Analysis Of The Results Of Scientific Research On Noise Reduction In Machine-Building Sectors And Related Enterprises

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ABSTRACT

This article extensively analyzes the problem of production noise arising in machine-building workshops and related industrial enterprises, the results of scientific research on its reduction, and the effectiveness of existing solutions. In scientific literature, it is noted that noise arising in production processes negatively affects human health, labor productivity, and occupational safety. According to international standards (ISO 9612:2009) and national sanitary standards, the level of noise pressure at workplaces should not exceed 85 dBA, however, observations conducted in blacksmithing and pressing shops showed results in the range of 95-100 dBA. This is significantly higher than the normative requirement and poses a risk to the hearing and nervous system of workers. According to the analysis of research, noise reduction was carried out in three main directions: noise reduction at the source, absorption in the path of propagation, and provision of personnel with personal protective equipment. Although structural improvements, reduction of resonant frequencies, and the use of noise-absorbing panels have yielded effective results in the woodworking and light machine-building industries, their application in heavy industry conditions is limited. In metalworking and blacksmithing workshops, acoustic screens, vibration-absorbing materials, and methods for stabilizing flow in hydraulic systems are considered promising solutions. At the same time, the ideas of noise control in real time using intelligent control systems are being put forward as an innovative direction. As a final conclusion, the necessity of a comprehensive approach to achieving effectiveness is emphasized, that is, the need for constructive optimization, the combination of absorbing means and personal protective measures on the way to dissemination. Also, the development of heat-resistant acoustic materials for high-temperature zones and the selection of cost-effective technologies are defined as a relevant area of further research.

Keywords: production noise, acoustic screen, vibration, occupational safety, blacksmithing, pressing, ISO 9612.

Noise levels in machine-building workshops are one of the most important occupational health and safety problems in industry. In international practice, the harmful effects of noise on human health, its negative impact on labor productivity, as well as the threat to safety in production processes have been deeply studied for many years. According to the ISO 9612:2009 "Acoustics - Determination of occupational noise exposure" standard, the noise level of the working zone should not exceed 85 dBA during an 8-hour workday[1]. At the same time, the current SanPiN RUz N 0325-16 also establishes the level of permissible noise pressure at workplaces [2].

In recent years, in the industry of Uzbekistan, in particular, in mechanical engineering and its components - blacksmithing

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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 D.R. Gagarin [5], comprehensive measures were developed to reduce noise levels in small woodworking enterprises. It achieved results mainly through the optimization of technological processes and the use of noise-absorbing coatings. However, there is no data on the effectiveness of the solutions developed by the author in the context of large-scale industry.

Осмоловский Д.С. [6] conducted research on the reduction of noise emitted by circular saw machines. The main direction in the research was the modification of the blade design and the reduction of resonant frequencies. This method is effective in the woodworking industry, but is not suitable for heavy machine-building workshops.

A research by Авакян А.А. [7] is devoted to reducing the noise of ribbon frames in woodworking, in which the mechanical modeling of the noise source and the application of insulation elements are theoretically substantiated. A similar approach was observed in the work of Chukarina N.A. [8], in which technological and sanitary-hygienic measures were developed to reduce the level of noise and dust on grinding machines.

The problem with metalworking is also acute. Гогуадзе М.Г. [9] in his work proposed a number of measures to reduce the noise level in heavy loading machines, including the use of noise-absorbing screens and combined design solutions. Солдатов А.Г. [10] developed an integrated solution for reducing noise and vibration in gear grinding machines.

Another approach is found in the research of Виноградов И.С. [11], who used a method of reducing resonant frequencies through special acoustic holes in wood saws. This approach is effective in reducing noise by reducing mechanical resonance, but its practical application in pressing or blacksmithing workshops is complex.

Analysis shows that most of the available research is focused on the branches of woodworking or light engineering. Solutions for noise reduction in heavy industry enterprises, such as blacksmith shops, have not been sufficiently developed. Especially in zones with high-temperature and heat-generating equipment, there are few scientifically based recommendations for the selection of materials and design solutions.

In previously considered scientific sources, noise reduction issues were mainly focused on machines in woodworking workshops. However, in recent years, noise from machine tools in the metallurgical and machine-building industries has also been recognized as a serious problem, and large-scale research has been conducted in this area. The analyzed scientific works show that during metalworking, especially during milling, thread cutting, and turning operations, the noise level exceeds regulatory requirements, which poses a risk to the health of operators. In the work of Ющенко А.В. [12], measures have been developed to reduce noise in the source in order to ensure acoustic safety in (gal'tovka) drums. The author mainly proves that it is possible to significantly reduce noise pressure by optimizing the working surfaces of the drums and applying shock absorbers. However, it is noted that the solutions used in the work are technologically complex and require high material costs. Разаков Ж.П. [13] considered the possibilities of noise reduction in thread and

spline grinding machines. He managed to reduce the acoustic load in the working zone by controlling the cutting speed of the machines and equipping them with noise-absorbing coatings. Although the research results allowed for noise reduction with high accuracy, additional economic evaluation is required for application in production conditions. The issue of ensuring safe working conditions on coordinate and profile grinding machines is highlighted in the dissertation of Курченко П.С. [14]. In it, the vibration and noise-generating elements of the machines were determined, and it was proven that the acoustic load can be reduced by 8-10 dB through structural changes. The mathematical model developed by the author showed its effectiveness under production conditions, however, the work does not sufficiently reveal a comprehensive approach in conjunction with passive insulation means. In the work of Досов В.Е [15], technical solutions for noise reduction on specialized wheeled milling machines were proposed. The author managed to reduce noise by 7-9 dB by using absorbing panels in the paths of noise propagation and constructive isolation of vibration sources. The practical significance of the research lies in the fact that the proposed tools can be used at many enterprises, but additional space and materials are required for their installation. In the work of Харламов О.Г. [16], technological methods for noise reduction on gear milling machines were developed. In particular, it has been shown that when machining gears, the noise pressure level can be reduced by up to 12% using a cutting speed control system and special coatings. The strength of the research is the possibility of achieving efficiency by changing technological modes without modernizing existing machines. The works of Kalashnikova O.A. [17] are devoted to the study of ways to reduce noise in milling sections of long-dimensional parts. The method proposed by the author is the use of noise-absorbing screens and vibration-absorbing materials. As a result of the experiments, a decrease of 6-8 dB was observed, however, data on the impact on the production rate are limited. Финоченко Т.А. [18] proposed the optimization of aerodynamic noise sources for controlling the noise level in high-speed tubular lathes. In the work, the acoustic load was mainly reduced by controlling the airflow in the cutting zone and adding special sound-absorbing elements to the machine's design. The results show that this approach is most suitable for high-speed machines. In the work of Агапитов В.Я. [19], measures to reduce noise in cable processing machines were developed. He achieved the result by separating the mechanical drives with elastic elements and using absorbent materials in the machine body. As a drawback, it is noted that additional structural elements can increase the weight of the machine tool. Трышкина О.В. [20] developed a smart cutting speed control system that allows for a significant reduction in not only noise but also vibration during metal processing. The advantage of this approach is the improvement of the acoustic environment without reducing production efficiency. However, due to the high cost of the system, the question of its widespread implementation remains open. Analysis of the above studies shows that currently there are two main directions for noise reduction: influencing the process of noise generation in the source (constructive and technological optimization) and using means that absorb or isolate noise in the path of its propagation. Also, in recent years, innovative developments aimed at controlling noise levels in real time using intelligent control systems have become widespread. At the same time, many works, while proposing constructive changes, did not pay sufficient attention to the issues of production costs and technological flexibility. Issues of noise reduction in machine-building workshops are relevant not only in woodworking or light industry, but also in heavy metalworking, pressing, and blacksmithing. Studies conducted in recent years, in particular, when working with press equipment and hydraulic systems, show a high level of acoustic load. According to the hygienic classification of working conditions, the noise level most often belongs to class 3.3 or 3.4, which is a hazardous zone for human health. In the work of Романов В.А. [21], proposals for ensuring hygienic requirements for model machines were developed. Along with noise

reduction, attention was also paid to the issue of reducing dust levels. According to the research results, it has been proven that noise-absorbing coatings and local barriers are effective for reducing noise pressure at a level of 6-8 dB. However, these solutions were used only for small and medium-power machines. In scientific research conducted by Азимова Н.Н. [22], methods for reducing the harmful effects of noise and dust generated during abrasive cutting were studied. He achieved the result by optimizing the design of abrasive discs and applying special absorbing materials to the working zone. A combination of local ventilation systems and acoustic barriers was also used. However, specific indicators for the impact on production efficiency are limited. Бондаренко В.А. [23] developed constructive solutions for reducing noise and vibration in the reducer system. In this work, as a result of increasing the accuracy of gears in gear transmission, using elastic couplings and damper elements, the noise level was reduced by 3-5 dB. The advantage of the study is that the modernization process is carried out with minimal costs, but its effectiveness is mainly limited by low-load transmissions. The problem of noise in pressing equipment is widely covered in the work of Козлюк В.В. [24]. He applied structural and acoustic measures to reduce noise in the work zones of electro-hydraulic pulse press operators. In the work, a decrease of 10-12 dB was observed as a result of the use of special sound-absorbing panels and vibration-separating elements in the press body. However, there is no precise data on the applicability of these solutions in blacksmithing conditions with high heat generation. In the research conducted by Иванов Ю.В. [25], the issues of developing noise and vibration protection systems in chisel pressing machines and units were considered. The main direction in the work was the use of sound-insulating materials in the path of noise propagation and the reduction of resonant frequencies in mechanical transmissions. As a result, the noise level was reduced by 8-10 dB, however, some solutions have limitations in terms of technological flexibility. Берестовицкий Э.Г. [26] proposed innovative methods for reducing noise and vibration associated with hydraulic control systems. As a result of the use in the work of hydraulic filters and elastic compensators that stabilize the flow velocity, the noise associated with hydraulic pulses is significantly reduced. The strength of this solution is the possibility of universal application, but it requires high costs. The above analysis shows that in recent years, scientific research on noise reduction in metalworking and pressing workshops has been intensively developing. Most of the research is aimed at the structural optimization of noise sources and the application of acoustic barriers in the path of propagation. At the same time, solutions have been developed for reducing resonant frequencies through the modernization of hydraulic systems and mechanical transmissions. However, such problems as ensuring efficiency in production conditions, economic feasibility, and increasing the durability of materials in high-temperature zones remain relevant. As can be seen from the above-mentioned scientific works, promising areas of noise reduction are: acoustic improvement of structural elements, the use of vibration-absorbing materials and elements, noise blocking in the path of its propagation, and optimization of processes using intelligent control systems. At the same time, a comprehensive approach is required to achieve high efficiency, since it is difficult to solve all acoustic problems with only one method. Previously considered works were mainly devoted to research on reducing the noise level of machines and mechanical machines from a source. In recent years, scientific research has been widely focused not only on constructive approaches to improving the acoustic environment, but also on the creation of materials designed to absorb and insulate noise through barriers. This direction is especially relevant in acoustic protection systems used in production buildings, workshops with a high noise level, and open areas. In the work of Макаров А.М. [27] a methodology for calculating noise and designing protective systems for normalizing the acoustic environment in industrial buildings was developed. He noted that the increase in noise

propagation through reflected waves increases the overall level inside the workshop by 3-5 dB, which requires a scientific justification for the placement of acoustic screens. The research is aimed at ensuring normative acoustic parameters in the production environment, but detailed information on their influence on technological processes is not provided. Чубарь Е.П. [28] studied issues of noise reduction in the field of railway transport, locomotive testing sections. The author developed constructive proposals for the use of barriers and special screens to reduce noise, increasing their acoustic efficiency. The significance of the work lies in the fact that these solutions can also be applied in large open spaces, but recommendations for adaptation to indoor environments, such as industrial buildings, are limited. Горбунова О.А. [29] developed environmental protection systems to reduce noise in the path of its propagation in order to reduce the impact of industrial enterprises on the environment. The structural features of noise-absorbing panels and screens were studied, and heat-resistant composite materials were recommended. This approach can also be applied in heavy industry workshops. In the work of Тюрина Н.В. [30], the mechanisms of noise reduction using acoustic screens in industrial buildings were analyzed. According to the research results, correctly placed screens can reduce noise by 8-12 dB. The work also developed recommendations for the selection of material and the optimal angle of placement of screens. In the research of Енин П.В. [31], issues of reducing noise caused by vibration sources in metal structures were considered. He achieved significant noise reduction using special vibration-absorbing elements. This approach can also be applied to machine tool housings. Мурзинов П.В. [32] developed lightweight, multilayer acoustic panels that showed high efficiency in reducing noise inside the workshop. The use of combined composite materials in the panel increased their sound absorption coefficient. Nevertheless, it was noted that the use of panels on large areas is costly from an economic point of view.

Conclusion

The research results show that the noise level in machine-building workshops and related industrial enterprises is significantly higher than regulatory requirements, which poses a serious threat to human health, labor productivity, and production safety. Analysis of scientific sources confirms three main directions of noise reduction: noise reduction at the source, absorption in the path of propagation, and personnel protection measures. However, existing developments are more focused on woodworking and light machinery, and their possibilities for application in heavy industry conditions, such as blacksmithing and pressing, are limited. For effective noise reduction, the use of structural optimization, acoustic screens, vibration-absorbing elements, and heat-resistant materials is of great importance. Also, real-time noise level control using intelligent control systems is recognized as one of the promising directions. In general, high efficiency can be achieved only through a comprehensive approach: the improvement of technological modes, the introduction of acoustic barriers, and the widespread use of personal protective equipment should be carried out in conjunction. Further research should be aimed at the development of economically viable materials suitable for high-temperature production conditions, as well as the development of acoustic modeling methods, taking into account the geometric characteristics of the workshops.

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