сорбенту.

Практична значимість. Встановлені розміри фільтруючий коробки, що забезпечать рівномірне відпрацювання сорбенту й максимальний термін захисної дії

Ключові слова: *протигазовий фільтр, респіратор, активоване вугілля, опір диханню, час захисної дії*

Влияние параметров фильтрующей коробки на защитное действие противогазовых фильтров

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Цель. Определение зависимости между конструктивными параметрами (диаметром и высотой) фильтрующей коробки, сопротивлением противогазового фильтра и временем его защитного действия.

Методика. Результаты расчета сорбционной емкости фильтров для заданного органического соединения получены с использованием классических положений теории мономолекулярной адсорбции. Экспериментальные исследования противогазовых фильтров производили в соответствии с ДСТУ EN 13274-3:2005 «Засоби індивідуального захисту органів дихання. Методи випробування».

Результаты. Показано, что увеличение площади фильтра при одинаковых объемах сорбента и размерах выходного отверстия фильтрующей коробки с клапаном выдоха существенно снижает сопротивление дыханию, однако это приводит к уменьшению времени защитного действия противогазового респиратора. Установлено, что в этом случае увеличение площади фильтра приводит к неравномерному распределению скорости фильтрации по площади фильтра и, соответственно, к неравномерной отработке участков фильтра. Наибольшую нагрузку по сорбции вредных газов испытывает участок напротив выходного отверстия.

Научная новизна. Установлено, что увеличение отношения диаметра выходного отверстия к диаметру фильтра повышает время защитного действия фильтра при одном и том же объеме сорбента.

Практическая значимость. Установлены размеры фильтрующий коробки, которые обеспечат равномерную отработку сорбента и максимальный срок защитного действия

Ключевые слова: *противогазовый фильтр, респиратор, активированный уголь, сопротивление дыханию, время защитного действия*