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PECULIARITIES OF SELECTING RESPIRATORY PROTECTIVE EQUIPMENT WHILE WORKING WITH CHEMICAL SUBSTANCES

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Abstract. A high degree of industrialization and urbanization characterizes the modern working environment. As a result, there is constant contact with various man-made factors (dust, smoke, fog or gas, steam), the concentration of which in the air is higher than the maximum permissible concentrations.

The purpose of the paper is to develop a procedure for assessing risks when working with chemicals, which allows substantiating the selection of adequate means of respiratory protective equipment to protect workers when performing production tasks.

Methods. To substantiate the selection of the type of respiratory protective equipment when working with chemical substances, a five-step approach to risk assessment is used. The approach is based on classification of chemical substances in terms of "R-phrase". This means risk factors that arise while working with hazardous substances described in Annex III of the EEC Directive 67/548/EEC. Together with the recommendations of the Approval of the Minimum Requirements for Safety and Health Protection When Employees Use Personal Protective Equipment at the Workplace (NPAOP 0.00-7.17-18), it allows to assess the occupational risk of danger from chemical substances taking into account their toxicity and substantiate the type of respiratory protective equipment.

Findings. An approach was developed to substantiate the selection of the type of respiratory protective equipment based on the hazard risk assessment. The correlation between the hazard group according to the "phrases" of a chemical substance and severity of the worker's health loss was defined. An algorithm for selecting respiratory protective equipment while working with chemical substances was proposed. An example of assessing the impact of sulphur dioxide during the work of miners with a recommendation of the type of respiratory protective equipment was considered.

Originality. A correlation between the protection class of the respiratory protective equipment and toxicity of the chemical substance according to the R-phrase was determined.

Practical value. An algorithm for selecting respiratory protective equipment to protect workers from chemical substances was proposed. The algorithm is based on five steps making it possible to develop an appropriate form of substantiation for the appropriate type and class of respiratory protective equipment.

Keywords: Respiratory protective equipment, risk, occupational disease, toxicity, concentration of harmful substance.

1. Introduction

Modern working environment is characterized by a high degree of industrialization and urbanization. As a result, there is constant contact with various technogenic factors (dust, smoke, fog or gas, and steam), which content in the air of the working area exceeds the maximum permissible concentrations. Respiratory diseases (first of all, pneumoconiosis) associated with inhaled mineral dust are incurable and irreversible; they make up a significant share among occupational diseases. According to Article 13 of the Law of Ukraine *On Labour Protection*, employers are obliged to create working conditions at workplaces in each structural subdivision in accordance with the normative legal acts; they are to ensure compliance with the requirements of the legislation regarding the rights of employees in the field of labour protection. If current level of the development of science and technology prevents from doing that, the respiratory protective equipment (RPE) should be used for protection [1]. The RPE selection is regulated by DSTU EN 529:2006 and consists of several stages: identification of harmful substances in the air of the working area, risk assessment, substantiation of the RPE selection according to protective characteristics, training of employees and guaranteeing the appropriate RPE maintenance [2]. However, the represented procedure needs clarification when selecting RPE for protection from chemical substances. For example, it is not quite clear in which cases it is better to use disposable or reusable RPE; whether RPE should be valved or valveless, with a filtering or an insulating face-piece. This is due to the lack of clear procedure for assessing risks when working with chemical substances, which would allow substantiating the selection of required RPE as stated in NPAOP 0.00-7.17-18 *On the Approval of the Minimum Requirements for Safety and Health Protection When Employees Use Personal Protective Equipment at the Workplace* [3]. This approach is especially necessary to determine the limits of applying RPE of various designs, taking into account an ergonomic component: a value of breathing resistance of the filters according to the difficulty of the work performed or the respirator weight, filter location, and headpiece design. Besides, a nominal protection factor of respirators defined in the laboratory conditions cannot be used to determine a degree of workers' protection at the workplace. There are numerous factors that can worsen the RPE effectiveness, which are not taken into account while laboratory testing. In particular, it is the tightness of half mask-face contacting. When determining an absorption coefficient in the laboratory conditions, those who failed to select a comfortable half mask are not allowed [4]. Taking into account the above, there is an urgent task to develop a risk assessment procedure when working with chemical substances. That would become the basis for the effective selection of respiratory protective equipment.

A number of papers are devoted to the selection of effective RPE to ensure the workers' protection while performing production tasks. The main issue here is defining the term of protective action of filters since a significant number of various gases are odourless [5–8]. Consequently, there arises a problem of developing the indication devices or schedules for the replacement of worn-out protective devices, which solution requires performing an adequate risk assessment. The conclusion is supported by a number of publications [8–12], where experts provided recommendations for the effective RPE use based on the risk assessment of users' occupational diseases. However, the indicated studies represent risk assessment using conventional qualitative methods based on several steps, which causes certain errors in the RPE selection, especially when operating in some specific conditions. For instance, when using the mentioned approaches, a degree of toxicity of chemical substances is not determined; that can lead to the use of an inappropriate type of filtering RPE not providing the appropriate class of protection. Due to suction of unfiltered air along the obturation contact line of the half-mask, filter respirators are an insufficiently reliable protective device, which leads to users' poisoning when working with the mentioned hazardous substances. The problem of selecting an effective RPE that meets the operating conditions as well as ergonomic and operational requirements is intensified by the fact that there are still no simple and reliable methods for determining proper user's half mask-face fit as well as the term of the filters' protective effect [13]. The service life of aerosol filter respirators is determined by breathing difficulties; in case of the gas ones, it is defined by smelling (however, it is not specified, which harmful gases can be detected by smell and which are prohibited categorically) [14]. The regulatory and technical documentation does not use information on visual indication and instrumental determination of toxicants' passing through dust and gas filters [15].

The analysis of scientific research concerning the RPE selection indicates the need to develop a specific risk assessment procedure when working with chemicals to substantiate RPE application not only basing on the concentration of harmful substances in the workplace air but also taking into account their toxicity.

The purpose of the paper is to develop a procedure for assessing risks while working with chemical substances, which will make it possible to select adequate respiratory protective equipment.

2. Methods

Risk assessment of the occurrence of occupational diseases (pneumoconiosis, dust bronchitis, chemical burns (dermatitis), oncological diseases etc.) due to the effect of various harmful (chemical) substances deteriorating the employees' health can be performed using the recommendations given in the *Medical and Sanitary Rules* to control hazardous substances approved in Great Britain in 2002 on the basis of "R-phrases" described in Annex III of the EEC Directive 67/548/EEC, being standard risk factors. The procedure involves insertion of health consequences due to potential exposure to chemicals, risk assessment, and substantiation of an adequate level of protection. Note that the impact of lead and radioactive substances is not evaluated. This approach can also be used to substantiate the RPE selection. The procedure involves five steps (Table 1).

Table 1 - Description of the steps for risk assessment when working with chemical substances

Step	Name	Description
1	Classification of hazards	Hazards are classified according to R-phrase or Globally Harmonized System (GHS) classification, where a substance is labelled as the one belonging to group A (low hazard), B, C, D (high hazard) and / or S (skin hazard)
2	Determining physical properties of chemical substances	Following scale to assess dustiness can be used: low, medium, and high
3	Assessing the workplace air exposure to liquid substances	Defining volatility of a chemical substance depending on the boiling temperature and temperature of a technological process, concentration, and other parameters. In addition, quite simple ranking can be applied: low, medium, and high
4	Defining risks and preventive measures	Substantiating the preventive measures basing on the risk level and maximum permissible concentration
5	Control and monitoring	Determining concentrations of hazardous substances and their constant monitoring to control their possible exceedence

To perform a risk assessment, we start by specifying a cause-and-effect relationship between the detected hazard (a hazardous event) and the consequences of a chemical substance for the employees' health. To do that, we determine the way how a person gets the harmful substance (through the respiratory tract, through the intestine or by skin contact), we detect whether harmful vapours, fog or smoke are emitted during the processing and, finally, we estimate the time of a production process, in accordance with the recommendations of the *Minimum Safety and Health Protection Requirements When Employees Use Personal Protective Equipment at the Workplace* (NPAOP 0.00-7.17-18).

Attention should be paid to the duration of staying within the working area along with the amount of applied chemical substance and its toxicity. You may also need information about work experience, pulmonary ventilation, and number of work shifts.

Step 1. Classification of hazards. Use the data of the European Union Directive 67/548 / EEC where all harmful substances are classified in terms of five groups from A to E basing on the characteristics of chemical substance hazards (R-phrases or H-phrases). The latter are assigned to chemicals in accordance with the *Rules on Chemical Substances* (data concerning hazards and packaging for transportation) [16].

Table 2 shows a classification range of chemicals by their hazard and associated R-phrases and H-phrases. The ratio of the absorbed dose to the safe dose in the target exposure zone is also taken into account. It is estimated that if the obtained ratio of a unit is exceeded, it will cause adverse consequences for the employees' health.

Table 2 - Distribution of chemicals according to the hazard classes by R-phrase/H-phrase [16]

Hazard group	Aerosol type	Concentration, mg/m^3	Measurement units	R-phrase	H-phrase
A	Dust	> 1 to 10	mg/m^3	R36, R38, and R-phrases not belonging to other groups	H303, H304, H305, H313, H315, H316, H318, H319, H320, H333, H336
	Gas	> 50 to 500	ppm		
B	Dust	> 0.1 to 1	mg/m^3	R20/21/22 and R68/20/21/22	H302, H312, H332, H371
	Gas	> 5 to 50	ppm		
C	Dust	> 0.01 to 0.1	mg/m^3	R23/24/25, R34, R35, R37, R39/23/24/25, R41, R43, R48/20/21 R68/23/24/25	H301, H311, H314, H317, H318, H331, H335, H370, H373
	Gas	> 0.5 to 5	ppm		
D	Dust	< 0.01	mg/m^3	R26/27/28, R60, R40 R39/26/27/28, R63 R61, R48/23/24/25, R62, R64	H300, H310, H330, H351, H360, H361, H362, H372
	Gas	< 0.5	ppm		
E	Dust		mg/m^3	R42, R45, R46, R49, R68	H334, H340, H341, H350
	Gas		ppm		

Step 2. Determination of physical properties of solid chemical substances involves evaluating their concentration in the environment according to three indicators: low, medium, and high (Table 3).

Step 3. Assessment of the ingress of liquid substances into the workplace air is based on their volatility depending on the boiling point and temperature of their use (Table 4).

Table 3 - Risk ranking by transformation of solid substances into dust

Dust generation	Description
Low	Non-loose solids (pellets), almost no dust is generated and observed visually while working with them (e.g. PVC pellets).
Medium	Crystalline granulated solids that generate dust while working with them; the dust deposits quickly and forms certain contaminating sediments on the working surfaces (e.g. washing powder, sugar powder).
High	Fine light powders generating a dust cloud, which remains in the air for some time (e.g. cement, titanium dioxide, toner for copy machines).

Table 4 - Risk ranking in terms of volatility of liquid substances

Volatility (transformation into a gaseous state)	At room temperature	At other working temperatures of a process (Tp)	Vapour pressure
Low	Boiling point is more than 150 ^{0}C	Boiling point is more than 5 x Tp + 50	Less than 0.5 kPa
Medium	Boiling point is from 50 to 150 ^{0}C	Other boiling points	0.5–0.25 kPa
High	Boiling point is less than 50 ^{0}C	Boiling point is less than 2 x Tp +10	More than 0.25 kPa

Quite a lot of the necessary information can be found in the safety data sheet of chemical products (SDS/MSDS), information sheets where the manufacturer provides data on the chemical substance according to the *Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals Regulations* (REACH), which provides a procedure for identifying a chemical substance to determine its hazard level. While using the information from the specified documents, it is appropriate to determine harm to the human body. To assess the risks, it is also necessary to understand the amount of a chemical substance the worker is dealing with (Table 5).

Table 5 - Determining the amount of the applied chemical substance

Amount of the applied chemical substance	Description
Small	Gramme or millilitres (up to 1 kg for solids or 1 l for liquids)
Medium	Kilogrammes or litres (the quantity is from 1 to 1000 kg for solids and from 2.5 to 1000 l for liquids)
Large	Tonnes or cubic metres (the quantity is more than 1 t for solids and 1 m^3 for liquids)

Step 4. Risk and degree of preventive measures are determined according to entering the results of preliminary assessments in the resulting Table 6 where the number of preventive measures is given as for the risk level defined in terms of hazard classification, physical properties, and the amount of applied chemicals.

Table 6 - Recommendations concerning the selection of preventive measures in terms of risk level determined according to hazard classification, physical properties, and amounts of chemical substances to be used

Hazard group	Amount	Physical properties of solid and liquid chemical substances (dust generation, volatility)			
		Low dust generation / low volatility	Medium volatility	Medium dust generation	High dust generation / high volatility
A (irritator)	Small	1	1	1	1
	Medium	1	1	1	2
	Large	1	1	2	2
B (harmful effect)	Small	1	1	1	1
	Medium	1	2	2	2
	Large	1	2	3	3
C (toxic effect)	Small	1	2	1	2
	Medium	2	3	3	3
	Large	2	4	4	4
D (effecting the reproductive function)	Small	2	3	2	3
	Medium	3	4	4	4
	Large	3	4	4	4
E (causes cancer, asthma, and other complex disorders)	Preventive measures of level 4 are applied				

Step 5. Control and monitoring of exposure to hazardous substances is the last step involving the RPE selection (Table 7) developed with the reference to hazard groups and interrelations with the maximum hazardous concentrations of chemical substances.

According to the type of chemical substances, we can select the appropriate class of filter (A, B, E, K and others), which will provide the appropriate level of protection. An important point here is to specify the term of protective effect. Thus, it is recommended to use either a replacement schedule provided by the manufacturer (developed according to the initial concentration and working conditions, climatic parameters, and other indicators), or special programmes posted on the website of the US Department of Labour Protection. A similar approach is used for skin protection, taking into account the type of workers' activity, which may lead to deposition of splashes, aerosol application or ordinary contact with the contaminated surfaces. It means that to select proper protective clothing and protective gloves, it is important to understand the range of hazards being also determined by the R-phrase or group.

Table 7 - Recommendations for the RPE selection

Hazard group	Amount	Recommendations for the protection level of filter gas-dust RPE according to physical properties of solid and liquid chemical substances (dust generation, volatility)			
		Low dust generation/low volatility	Medium volatility	Medium dust generation	High dust generation /high volatility
A	Small	-	-	-	-
	Medium	-	-	-	R2
	Large	R1	R2	R2	GM3
B	Small	-	-	R1	R1
	Medium	-	R2	R2	R3
	Large	R2	R3	GM3	Self-contained breathing apparatus
C	Small	-	R2	R2	GM3
	Medium	R2	R3	R3	Self-contained breathing apparatus
	Large	GM3	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus
D	Small	R2	R3	Self-contained breathing apparatus	Self-contained breathing apparatus
	Medium	GM3	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus
	Large	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus	Self-contained breathing apparatus
E	Small	R3	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus
	Medium	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus	Self-contained breathing apparatus
	Large	GM3	Self-contained breathing apparatus	Self-contained breathing apparatus	Self-contained breathing apparatus

Notes: R – respirator; GM – gas mask; figure – protection class.

3. Research results

Consider an example of the RPE selection while working at coal enterprises where chemical impurities can be released into the air of the working area. In particular, the mine air composition is characterized by the presence of carbon oxide, nitrogen oxides, hydrogen sulphide, sulphur dioxide, methane, and other impurities formed as a result of various mining operations. In addition, the main pollutant includes coal dust since the main adverse factor in coal mines is formed and enters the air during all operations related to drilling, cutting, loading, transportation, and overloading of coal. The amount of dust particles in the air can be equal to 30 thousand per 1 cm³ or more. Dust concentration during the operation of a cutter of a continuous heading machine can be hundreds of milligrammes per 1 m³ [17].

The problem is to select a means of personal respiratory protection to protect miners working in an underground mine where sulphur dioxide with a concentration of 0.8 mg/m^3 is released. According to DSTU-N B A.3.2-1:2007 «System of labor safety standards. Guidelines on the determination of dangerous and harmful factors and protection against their influence in the production of construction materials and products and their use in the process of construction and operation of construction objects», sulphur dioxide is a highly toxic substance with a maximum permissible concentration of 0.3 mg/m^3. The severity of consequences of inhaling this harmful admixture leads to shortness of breath and pneumonia. If we use general approaches to risk assessment, then after assessing the probability of dangerous event occurrence, i.e. pneumonia from the time of being in the zone of the specified harmful admixture effect, and calculating the pollution coefficient based on the ratio of sulphur dioxide concentration to its maximum permissible value, we can determine the RPE protection class. However, as stated, the indicated approach does not allow taking into account toxicity, which will lead, in this case, to the selection of a filter gas-dust protective respirator with an E-type filter box of the first protection class. It is due to the fact that the main condition for selection is the excess of protective properties of the respirator compared to the pollution coefficient. In this case, a pollution coefficient is 2.6 while a first-class respirator can be used up to 4 MPC.

As we can see, there is an error in the described approach that can lead to workers' poisoning; therefore, in case of available chemical impurities in the air of the workplace, the proposed approach should be applied taking into account the R-phrase. During step 1, we identify a harmful substance or their combination, establish the actual concentrations, and check the maximum permissible concentrations. We build a cause-and-effect relationship between the hazard (a hazardous event) and severity of consequences.

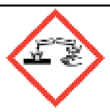
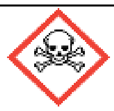
To do this, specify the R-phrase of sulphur dioxide that will help find the hazard level in terms of international classification of chemical substances. In this case, sulphur dioxide belongs to hazard group C (Table 2). Taking into consideration that the boiling point of sulphur dioxide reaches -10 ^{0}C, which refers to high volatility when the maximum permissible concentration is exceeded by almost 3 times, it can be attributed to a large quantity of this harmful substance to be used according to Table 3, and we select a self-contained breathing apparatus. Even if we consider that the excess concentration of the harmful substance is not significant, the workplace with the specified release of sulphur dioxide belongs to class 3.1 according to the *Hygienic Classification of Working Conditions and Indicators of Harmfulness and Hazard of Factors of the Industrial Environment* [18], there is still a need to use a gas mask with a full-face half mask to protect workers. The result of the conducted risk assessment for the RPE substantiation is shown in Table 8.

4. Discussion

Unfortunately, even conscientious implementation of the described procedure for RPE selection according to the requirements of DSTU EN 529:2006 *Means of Personal Respiratory Protection. Recommendations on Selection, Care and Maintenance*

[19] cannot guarantee effective protection of the user's respiratory organs, since the developers of DSTU EN 529:2006, who formalized stages for selecting effective functional respirators, do not even mention that their selection should be carried out, first of all, according to the classification and operating conditions, taking into account technical characteristics of respirators and features of the anthropometric dimensions of the faces of users of different nationalities, genders, and age groups. In case of the half mask incompatibility with a face, gaps are formed along the obturation line and toxic substances are sucked into the under-mask space. Therefore, when performing production operations within the areas with chemical substance releases, it is necessary to be very responsible while selecting RPE. In addition, the Standard provides three different indicators characterizing the protective properties of respirators but nothing is said about the "national" protection factor, by which it is recommended to make a choice (it is unknown where it is taken from and how it is determined).

Table 8 - Substantiating the RPE selection according to risk assessment

<table>
<tr><td colspan="8">HAZARD – Sulfur dioxide</td></tr>
<tr><td>Corrosive</td><td>Toxic</td><td colspan="6" rowspan="2">Sulphur dioxide is poisonous though far less than hydrogen sulphide. Its presence in the air, being 0.3 mg/m³ and more, causes shortness of breath and pneumonia</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Hazard group for the health:</td><td colspan="2">Amount to be used</td><td colspan="2">Dust formation of a chemical substance</td><td colspan="2">Volatility of a chemical substance</td></tr>
<tr><td>A</td><td></td><td rowspan="2">Small</td><td rowspan="2"></td><td rowspan="2">Low</td><td rowspan="2"></td><td rowspan="2">Low</td><td rowspan="2"></td></tr>
<tr><td>B</td><td></td></tr>
<tr><td>C</td><td>+</td><td rowspan="2">Medium</td><td rowspan="2">+</td><td rowspan="2">Medium</td><td rowspan="2"></td><td rowspan="2">Medium</td><td rowspan="2"></td></tr>
<tr><td>D</td><td></td></tr>
<tr><td>E</td><td></td><td rowspan="2">Large</td><td rowspan="2"></td><td rowspan="2">High</td><td rowspan="2"></td><td rowspan="2">High</td><td rowspan="2">+</td></tr>
<tr><td>S (C)</td><td></td></tr>
<tr><td colspan="8">Exposure limitation at the workplace: maximum permissible concentration is 0.3 mg/m³</td></tr>
<tr><td colspan="8">Maximum permissible concentration at the workplace</td></tr>
<tr><td colspan="3">Average daily concentration at the workplace</td><td>0.8 mg/m³ mg/m³</td><td colspan="3">TDI (tolerable daily intake) Complexity of work</td><td>0.3 mg/m³ mg/m³</td></tr>
<tr><td colspan="3">Maximum one-time concentration at the workplace</td><td>-</td><td colspan="3">Work duration within the dangerous zone</td><td>4 hours</td></tr>
<tr><td colspan="3">Contamination factor at the workplace</td><td>2.66</td><td colspan="3">Complexity of work</td><td>Hard</td></tr>
<tr><td colspan="8">Substantiation of the personal protective equipment</td></tr>
<tr><td colspan="2"></td><td colspan="6">To protect miners' respiratory organs when a mine working lacks ventilation, we select a gas mask with a full-face mask with an E-type filter element</td></tr>
</table>

A problem of selecting an effective respirator suitable for operating conditions along with ergonomic and operational requirements is complicated by the fact that there are still no simple and reliable methods for determining the tight half mask-face contact; specific obturator pressure on the face along the obturation line; and a period of protective action, being important for the health of RPE users. Unfortunately, the regulatory and technical documentation does not use information concerning visual indication and instrumental determination of the "slip" of toxicants through dust and gas filters.

This procedure has a number of limitations. First, it does not provide for substantiation of the constructive design of filter RPE: disposable or reusable, valved or valveless. In addition, a partial substantiation of the selection based on the ergonomic component was carried out, i.e.: a breathing resistance value of filters according to the difficulty of performed works or the respirator weight, filter location, and headpiece design. In order to consider these factors, additional research is required.

In any case, when there are numerous influencing factors being difficult to predict, the best solution will be the selection of respirators with forced air supply, which are recommended to be used for protection against toxic dust when it is necessary to create excess pressure in the under-mask space to prevent entry of harmful substances through the gaps in the obturation line. The front part selection depends on the irritation of the eyes by aerosol. If there is the irritation, then a mask should be worn; otherwise you can use a half mask. High temperature and air humidity will contribute to the accumulation of moisture in the under-mask space; consequently, a half mask with inhalation and exhalation valves is required.

5. Conclusions

1. An approach has been developed to substantiate the selection of the type of personal respiratory protective equipment based on the risk assessment of the danger of chemical substances by classifying their R-phrases; that makes it possible to consider a degree of toxicity.

2. The interrelationship between the hazard group according to the "phrases" of chemical substances and level of worker's health loss has been determined; that helped identify the types and protection class of the workers' personal respiratory protection.

3. An algorithm for selecting the respiratory protective equipment against chemical substances has been proposed with the development of the appropriate form necessary to substantiate the corresponding type and class of respiratory protective equipment.

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ОСОБЛИВОСТІ ВИБОРУ ЗАСОБІВ ІНДИВІДУАЛЬНОГО ЗАХИСТУ ОРГАНІВ ДИХАННЯ ДЛЯ РОБОТИ З ХІМІЧНИМИ РЕЧОВИНАМИ

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Анотація. Високий ступінь індустріалізації та урбанізації характеризує сучасне робоче середовище. Внаслідок цього відбувається постійний контакт з різними техногенними факторами (пил, дим, туман або газ, пара), концентрація яких у повітрі перевищує гранично допустимі концентрації.

Метою роботи є розробка процедури оцінки ризиків при роботі з хімічними речовинами, яка б дозволила обґрунтувати вибір адекватних засобів індивідуального захисту органів дихання для захисту працівників при виконанні виробничих завдань.

Методи. Для обґрунтування вибору типу засобів індивідуального захисту органів дихання при роботі з хімічними речовинами використано п'яти-кроковий підхід щодо оцінки ризику, який базується на визначенні класифікації хімічних речовин на основі «R-фрази». Останні представляють собою фактори ризику, які виникають при роботі з небезпечними речовинами, що описані в додатку III Директиви 67/548/EEC ЄЕС. В сукупності з рекомендаціями Мінімальних вимог безпеки і охорони здоров'я при використанні працівниками засобів індивідуального захисту на робочому місці (НПАОП 0.00-7.17-18) дозволяє оцінити професійний ризик небезпеки від хімічних речовин з урахуванням їх токсичності та обґрунтувати тип засобів індивідуального захисту органів дихання.

Результати. Розроблено підхід з обґрунтування вибору типу засобів індивідуального захисту органів дихання на основі оцінки ризику небезпеки. Встановлено взаємозв'язок між групою небезпеки за «фразами» хімічної речовини і важкістю втрати здоров'я працівником. Запропоновано алгоритм вибору засобів індивідуального захисту органів дихання від хімічних речовин. Розглянуто приклад з оцінки впливу діоксиду сірки при роботі гірників з рекомендацією типу засобу індивідуального захисту органів дихання.

Наукова новизна. Встановлено взаємозв'язок між класом захисту засобу індивідуального захисту органів дихання і токсичністю хімічної речовини за R-фразою.

Практична цінність. Запропоновано алгоритм з вибору засобів індивідуального захисту органів дихання для захисту від хімічних речовин, який базується на п'яти кроках, що дозволило розробити відповідну форму обґрунтування відповідного типу і класу засобу індивідуального захисту органів дихання.

Ключові слова: Засоби індивідуального захисту органів дихання, ризик, професійне захворювання, токсичність, концентрація шкідливої речовини.