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THE ROLE OF MEANS OF INDIVIDUAL PROTECTION FOR RESPIRATORY ORGANS IN PROPHILAXIS OF THE COAL – DUST ETIOLOGY

Розкрито питання пов'язані зі зниженням захворювань пилової етіології. Проведена оцінка захисної ефективності засобів індивідуального захисту органів дихання по вугільному пилу. Розраховано ризик захворювань пневмоконіозом за наявності респіратора.

Раскрыты вопросы, связанные со снижением заболеваний пылевой этиологии. Проанализирована защитная эффективность средств индивидуальной защиты органов дыхания по угольной пыли. Рассчитан риск заболевания пневмокониозом при наличии респиратора.

The problems, bound diseases a dust of an etiology lowering are uncovered. The protective efficiency of resources of individual protection of organs of respiration on braise is parsed. The hazard of disease by a dust disease at presence of an oxygen breathing apparatus Is calculated.

The problems concerned the lowering dust diseases etiology are being uncovered. The protection organs from coal dust have already been analyzed. The hazard of dust disease at the presence of an oxygen breathing apparatus is calculated.

Today the situation bound with professional discases is quit complicated in Ukraine. For the last ten years they have grown almost five times as many. According to the data presented by the State Department of Industrial Safety, labour protection and mining inspection over half cases of professional diseases are bound up with dust etiology.

The high levels of dust concentration within working zone and also hardships of standardization of labour conditions because of the dust factor make the pneumoconiosis problem as the most urgent of today's ones. According to the data presented by Donetsk NDI of Labour Gygiene and profdiseases the coal industrial branch loses over 200 mln hrn yearly for recovering losses to the miners caused by diseases to the number of which exceeds 57 thousand people. (1). Besides, this causes such considerable negative social consequences: disablement is growing as well as mortality, the total miners life – time duration shortens.

Thus, profdiseases by dust etiology take the first place among others, that's why the matter of their prophilaxy is quite actual today. One of the ways for solving this problem is constant and reliable control over the dust load on miners' lungs. The long storage of the information about the dynamics of obtained doses (for example at electronic bearers) will permit to get prognosis about chances of workers' diseases by pneumoconioses or dust bronchitis, to estimate their state of health and obtain the trustworthy data for medical inspections and expertise's.

In common case for defining dust amount getting into a person's lungs for a certain period of time it's necessary to know dust concentration "C" in the air of working space, the meddle changing volume of lungs' aeration "Q", working shift's duration "t", and number of working shifts "N":

$$D = 0.001kCQtN, \text{ gr},$$

where “D” – is dust load, gr, k – coefficient which accounts respirator's presence.

As from the deduction (1) is evident while calculation of dust load it's necessary to consider respirator's presence that reduces dust amount greatly which gets to the lungs. Authors offered (1) admitting coefficient's value k = 0.1 if device for individual protection of respiration organs DIPOR is really applied, but if it is not – then k = 1. However, each type of respirator has its own qualitative indices that depend on the constructional king of the half mask as well as on air filter's properties from material of which the DIPOR is made. Besides, at coal mines they can use various types of respirators, as well as various air filters for them. Accounting it to use one and the same coefficient's meanings is unsuitable and while calculation of dust load it's necessary to account the efficiency of specific protective devices for organs of respiration, since they remarkably lower the risk of diseases by pneumoconiosis and dust bronchitis.

It's rather hard to investigate the level of diseases relating to dust depending on respirators' using because of a number of subjective and objective reasons one principal among which is that for qelting some statistically grounded data the long-term research of workers' morbidity is necessary to do. However certain investigations in this aspect were held. So, on the base of study the dynamics of dilation pneumoconiosis among miners at groups of coal mines the fact was determined that for the space of 20 years the morbidity was lowered to 3 – 7 times as much (2). This great disparity is explained by the fact that it's rather difficult to check the correctness of using respirators by miners, but the essential reducing of the numbers of diseases by pneumoconiose is an argument of efficiency of using respirators. In order to learn and determine dust load and trustworthiness of disease for certain too, it is necessary to devise a new approach for an estimation of DIPOR quality.

All of them are characterized by two main indices – those are resistance to respiration coefficient of penetrating. The latter shows on a half mask construction and properties of filtering material that protectional device is made of. The analysis of coefficient's essence acconting respirator's presence shows that it can be equated to the coefficient of penetration of DIPOR which was experimentally defined (fig. 1) as relation of concentrations dispersive particles of aerosol “before” and “after” respirator, that is it expresses the mass portion of particles that penetrated through the protective device.

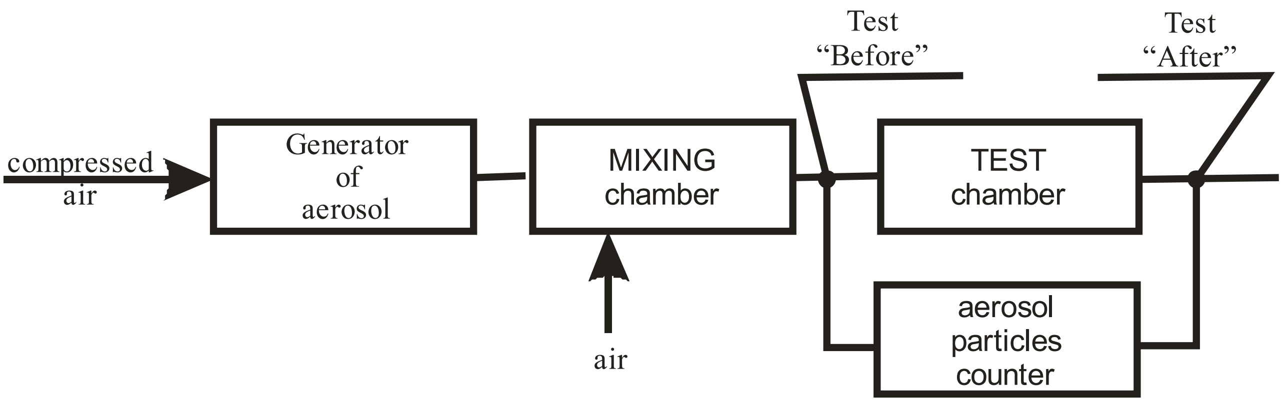

Fig. 1. The principal diagram of respirator's test on aerosol

$$K_n = \frac{N_0}{N}100 \text{ ,\%}$$

where "N_0" - concentrations dispersive particles of aerosol before respirator, mg/m^3; "N" - concentrations dispersive particles of aerosol after respirator, mg/m^3.

While respirator's test – aerosol from the generator through mixing chamber where it's diluted with pure air up to the concentration that is needed gets into the test chamber in which respirator is placed. Coefficient of penetration is calculated with the help of the counter of aerosol particles; it is determined entering and leaving concentrations of test – aerosol and with the formula (2). Instead of test – aerosol turbine oil or liquid paraffin are used as well as sodium chloride and others. Dispersive structure of these aerosols essentially differs from that of coal dust. It as test – aerosol coal dust is used it'll let the modeling processes which are going on in DIPOR, when powdering them with dist in real conditions of mining production, and in this way to determine coefficient's value by first approach considering the presence of respirator. On the base of testing laboratory of technical expertise on means of collective and personal protection of respiration organs among workers a universal stand was designed which provides preparing and feeding newly – created dust with the given ahead dispersive component (3), with the help of which it's possible to estimate the efficiency of respirators at coal dust (fig.2).

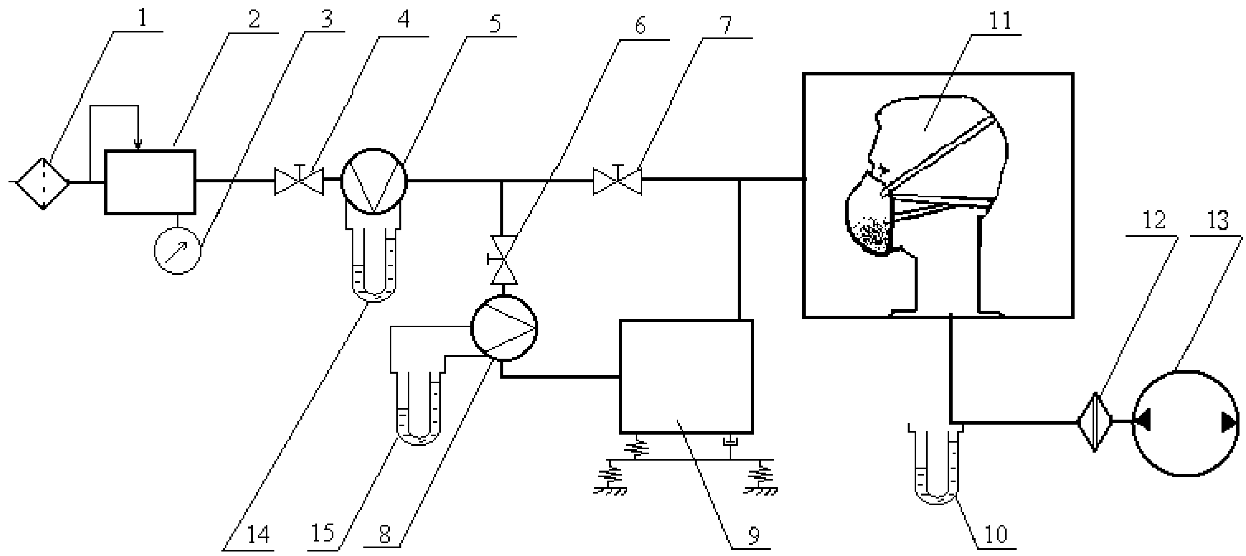

Fig. 2. Scheme of aggregate for testing DIPRO: 1 – air filter for previous cleaning; 2 – manometer; 3 – stabilizer of pressure; 4,6,7 – regulating valves; 5 – diaphragm; 8 – rotameter; 9 – dust generator; 10 – micromanometer; 11 – test chamber with the mauler; 12 – allonge with filter AFA; 13 – vacuum air pump.

The aggregate works as follows. Under air pressure from compressor it gets through the air filter of previous refinement 1 on the stabilizer 2. This air supply is regulated with the air valve 4 and controlled by manometer proceeding from pressure recession on the gagging diaphragm 5. For producing dust aerosol from 2 up to 10 l/min of clean air are feeded into the vibrating dust generator depending on dust concentration given ahead. The vibratory dust generator presents by itself a steel glass with the inlet and outlet shtutser into which mass of previously crushed to pieces coal of total mass of about 100 gr. Under the vibratory chamber the intensive self – breaking of these pieces into the state of dust takes place. For accelerating of crushing process the charge of steel spheres of 10 – 15 mm in diameter is provided into the chamber of generator. With the air – cock (6) and rot meter (8) the regulation of air supply getting into generator is realized owing to which fact not only different dust concentration but also different dispersive compound can be obtained. Other portion of clean air is delivered into the test chamber 11 with the respirator placed in it. The purified air from under mask space DIPRO in amount of 30 l/min is discharged by means of the allonge through the air filter AFA 12 with the help of vacuum pump 13. The dusty piling up on the protective device is controlled thanks to the growth of aerodynamic counteraction indicated by readings of micro manometer 10. The dust amount that didn't stay in DIPRO that means it got into the man's lungs, is fixed with the air filters AFA which were weighed previously on the analytical scales.

Thus, proceeding from disparity between the dustered and clean filters AFA we can ascertain the air output which could get into the worker's lungs that allows to estimate the dust load. In this case the coefficient accounting respirator's presence we'll fix on the formula:

$$k = \frac{M_1 - M_\phi}{(M_1 - M_\phi) + (M_2 - M_p)}$$

where: M_1 – is mass of the dustered filter AFA, gram; M_2 – mass of dostered filters of respirator, gram; M_F – mass filter AFA, gram; M_p – mass of resp. filter, gram.

For researches the most popular in coal and mining oeres industry several patterns of respirators: ShB – 1 "Lepestok – 40", ShB – 1 "Lepestok – 200", RPA – TD – 1, RPA – TD – 2 were used. As it was mentioned above, the filtering cells for DIPRO of repeated using can be made of materials which greatly differ from each other by their technical characteristics and that may influence in great extent for the respirators' quality in whole.

That's why afficientive range of applying protectional devices is necessary to estimate according to the quality of the filtering cell. Results of researches on estimation of coefficient "k", accounting respirator's presence are shown in the table 1.

To appraise the role of devices for individual protection of respiratory organs in prophylaxis from dust etiology let's use the method of calculation chances of disease among workers in a dust contact that woes worked out and installated in Russia where miners' chance of disease can be determined by the integral index of morbidity risk (4):

$$R = 8{,}6x_1 + 6{,}0x_2 + 19{,}4x_3k_1 + 6{,}4x_4k_2k_3, \quad (3)$$

where R – is integral index of risk; x_1 – the worker's age, years; x_2 – the total service length, years; x_3 – the length of works in dust contact, years; x_4 – dust load, g; k_1 – coefficient accounting the content SiO_2 (it's within the limits of 0.6 – 1.20); K_2 – coefficient accounting mineral compound and dust concentration in the air (for the coal dust with the content of spare silica to 5 % within the scope from 0.47 to 2.2 it depends on exceeding YPK on dust in the air of working zone); k_3 – coefficient counting toil hardness (in the limits of 1.1 – 1.8).

Table 1

Type DIPRO with filtering cell	Dust concentration in chamber, C, mg/m^3	Time, dusting, t, min	Mass dust on DIPRO, before dusting, P, g	Mass of dust after DIPOR on filter AFA, P_c, g	Meaning of coefficient counting respirator's presence, k
ShB – 1 "Lepestok – 200"	близь-ко300	120	1,06±0,03	21,8±2,5	0,021
ShB – 1 "Lepestok – 40"	близько 300	120	1,07±0,04	26,4±2,4	0,024
RPA – TD – 1 with filters of material "FPP 15 – 0.6"	близько 300	120	1,07±0,07	21,1±1,3	0,019
RPA – TD – 1 with filters of material "FPP 15 – 1.5"	близько 300	120	1,06±0,08	22,9±1,1	0,022
RPA – TD – 1 with filters of material "eleflen 5C"	близько 300	120	1,09±0,05	21,6±1,5	0,020

The risk of disease is defined proceeding from the value of index (tab. 2(5)).

Table 2

Integral index	1000 1150	1151 1200	1201 1250	1251 1300	1301 1350	1351 1400	1401 1450	1451 1500	1501 1550	1551 1600	більше 1600
Risk of disease, %	> 2	5	10	20	30	40	50	60	70	80	90

Disposing indices which characterize miners' age, their length of working dust contact and coefficients accounting SiO_2 content, mineral structure and dust concentration in the air and hard toil conditions as well, it's possible to calculate the integral index of disease risk modifying by indices of dust load accounting DIPOR'S presence and lack of it. For example, a worker's age is 30 years, his total length of work is 9 years including 7 years in dust contact under average dust coal concentration (together with spare silica to 5%) 300 gr/m^3/without respirator for conditions cited above the integral index R, equals 43789 and risk of disease is over 90%. To what extent the respirator's presence lowers the risk of diseas by dust etiology – this can be found by comparing the results of calculations (table 3).

Table 3

Type of respirators	Integral index of risk disease R, accounting DIPOR presence	Risk of disease at DIPOR presence, %

ShB – 1 "Lepestok – 200"	1031	до 2
ShB – 1 "Lepestok – 40"	1167	до 5
RPA – TD – 1 with filters of material "FPP 15 – 0.6"	1011	до 2
RPA – TD – 1 with filters of material "FPP 15 – 1.5"	1061	до 2
RPA – TD – 1 with filters of material eleflen	1025	до 2

It's clear that in conditions of laboratory we are unable to reproduce all factors that affect upon the possibility of morbidity by pneumoconiosis. For instance, while hard toiling which is common for miners' work the air supply through DIPOR many reach 300 l/min, the can considerably increase the probability of hitting the dust. Besides, nobody controlled whether workers put on respirators correctly, either how much more is getting the value of unfiltered air which is ejected through the obturator's stripe past accumulation of sufficient amount dust on the air filter. This publication deals with only a slight part of the problem which regards with estimation after – effects of using respirators and defining of dust load. In order to define the effects of special types of respirators upon the lowering of morbidity risk confidentally, it's necessary to proceed with researches in this. But aspect one thing is of no doubt that using of all our explored types of respirators decreases greatly the risk of rising diseases by pneumoconiosis.

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