Modern Scientific Research On Noise Reduction In Production Processes

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ABSTRACT

This article examines modern scientific research on the problem of noise and its reduction in industrial production processes, in particular, in machine-building workshops and related enterprises. Noise is one of the dangerous production factors in the occupational health and safety system, and its high level leads to a decrease in hearing, diseases of the nervous system, and a decrease in labor productivity in workers. Although world and national standards indicate that noise above 85 dBA contradicts regulatory requirements, in workshops using heavy mechanical equipment, indicators up to 95-100 dBA are observed. The article analyzes scientific research conducted in recent years and separately considers three main noise reduction strategies - direct impact on the noise source, the use of acoustic barriers in the path of propagation, and the use of personal protective equipment. The effectiveness of acoustic screens and absorbing panels, new types of noise-absorbing materials, vibration-reducing structural solutions, and protective equipment that meet ergonomic requirements were analyzed. It is also shown that special clothing and innovative solutions based on acoustic filtration have the possibility of application in the production environment. The results of the analysis show that in the fight against noise, it is not enough to take only one approach, but it is necessary to apply a set of measures. At the same time, the issues of integration with technological processes, economic efficiency, and material stability in high-temperature zones have not yet been fully resolved. In future scientific research, noise control in real time using intelligent control systems, the use of composite materials, and the development of environmentally safe solutions are proposed as promising areas.

Keywords: Industrial noise, noise protection equipment, research work, acoustics, noise barriers, noise protection equipment

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Noise levels in machine-building workshops are considered one of the most critical occupational health and safety issues in industry. In international practice, the harmful effects of noise on human health, its negative impact on work productivity, as well as the threat to safety in production processes have been extensively studied for many years. According to the ISO 9612:2009 "Acoustics - Determination of occupational noise exposure" standard, the noise level in the working area should not exceed 85 dBA during an 8-hour workday [1]. Similarly, the current SanPiN RUz N 0325-16 also establishes permissible noise pressure levels at workplaces [2]. In recent years, in the industry of Uzbekistan, in particular, in mechanical engineering and its components - blacksmithing and pressing workshops, with the increase in heavy mechanical equipment, the intensity of noise in workplaces has increased. Studies show that the noise level in blacksmith shops often reaches 95-100 dBA, which is 10-15 dBA higher than the norm [3]. This factor can lead to hearing loss, diseases of the nervous system, and decreased work capacity in production workers. Therefore, scientific research on noise reduction is of current importance. Analysis of scientific dissertations published in recent years shows that research on noise reduction has been conducted in three main areas:

1. Noise reduction - structural improvement of equipment.

2. Reduction in the path of propagation - the use of noise-absorbing materials and barriers.

3. Worker protection - personal protective equipment (headphones, headphones, earplugs) and optimization of work mode [4;12-b].

In the work of Жданов А.Е. [5], the regularities of the propagation of reflected sound waves in industrial buildings were studied, and proposals for calculating noise and designing insulation structures were developed. The research is especially relevant for large-sized buildings and can be applied practically in the design of acoustic systems. Шубин И.Л.. [6] proposed a methodology for calculating and designing acoustic screens. It has been established that the height and thickness of the screens, as well as the parameters of the absorbing coatings, have a significant influence on the level of noise reduction. Радоуцкий В.Ю. [7] developed comprehensive technologies for noise reduction in agricultural enterprises. In the study, along with acoustic screens, vibration-absorbing structural solutions were also used. The results can also be applied in industrial conditions. Литус А.А. [8] conducted research on the development of noise-absorbing materials that perform various functional tasks. The lightness and high acoustic efficiency of the materials allow them to be effectively used in industrial enterprises. Research aimed at increasing the acoustic efficiency of structures has been studied in the works of Кочкин А.А. [9], Паузин С.А. [10], Щеголев Д.Л. [11], Иванова А.В. [12], and other authors. These works mainly cover the issues of using vibration-absorbing layers, multilayer panels, and special orthotropic materials to improve sound insulation. According to the research results, it has been proven that noise can be reduced by 10-15 dB using two-layer structures, vibration damper elements, and acoustic screens. Шульдешов Е.М. developed a wide range of sound-absorbing materials designed to reduce the noise of aircraft engines. These technologies can also be used in industrial workshops, but further research on technological flexibility is needed. The analyzed studies show that, along with constructive solutions for noise reduction, the use of acoustic screens, absorbing panels, and new types of materials allows for effective noise reduction in industrial environments. At the same time, in most studies, the issues of integration with technological processes, economic efficiency, and heat resistance of materials are insufficiently covered. Further research on these aspects is needed in the future.

In recent years, the risks associated with high noise levels in the production environment have become the subject of many scientific studies. At the same time, the role of personal protective equipment (PPE) as one of the most important areas of human health

protection is being fundamentally revised. Research in this area is aimed not only at assessing the effectiveness of existing tools, but also at improving their ergonomic and acoustic properties. For example, Должиков И.С. in his dissertation [13] developed a new design of personal protective equipment against noise. Based on the research, a combination of materials that effectively absorb noise in different frequency ranges was used. The effectiveness of the PPV was tested in laboratory and real industrial environments. The results showed that the proposed device provides a higher level of acoustic insulation compared to traditional headphones, showing a decrease of about 9-12 dB, especially in the frequency range of 1000-4000 Hz. In this case, an anatomical configuration corresponding to the structure of the human auricle was selected, which increased the level of convenience for long-term use. The selection of materials intended for VHS is based on the criteria of environmental safety, lightness, and vibration resistance. Importantly, this tool was tested among factory workers and received positive results through subjective assessments. In a study conducted by Еремина Ю.В. [14], special clothing was designed as a means of protection. This approach, unlike classical hearing protection, is based on the principle of protecting the entire body and performs the function of reducing the overall impact of industrial noise on the body. The materials developed by the author include multilayer compositions, microporous structures, and microclimate regulating fibers. According to the results of the experiment, such special clothing reduced the noise around the human body by 6-8 dB. The shape and coatings of the garment served to reduce the internal resonance. In particular, special cushion zones in the head and chest regions helped to effectively reduce the intensity of waves reaching the human hearing organs. This approach lays the foundation for a new direction in the improvement of PPE - the concept of "functional clothing." Алимов Н.П. in his research [15] proposed scientific and practical solutions for improving the efficiency of civil defense for employees working in the construction industry. In his research, he identified the weaknesses of modern protective equipment and managed to create an optimal model by introducing structural and technological changes to them. At the same time, based on the resources available in production, the possibilities of local production of motor vehicles were also analyzed. In some cases, noise reduction was carried out not by headphones, but by means of air-efficient protective devices, i.e., sound waves were absorbed by air-filtering structures. This is considered one of the innovative approaches. Comfort, ergonomics, vibration resistance, and the coefficient of protection from hypothermic influences were also tested during VHS tests, and their results were documented. Summarizing the research of all three authors, it can be concluded that the modern concept of PHC is not limited only to sound absorption, but also includes such approaches to human physiology as flexibility, multifunctionality, and updating the structure of materials. In this case, innovative materials, 3D forming technology, acoustic modeling, and anthropometric design are distinguished as the main directions.

At the same time, the effectiveness of the proposed solutions in relation to production and operating costs, their compatibility with regulatory documents, and the possibilities of practical implementation in industry were assessed separately.

Conclusion

The analysis of modern scientific research confirms that industrial noise remains one of the most critical challenges in ensuring occupational health and safety. Studies show that in machine-building and related workshops, noise levels often exceed permissible standards, leading to serious risks for workers' health and productivity. A wide range of strategies has been explored, including constructive improvements to machinery, the use of acoustic barriers and absorbing panels, as well as the development of advanced personal protective equipment. Recent innovations, such as functional protective clothing, composite sound-absorbing materials, and ergonomically optimized devices, demonstrate significant progress. However,

unresolved issues remain in terms of integration with technological processes, economic feasibility, and the durability of materials under high-temperature industrial conditions.

In conclusion, effective noise reduction cannot rely on a single method but requires a complex approach that combines technical, organizational, and protective measures. Promising directions for further research include the application of intelligent control systems for real-time monitoring, the design of heat-resistant and eco-friendly acoustic materials, and the development of multifunctional PPE tailored to human ergonomics. These steps will allow not only compliance with regulatory standards but also the creation of safer and more sustainable working environments in modern industry.

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