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IMPACT OF PRODUCTION ENVIRONMENT AND LABOR PROCESS FACTORS ON THE BODY OF FOUNDRY WORKERS

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Abstract*. This article examines the production factors of working conditions at foundry workers' workplaces, provides the actual values of the parameters under consideration and their impact on the body of workers. The most common diseases among foundry workers are diseases caused by exposure to dust (silicosis and dust bronchitis), vibration (vibration disease), and noise (sensorineural hearing loss). When assessing the working conditions of workers in foundries, it is necessary to take into account the impact of a complex of factors in the production environment, the technological processes and equipment used, and the duration of stay working in the zone of influence of the factors.*

Keywords*: production factors, noise, vibration, dust, gas contamination, microclimate parameters, illumination, electromagnetic fields, working conditions, foundry, foundry.*

Introduction. In a foundry, the working conditions of workers are determined by the following production factors: dust, gas contamination, noise, vibration, thermal radiation, microclimate parameters, electromagnetic radiation [1-3]. The impact of these factors on workers can lead to an increase in general morbidity, the development of occupational diseases and an increase in occupational injuries. Therefore, when choosing technological processes for manufacturing castings, it is necessary to take into account occupational risks from the point of view of the impact of production factors on the body of workers.

Dangerous and harmful production factors affecting humans are divided into three groups:

active, including *subgroups*: *mechanical* (noise, vibration, dust, etc.); *thermal* (temperature of heated objects and surfaces, microclimate parameters); *electric* (electric current, electrostatic charges, air ionization); *electromagnetic* (ultraviolet and infrared rays, ionizing radiation, magnetic fields); *chemical* (presence of harmful impurities in the air); *psychophysiological* (stress, overexertion, fatigue, etc.).

- *passive-active* - activated by energy carried by a person or equipment (sharp objects, uneven surfaces on which a person and machine move, as well as tilting and lifting).

- *passive* ones manifest themselves due to explosions, destruction, falls and other accidents (related to the properties of materials and objects: corrosion of metals, insufficient strength of structures, increased load on equipment, mechanisms, machines, etc.).

The direction of production activity, specific production operations, tools, forms of labour organization, etc. are essential for preserving the health of workers. Each of these indicators requires certain physical and psychophysiological qualities. These factors individually and

especially in combination can have an adverse effect on the human body during production activities (harmful substances, microclimate, noise, vibration, thermal and electromagnetic radiation, workplace illumination, psychological tension, work schedule, etc.).

Material and methods. An analysis of the state of occupational morbidity in foundries showed that the most common diseases among foundry workers are diseases caused by exposure to dust (silicosis and dust bronchitis), vibration (vibration disease), and noise (sensorineural hearing loss). At the same time, workers in foundries account for 61.3% of vibration disease, 37.4% of sensorineural hearing loss, 92.8% of silicosis and 83.1% of dust bronchitis of the total number of similar occupational diseases at machine-building enterprises [18-20].

Let us take a closer look at the influence of individual production factors on workers.

Dust is released into the air of working areas during many production operations: preparation and preparation of moulding and core mixtures, production of cores and moulds, metal smelting, knocking out castings from poured moulds, trimming and cleaning castings, repairing melting units and pouring ladles and others. The qualitative composition of dust determines the possibility and nature of its effect on the human body. Of particular importance are the shape and consistency of dust particles, which easily settle on the mucous membrane of the upper respiratory tract and can cause chronic tracheitis and bronchitis, as well as occupational dust diseases. A significant place is occupied by pneumoconiosis (fibrosis of the lung tissue - a lung disease, which is based on changes caused by the deposition of dust and its subsequent interaction with the lung tissue). Among pneumoconiosis, the greatest danger is silicosis - a slowly occurring chronic process that develops in people who have worked for several years in conditions of significant air pollution with free silicon dioxide (SiO_2) [4-6]. In foundries, silicosis is observed among farmers, core workers and moulders, since dust concentrations in their work areas during different operations range from 2 to 12 mg/m3. When knocking castings out of flasks, cutting and cleaning, the permissible concentrations can exceed tens of times [7, 8]. The likelihood of occupational disease in conditions of increased dust increases with the concomitant influence of such production factors as heavy physical activity, microclimate, and harmful substances. The effect of dust on the eyes causes conjunctivitis.

Work experience before the development of silicosis in dusty conditions in modern enterprises on average exceeds 15–20 years. The incidence of silicosis is directly dependent on the amount (concentration) of inhaled dust and the content of free silicon dioxide in it. The most aggressive particles are those ranging in size from 0.5 to 5 microns, which reach the lungs and remain there. The determining factor in the course of silicosis is the aggressiveness of the dust factor (concentration and dispersion of dust, the content of SiO_2 in it). The disease has an unfavourable course in people who started working at a very young and middle age (over 40 years old). Silicosis is a disease that tends to progress even after cessation of contact with dust. There is a gradual worsening of respiratory failure.

Harmful substances in the air of working areas of foundries are detected during various technological processes: during the manufacture of cores and moulds, melting and pouring metal, drying pouring ladles and others. Let's consider the effect of the most commonly encountered substances in foundry production.

As a rule, carbon monoxide is found in the air of the working area, which is mainly formed during the combustion of fuel in a cupola furnace and the burnout of organic components from the moulding sand and cores. Carbon monoxide poisons the body of workers. In acute poisoning and

very high concentrations of carbon monoxide, loss of consciousness, convulsions and death from oxygen starvation are noted. In milder cases, three degrees of severity are distinguished: mild - severe headache, dizziness, tinnitus, weakness, palpitations, shortness of breath, nausea, vomiting, increased pressure, dilated pupils, loss of orientation in space; medium - symptoms sharply intensify, marked drowsiness, weakness are characteristic, the skin and mucous membranes acquire a purple tint, shortness of breath increases, blood pressure drops; the third is loss of consciousness, loss of reflexes, convulsions. The most unfavourable situation for carbon monoxide is observed in the workplaces of smelters and pourers, where concentrations exceed the permissible 20 mg/m^3 by 1.24 - 2.07 times, which is also noted in works [7, 8].

Nitrogen oxides are fixed in the air of working areas during the operation of melting units, pouring liquid metal into moulds, etc. The content of nitrogen oxide, as a rule, does not exceed the permissible concentration. Nitrogen oxides cause vasodilation and reduce blood pressure, lead to pulmonary edema, have an effect on the central nervous system, the light sensitivity of the eye changes, a person’s sense of smell decreases, dryness in the nose and throat, and unpleasant pain appear.

When making cores and moulds from mixtures using organic binders, phenol, formaldehyde, and methanol are fixed in the air of working areas.

Phenol is highly toxic, is a nerve poison, and has a pronounced irritant effect. In acute poisoning, weakness, agitation, headache, dizziness, increased salivation, and irritation of the mucous membranes of the upper respiratory tract are noted. Acute poisoning can occur as a result of phenol coming into contact with the skin. Signs of a burn (initial pallor, wrinkling of the affected area of skin, formation of blisters) can occur already when 2–3% phenol solutions come into contact with the skin.

Formaldehyde is a gas that is generally toxic, irritates the skin and mucous membranes, leads to spasms and swelling of the larynx, cough, shortness of breath, bronchitis, and pneumonia. Upon contact with the skin, dermatitis appears; upon ingestion, burns of the digestive tract occur, a burning sensation in the mouth and behind the sternum, accompanied by nausea and vomiting with blood. Affects the liver and kidneys. Large concentrations can lead to coma and damage to the heart muscle. Increased concentrations of phenol, formaldehyde and methanol were observed at core workers’ workplaces during the manufacture of cores using heated equipment and pouring moulds with liquid metal, exceeding the MPC by 1.19 to 3.3 times [7, 8].

Methyl alcohol (methanol) is a strong nervous and vascular poison that irritates the mucous membranes of the upper respiratory tract and eyes. Toxicity is associated with the formation of formaldehyde and formic acid in the body. After a few hours, headache, heaviness in the head and chest, difficulty breathing, general malaise and blurred vision appear; puffy face, shortness of breath, tachycardia. Then anxiety develops with complaints of difficulty breathing, chest tightness, fear of death, and convulsions. In industrial conditions, inhalation of methyl alcohol vapor may cause fainting, headaches, feelings of intoxication, and irritation of the mucous membranes of the eyes and respiratory tract.

Lead (manufacturing castings from bronze and brass) - signs of intoxication include anemia, fatigue, weakness, irritability, headache, dizziness, memory loss, pain in the extremities. In more pronounced cases, there is trembling of the fingers of outstretched arms, tongue, eyelids, changes in the digestive organs: the most severe syndrome of damage to the gastrointestinal tract is “lead” colic.

Antimony is used in various alloys (bronze). Antimony is deposited in the liver, skin and hair. Antimony compounds have an irritating effect on the skin, mucous membranes of the eyes, upper respiratory tract and digestive tract; affect the central nervous system and heart muscle. When exposed to antimony compounds in the form of vapor, irritation of the mucous membranes of the eyes (possible damage to the cornea) and the upper respiratory tract is observed.

Zinc is used to form alloys with other metals, mainly copper (brass). Enters the body through the respiratory system, partly through the gastrointestinal tract. Zinc metal in the solid and dusty state is non-toxic. Inhalation of zinc fumes causes so-called “zinc” or “foundry fever”. Soluble zinc salts have a significant cauterizing effect on the skin and mucous membranes. Foundry workers' fever, brass fever, is an occupational disease that occurs when inhaling vapours of various metals (zinc, copper, brass, iron, etc.). When zinc is ingested through the mouth or upper respiratory tract, a sweetish taste in the mouth, thirst, fatigue, feelings of weakness, nausea and vomiting, chest pain, red eyes, and dry cough may occur.

Sulphur and its compounds – workers may complain of burning eyes, lacrimation and photophobia; fatigue, increased irritability, headaches, dizziness, pain and discomfort in the heart area. There is an increased incidence of acute catarrh of the upper respiratory tract, tonsillitis, chronic bronchitis, gastritis, gastric and duodenal ulcers.

Manganese - intoxication manifests itself in the initial stages as weakness in the legs, trembling, pain in the limbs. In more severe cases, damage to the central nervous system, speech disorder, tremor, apathy, drowsiness, and lethargy are noted. Chronic manganese poisoning is characterized by damage to the respiratory system (manganese pneumonia, bronchial asthma).

Nickel - affects the nervous system, there is a feeling of anxiety, restlessness, chronic fatigue, possible development of Parkinson's disease, depression of the cardiovascular system.

Concentrations of lead, zinc, antimony, sulphur, manganese and nickel in the air of the working area, as a rule, do not exceed the maximum permissible concentrations, however, the above symptoms must be taken into account when studying the consequences of their possible exposure to workers.

Aluminium and its compounds are fixed in the air of working areas during melting and pouring of moulds and moulds. It has moderate toxicity. When aluminium dust is inhaled, signs of inflammation appear in the lungs (pulmonary ventilation decreases, and at high concentrations - severe pneumonia), which affects the central nervous system.

Weather conditions. The influence of a heating microclimate on the human body in the conditions of foundries can lead to serious changes in the cardiovascular, central nervous and other systems, causing a decrease in human weight, blood thickening, salt imbalance, the development of vitamin deficiency, insufficient blood circulation of the heart, decreased gastric secretion and pancreatic juice, bile, weakening of attention, deterioration of coordination of movements, slower reactions, heat stroke. The results of studies of microclimate parameters at workplaces in foundries show that during the warm period of the year, the air temperature at workplaces in the melting and pouring area often exceeds permissible values by 6-10°C or more. It was noted that the permissible temperatures were exceeded by 3-7°C in the thermal processing departments. During the cold period of the year, such excesses are recorded and are even somewhat larger (standard values during this period have lower absolute values). The intensity of thermal radiation when working at melting units and pouring liquid metal sometimes exceeds the permissible value (140 W/m^2)

tens of times, depending on the metal used and the technological operation being performed [9-11].

High temperatures and the intensity of thermal radiation significantly affect the heat exchange of the worker, leading to disruption of water-salt metabolism, functional disorders of the nervous system and metabolism with the formation of toxic products.

As a result of heart overload and changes in the heart muscle and blood vessels caused by high temperature, acute cardiovascular failure can occur. In cases where thermal exposure is accompanied by a large loss of chlorides, a convulsive disease occurs (complaints of periodically occurring painful spasms of various muscle groups, more often the legs, face, sometimes turning into general spasms). Systematic deviations of microclimate parameters from norms lead to chronic colds, joint diseases, heat strokes, convulsions, and stress conditions.

All this leads to a decrease in efficiency in the workshop and an increase in the number of colds. The overall morbidity rate among workers in foundries exceeds general plant indicators by 1.18–1.72 times. Analysis of morbidity with temporary disability showed that in the structure of morbidity, after acute respiratory infections (on average 38.12% of all cases) and diseases of the musculoskeletal system (11.07), influenza (6.86), organ diseases breathing (4.3), hypertension (2.27), infections and skin diseases (2.1), mental disorders (1.36), heart disease (1.24), pneumonia (1.2), nervous diseases systems (1.07) [17, 18].

Lighting. The results of studies of artificial and natural lighting in areas of foundry shops showed that illumination indicators do not correspond to standardized values in almost all areas of workshops. An analysis of the distribution of artificial lighting by level before and after cleaning, washing lamps and replacing burnt-out lamps showed that before preventive measures, illumination met the standards in only 21.5% of workplaces in mass foundries, 15.4% in serial foundries, and in 12.8 % small-scale production workshops. After the implementation of preventive measures, illumination met the standards in 78.6% of workplaces in mass foundries, 63.6% in mass production and 58.3% in small-scale production [12].

Lighting provides visual perception, affects the endocrine system, the system of formation of the immune defense, the growth and development of the body and affects metabolism and resistance to adverse environmental factors, and increases labor safety. Unsatisfactory lighting can distort the information a person receives through vision, causes fatigue of the body as a whole, negatively affects the state of the central nervous system, and can cause occupational injuries. Lighting affects labor productivity and the quality of products.

Noise is one of the most harmful production factors that determine working conditions in foundries and adversely affect workers. The results of studies of the noise of foundry equipment showed that the noise parameters at the workplaces of mixing, core, moulding, melting and pouring, knocking out and trimming and cleaning areas exceed the permissible values. The greatest excesses of the permissible sound level are observed at workplaces at core and moulding shaking machines (by 9-16 dBA), at knockout grids (by 14-22 dBA), and at chipping and cleaning equipment (by 16-24 dBA) [13-14, 19].

Noise has a dual effect on the worker’s body: specific (affects the auditory analyzer, which leads to the development of occupational hearing loss) and nonspecific (affects the function of the central nervous and digestive systems (ulcerative defects); heart (myocardial infarction); blood vessels (circulatory disorders). An occupational disease from exposure to noise, sensorineural hearing loss is a gradual decrease in hearing acuity caused by prolonged exposure (mainly high-

frequency). Noise-hazardous professions and, accordingly, a high degree of hearing loss are found among moulders, rougheners, casting cleaners, sanders, etc.

When noise is combined with exposure to vibration, dust, toxic and irritating substances, microclimate factors, and physical overstrain, the development of pathology accelerates. The combined effect of noise and vibration causes changes in the vestibular analyzer. There are complaints from the nervous system - irritability, increased fatigue, sleep disturbances, inability to concentrate, headaches, dizziness; from the cardiovascular system - first stabbing, then squeezing pain in the heart area, changes in pulse and pressure, increased sweating, chilliness and freezing hands and feet.

Vibration. The results of studies of vibration of foundry equipment showed that the highest excess levels of general vibration are observed at the workplaces of moulders at shaking machines and beaters. However, foundry workers operating hand-held moulding tools, machines and tools for cleaning castings and tools for trimming castings are exposed to significantly greater exposure to local vibration. Those working in foundries are exposed to vibration when making moulds from sand-clay mixtures on shaking moulding machines, when knocking castings out of moulds, when cleaning and trimming castings, i.e. where a person is near impact-type foundry equipment (with general vibration) or comes into contact with vibration sources through his hands (local vibration). The level of general technological vibration at workplaces with impact equipment does not exceed the permissible value, and when working with hand-held vibrating tools when forming, trimming and cleaning castings, the permissible value is exceeded by 3-7 dB [15, 16, 20].

Vibration with prolonged exposure to the human body can lead to pathological changes, and then to an occupational disease - vibration disease. Exposure to general vibration disrupts the functioning of the nervous system and analyzers: vestibular, visual. Observed: headaches, pain in the lower back, in the limbs, in the stomach, irritability, loss of coordination of movements, vestibular instability. Local vibration causes spasms in the blood vessels of the hand and forearms, disrupting the blood supply to the limbs. At the same time, the effect of vibration on nerve endings, muscle and bone tissues is observed, which is expressed in a decrease in skin sensitivity, hardening of muscle tendons, deposition of salts in the joints of the hands and fingers, which leads to pain, deformation and decreased joint mobility. Factors that aggravate the impact of vibrations on the body include muscle loads, microclimate, and intense noise. When working with hand-held power tools, acroasphyxia (symptom of dead fingers) may occur - loss of sensitivity, whitening of fingers and hands. When exposed to general vibration, changes in the central nervous system are more pronounced: dizziness, tinnitus, memory impairment, impaired coordination of movements, vestibular disorders, weight loss.

Electromagnetic fields (working in induction melting furnaces) of high intensity lead to a thermal effect (heating of organs and tissues, thermal damage). When exposed to high and ultra-high frequency currents, functional disorders occur in the nervous and cardiovascular systems. A temperature reaction is observed (39–40°C); shortness of breath, a feeling of aching in the arms and legs, muscle weakness, headaches, and palpitations appear. With chronic exposure, workers complain of fatigue, sleep disturbance, irritability, sweating, headache, pain in the heart, and shortness of breath. Microwaves under particularly unfavourable working conditions have a damaging effect on the eyes, causing clouding of the lens (cataract).

Ultrasound is becoming more widespread in manufacturing (technological processes based on the use of ultrasound energy). Ultrasound has a mainly local effect on the body, since it is

transmitted through direct contact with an ultrasonic instrument, workpieces or environments where ultrasonic vibrations are excited. Ultrasonic vibrations generated by ultrasonic low-frequency industrial equipment have an adverse effect on the human body. Long-term systematic exposure to airborne ultrasound causes changes in the nervous, cardiovascular and endocrine systems, auditory and vestibular analyzers. The most characteristic is the presence of vegetative-vascular dystonia and asthenic syndrome. The degree of severity of the changes depends on the intensity and duration of exposure to ultrasound and increases in the presence of high-frequency noise in the spectrum, while a pronounced hearing loss is added. If contact with ultrasound continues, these disorders become more persistent. Under the influence of local ultrasound, phenomena of vegetative polyneuritis of the hands (less often of the legs) of varying degrees of severity occur, up to the development of paresis of the hands and forearms, and vegetative-vascular dysfunction.

Conclusion. Thus, when assessing the working conditions of workers in foundries, it is necessary to take into account the impact of the complex of the above-mentioned factors of the production environment, the technological processes and equipment used, the duration of stay working at the equipment and in the area of influence of the mentioned factors.

REFERENCES

1. Лазаренков А.М. Классификация производственных факторов литейного производства / А.М. Лазаренков // Литье и металлургия. – Минск, 2021, № 3 – С. 118-122.
2. Лазаренков А.М. Методика комплексной оценки условий труда в литейном производстве / А.М. Лазаренков, Т.П. Кот // Литье и металлургия. – Минск, 2021, № 3 – С. 112-117.
3. Лазарев Н.В. Вредные вещества в промышленности. Справочник //под ред. Н.В. Лазарева и Э.Н. Левиной. В 3-х томах. Том 1. Органические вещества. – Л., Химия, 1976. 592 с.
4. Лазарев Н.В. Вредные вещества в промышленности //под ред. Н.В. Лазарева и И.Д. Гадаскиной. В 3-х томах. Том 3. Неорганические и элементнонеорганические соединения. – Л., Химия, 1977. 608 с.
5. Косарев В.В. Профессиональные болезни: учебное пособие /В.В. Косарев, С.А. Бабанов // Москва: Вузовский учебник: ИНФРА-М, 2011 – 252 с.
6. Лазаренков А.М. Исследование воздушной среды рабочих зон литейных цехов при современных технологиях изготовления стержней и форм / А.М. Лазаренков, М.А. Садоха // Литье и металлургия. – Минск, 2022, № 3 – С. 122-126.
7. Лазаренков А.М., Хорева С.А. Оценка параметров микроклимата рабочих мест литейных цехов //Труды 25-й Междунар. науч.-техн. конф. «Литейное производство и металлургия 2017, Беларусь». Минск, 18-19 октября 2017. С. 216-218.
8. Лазаренков А.М. Исследование теплового фактора условий труда в литейном производстве / А.М. Лазаренков, И.А. Иванов, М.А. Садоха // Литье и металлургия. – Минск, 2022, № 2 – С. 123-129.
9. Лазаренков А.М. Исследование зрительных условий труда в литейном производстве / А.М. Лазаренков, М.А. Садоха // Литье и металлургия. – Минск, 2022, № 3 – С. 112-115.

10. Лазаренков А.М. Исследование шумового фактора условий труда в литейном производстве / А.М. Лазаренков, М.А. Садоха // Литье и металлургия. – Минск, 2022, № 2 – С. 130-136.
11. Лазаренков А.М. Оценка влияния вибрации на работающих в литейном производстве / А.М. Лазаренков, С.А. Хорева, В.В. Мельниченко // Литье и металлургия. – Минск, 2011, № 3 (62) – С. 192-193.
12. Лазаренков А.М. Влияние локальной вибрации на работающих в литейных цехах / А.М. Лазаренков, С.А. Хорева // Литье и металлургия. – Минск, 2016, № 3 (84) – С. 128-130.
13. Лазаренков А.М. Исследование влияния условий труда на общую заболеваемость литейщиков / А.М. Лазаренков // Литье и металлургия. – Минск, 2019, № 3 – С. 156-159.
14. Лазаренков А.М. Анализ условий и безопасности труда литейщиков / А.М. Лазаренков, Ю.А. Николайчик, М.А. Садоха // Литейное производство. – Москва, 2022, № 1– С. 26-32.
15. Лазаренков А.М. Условия труда работающих в литейных цехах // Литье и металлургия. – Минск, 2018, № 4 (93) – С. 160-164.
16. Лазаренков А.М. Исследования влияния условий труда на работающих в литейных цехах // Литье и металлургия. – Минск, 2019, № 2 – С. 134-137.
17. Лазаренков А.М. Условия труда на рабочих местах в отделениях финишных операций литейных цехов / А.М. Лазаренков, М.А. Садоха, А.А. Новик// Литье и металлургия. – Минск, 2023, № 1 – С. 138-142.
18. Narziev S., Asqarov J., Khokimyatov A. Methodology Of Organization Of The Labor Process And Preservation Of Employees' Health //The American Journal of Engineering and Technology. – 2021. – Т. 3. – №. 04. – С. 79-84.
19. Shovkiddin N. et al. Problems of ensuring the safety of sports activities and reducing injuries //Journal of Critical Reviews. – 2020. – Т. 7. – №. 11. – С. 428-432.
20. Murtozaevich N. S., Shonazarovich J. B. Techniques for improving the effectiveness of women labour protection management //American Journal of Interdisciplinary Research and Development. – 2022. – Т. 6. – С. 57-63.