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HYGIENIC SITUATION AND OCCUPATIONAL MORBIDITY AT COPPER-ZINC ORE MINING ENTERPRISES

The article is devoted to the hygienic assessment of working conditions and their impact on the health of employees of a mining enterprise engaged in the extraction and processing of copper-zinc ore located in the Southern Urals. The relevance of the study is due to the need for a detailed study of the hygienic situation in all divisions of a mining enterprise in order to assess the levels of occupational risk of damage to the health of employees and timely preventive measures aimed at minimizing it. Priority harmful production factors have been identified in the workplaces of various departments: during underground ore mining, noise, vibration, lack of natural light, unfavorable microclimate, severity, and labor intensity; during transportation of extracted ore, vibro-acoustic factors, severity, and labor intensity; during ore processing, noise. The overall assessment of the workers' working conditions corresponded to harmful classes 3.1-3.3. Working environment factors contributed to the formation of chronic somatic diseases among workers engaged in mining and transporting ore, among which dorsopathies and arthropathies prevailed, which is confirmed by the high strength of the association of these diseases with working conditions. In the workers of the processing plant, dorsopathies with an average degree of association were attributed to diseases related to working conditions. The structure of occupational morbidity was dominated by diseases caused by exposure to vibration, aerosols, mainly fibrogenic effects, and physical overloads. Workers engaged in mining and transporting ore have the highest occupational morbidity index (0.32 - 0.50). The highest total assessment of occupational health risk, taking into account all the studied indicators, was established for workers engaged in underground mining. The materials of the conducted research served as the basis for the development of medical and preventive recommendations to minimize the occupational risk to the health of employees of the studied enterprise.

Keywords: mining enterprise, workers, harmful production factors, occupational diseases, diseases related to working conditions

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Introduction. Despite the implementation of national programs aimed at preserving the longevity and active life of the working population, a high proportion of workers employed in unfavorable working conditions remains at individual enterprises in various sectors of the economy, and occupational diseases are registered. Such industries include mining, in which more than half of employees work in conditions that negatively affect their health, and the level of occupational morbidity over the past five years, according to Rosstat, has varied from 15.2 to 21.2 cases per 10,000 employees.

There is a high risk of adverse effects of harmful production factors on the health of employees of enterprises in this industry, including companies engaged in the extraction and processing of metal ores [3-5, 7, 8, 10, 13, 15].

According to various authors, vibration sickness, sensorineural hearing loss, diseases of the peripheral nervous

system and musculoskeletal system, as well as pneumoconiosis account for the largest share in the structure of occupational diseases of mining workers. [3, 9, 11, 12, 14].

Mining enterprises in their structure have mines for underground mining, open pits, processing plants, motor transport units that transport ore, as well as auxiliary sites. The largest number of studies are focused on assessing the working conditions and health of workers engaged in underground mining [3, 2, 6, 8-11]; some information is available about the working conditions of workers engaged in ore transportation and processing [1, 2].

The relevance of this study is due to the need for a detailed study of the hygienic situation in all divisions of a mining enterprise in order to rank them according to the levels of occupational risk of damage to the health of employees and timely preventive measures aimed at minimizing it.

Materials and methods of research. Hygienic studies of working conditions were carried out at the enterprise for the extraction and processing of metal ores located in the Southern Urals. Based on the results of measurements of the factors of the working environment and the labor process, as part of the conducted production control, the working conditions at the workplaces of various departments were assessed in accordance with the requirements of the Manual R 2.2.2006-05[1].

During the periodic medical examination, in accordance with the Order[2] of the Ministry of Health of the Russian Federation No. 29n, 821 male employees of various production units aged from 23 to 58 years were examined, with an average age of 45.2 ± 2.4 years and professional experience of 16.4 ± 0.8 years. Occupational morbidity rates among workers have been studied over the past ten years.

Occupational risk and the degree of occupational conditioning are calculated in accordance with the requirements of Guideline P2.2.3969-23[3], taking into account the class of working conditions, indicators of occupational morbidity and diseases related to working conditions (BSUT). The degree of professional conditionality of the identified chronic somatic diseases of employees of production units was carried out based on the calculation of relative risk (RR, units) and etiological proportion (EF, %).

The comparison group included 238 male workers who worked in auxiliary departments in the professions of locksmith of control and measuring devices and automation, electrician, foreman of sites, employees of the central factory laboratory, whose working conditions were not related to underground conditions and corresponded to the permissible class. The compared group was comparable with the main professional groups in terms of age (43.5 ± 3.5 years) and work experience (18.9 ± 1.3 years) by profession.

Statistical processing of the obtained data was carried out using Microsoft Excel programs.

Results and discussion. The functioning of a certain technological stage is associated with the presence of certain harmful production factors and their combinations in the workplace, the intensity of which depended on the power of the equipment used, the type of work performed, raw materials, reagents, the degree of automation and mechanization of production, etc.

The workplaces of workers engaged in the management and maintenance of in-mine equipment for underground ore mining (drilling rig operator (BU), loading and delivery machine operator (PDM), loading and screening machine operator (PSM), fastener) were characterized by harmful working conditions due to a combination of production factors (noise, vibration, illumination (lack of natural lighting), chemical, ACE, microclimate, severity, intensity of the labor process) (Table 1).

Industrial noise generated by in-house machinery and mechanisms, the levels of which exceeded the maximum permissible level (remote control) by 5-17 dBA, is typical for all workplaces studied (classes 3.1-3.3). Vibration acceleration levels at individual workplaces exceeded hygienic standards by 1-3 dBA. The lack of natural lighting in the mine workings, taking into account the assessment of artificial lighting of the work areas, made it possible to classify the working conditions for lighting as a harmful class of the first degree. On mining equipment operated at the bottom of the mine, which does not provide isolated cabins, the microclimate parameters in the working area did not correspond to the established normalized levels (class 3.1).

The presence of carbon monoxide and nitrogen oxide was recorded in the air of the PDM and PSM machinists' working area, the concentrations of each of them did not exceed the relevant hygienic standards, taking into account the summation coefficient, the class of working conditions corresponded to the harmful class 3.1. When preparing the cement mixture by the fastener for applying it to the arches of the workings, an increased content of silicate dust (cement) in the air was found weakly fibrogenic effect; the frequency of excess reached up to 1.45 times (class 3.1).

The work of the employees of the entire professional group is stressful (class 3.1) due to significant emotional and sensory stresses, which is due to the peculiarities of conducting the technological process of underground ore mining.

The labor process of the fasteners is difficult (class 3.1), as they perform a number of manual auxiliary work related to the movement of cargo up to 35 kg.

The general class of working conditions of workers engaged in underground mining corresponded to the harmful class of the second – third degrees of harmfulness (3.2-3.3).

The extraction, loading and transportation of the extracted ore was carried out using specialized equipment: excavators, bulldozers, tractors, heavy-duty dump trucks of various brands. The professional group in this division is represented by a car driver, a bulldozer driver, an excavator driver and a tractor driver. The combination of harmful production factors affecting the workers of this group was the same and consisted of the vibroacoustic factor, the severity and intensity of the labor process with a general assessment of working conditions corresponding to the harmful class 3.2.

The extracted ore is delivered to the processing plant in order to obtain a com-

[1] Guidelines for the hygienic assessment of the factors of the working environment and the labor process. Criteria and classification of working conditions: Manual R 2.2.2006-05. Bulletin of regulatory and methodological documents of Gossanepidnadzor. 2005; 3(21): 3-144.

[2] Order of the Ministry of Health of the Russian Federation No. 29n dated January 28, 2021 "On Approval of the Procedure for Mandatory Preliminary and Periodic medical examinations of employees Provided for in Part Four of Article 213 of the Labor Code of the Russian Federation, the list of medical Contraindications to work with Harmful and (or) Dangerous Industrial factors, as well as work performed during which mandatory preliminary and periodic medical examinations are carried out (as amended on February 1, 2022)". Registered with the Ministry of Justice of the Russian Federation on 29.01.2021 N 62277.

[3] P 2.2.3969-23 "Guidelines for occupational health risk assessment for employees. Organizational and methodological foundations, principles and evaluation criteria"

mercial concentrate with a higher content of valuable components compared to the initial ore mass. The technological process involves a crusher, a conveyor operator, a mill operator, a flotation device, a reagent solver, a thickener apparatchik, a filter and a dryer. The leading harmful production factor in their workplaces was noise, the intensity of which was determined by the type and corresponding capacity of the equipment used (class 3.1-3.2). In addition, there was an increased level of general vibration at the crusher's workplace (class 3.1), an unfavorable microclimate (class 3.1) for workers serving the drying and filtration department, and the presence of silicon dioxide, the content of which exceeded the maximum permissible concentration by 1.5 - 2.8 times (class 3.1), was recorded in the crusher, conveyor machinists, and mills.

The working conditions in terms of the severity of the labor process at most workplaces were acceptable (class 2), with the exception of the workplace of the solvent of reagents, whose work involves manually moving a load weighing 25-30 kg and was characterized by the third class of the first degree of harmfulness (class 3.1). The general class of working conditions of employees of the enrichment plant corresponded to class 3.1-3.2.

According to the results of the medical examination of the employees of the studied enterprise, only 18-24% of the surveyed were recognized as healthy, while 76-82% have chronic diseases.

The main chronic somatic diseases among workers engaged in mining and transporting ores were dorsopathy (53.2%), nervous system disorders (27.5%), diseases characterized by high blood pressure (18.2%), as well as diseases of the digestive system (7.7%).

The processing plant workers were diagnosed with diseases of the musculoskeletal system and connective tissue (52.5%), mainly dorsopathy, respiratory diseases (45.8%), with a significant proportion being chronic bronchitis (8.6%) and upper respiratory tract diseases in the form of rhinitis, pharyngitis (37.4%), as well as diseases of characterized by high blood pressure (33.3%).

The calculation of the degree of occupational risk of developing BSUT, depending on the specifics of the work performed, demonstrated significant differences. Respiratory diseases (RR = 2.9, EF = 52.0%) have a high degree of association of health disorders with working conditions in workers of the processing plant, diseases characterized by high blood pressure (RR = 1.9, EF = 43.2%), as well as dorsopathy (RR = 1.91, EF = 47.6%) have an average degree.

For workers engaged in mining and transporting ore, dorsopathies (RR = 2.7 – 3.2, EF = 61.0 – 65.2%) and arthropathies (RR = 2.5 – 3.2, EF = 51.0 – 65.3%) have a high degree of association with working conditions, while diseases characterized by high blood pressure have an average degree (RR = 1.8, EF = 42.3%).

Occupational diseases in workers engaged in the extraction and transportation of metal ores were represented by vibration disease, autonomic sensory polyneuropathy of the extremities and radiculopathies, as well as pneumoconiosis. The HP index was 0.32 – 0.50, and the risk was high. At the same time, the age at which occupational diseases were detected ranged from 40.7 to 52.7 years, and professional experience ranged from 14.4 to 20.8 years.

No occupational diseases have been identified in the workers of the enrichment plant.

The frequency of development of signs of noise exposure to the hearing organ in the surveyed differed slightly and amounted to 19.6 ± 1.2% for workers engaged in underground mining, 15.8 ±

Table 1

Working conditions of employees of various divisions of a mining enterprise

The production environment factor	The class of working conditions in the workplace		
	mining of ore by underground method	ore transportation	enrichment plant
Chemical	2 - 3.1	2	2
Aerosols of predominantly fibrogenic action	2 - 3.1	2	2 - 3.1
Noise	3.1 - 3.3	3.1 - 3.2	3.1 - 3.2
Vibration	2 - 3.1	3.1	2 - 3.1
Microclimate	2 - 3.1	2	2 - 3.1
Illumination	3.1	2	2
The severity of the work	2 - 3.1	3.1	2 - 3.1
Labor intensity	3.1	3.1	2
General class of working conditions	3.2 - 3.3	3.2	3.1 - 3.2

Table 2

Assessment of the occupational risk of damage to the health of employees of the main divisions of the enterprise for the extraction and processing of metal ores

Indicator	Division		
	mining of ores by underground method	ore transportation	ore processing
Class of working conditions	3.2 - 3.3	3.2	3.1 - 3.2
Risk category - points	average – 1.5 high – 2.0	average – 1.5	moderate – 1.0 average – 1.5
Clinical signs of occupational diseases and diseases related to working conditions	There is a clinical picture of occupational diseases and diseases related to working conditions		early signs of occupational diseases and diseases related to working conditions have been identified
Scores	7.0	7.0	5.0
Total	8.5 - 9.0	8.5	6.0 - 6.5

1.3% for workers transporting ore, and 14.3 ± 1.8% for workers at the processing plant.

Based on the studied indicators, an assessment of the occupational health risk of employees of various divisions was carried out (Table 2). When ranking the divisions of a mining enterprise, it was found that workers engaged in underground ore mining have the greatest risk of health problems (the sum of the points is 8.5 - 9.0), followed by workers engaged in ore transportation, having 8.5 points. The lowest risk of health damage in terms of the total score (6.0 – 6.5) is typical for employees of the processing plant.

The unfavorable hygienic situation at this enterprise is similar to the results of research on working conditions at other enterprises in the industry, as evidenced by publications [2].

The clinical examination data confirms the results of hygienic studies. Only 18-24% of the surveyed were recognized as healthy and practically healthy, while the rest had chronic somatic diseases such as dorosopathy, nervous system disorders, diseases characterized by high blood pressure, etc. Our data coincide with the results of other researchers who have studied occupational morbidity and health status of employees of mining and processing enterprises [2,5, 10].

The results of the study substantiate the need to develop and implement comprehensive measures, including technical, organizational, and therapeutic measures aimed at reducing the occupational risk of health problems among employees of various departments of the enterprise.

Conclusions:

1. The working conditions of the employees of the studied enterprise were characterized by the impact of a complex of harmful production factors of varying intensity, which was determined by the stage of the technological process, the equipment used and its capacity, the type of work performed, the degree of automation and mechanization of production, etc., with a general assessment of working conditions 3.1 - 3.3.

2. The unfavorable hygienic situation at work causes the formation of occupational diseases and diseases related to working conditions in employees, the levels of which correspond to high – medium occupational risk categories.

3. The determining role of working conditions (the relative risk of RR is more than two units and the etiological proportion of EF is above 50%) has been identified for chronic diseases of the musculoskeletal system in workers engaged in mining and transporting ore, respiratory organs – in workers of the processing plant.

4. Occupational diseases in workers engaged in the extraction and transportation of metal ores were represented by vibration disease, autonomic sensory polyneuropathy of the extremities and radiculopathies, pneumoconiosis with a high (0.32 – 0.50) HP index.

5. The materials of the conducted research served as the basis for the development of medical and preventive recommendations to minimize the occupational risk to the health of employees.

The authors declare no conflict of interest.

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