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АНАЛІЗ РЕСУРСНИХ ОСОБЛИВОСТЕЙ ВИКОРИСТОВУВАНИХ ГІДРОАБРАЗИВНИХ МАШИН

У статті проведено аналіз ресурсних особливостей гідроабразивних машин, які широко використовуються в сучасній промисловості для обробки різноманітних матеріалів. Розглянуто ключові фактори, що впливають на термін служби основних компонентів обладнання, такі як тиск води, витрата абразивного матеріалу, якість води та абразиву, а також інтенсивність експлуатації. Визначено основні вузли, що піддаються найбільшому зносу, та запропоновано шляхи оптимізації їхнього ресурсу для підвищення ефективності та економічності технологічного процесу. Ця розширена анотація присвячена глибокому аналізу ресурсних особливостей гідроабразивних машин, які набувають все більшого поширення в різних галузях промисловості завдяки своїй універсальності та здатності обробляти широкий спектр матеріалів. Дослідження охоплює ключові аспекти, пов'язані з ефективністю використання ресурсів, оптимізацією експлуатаційних витрат та впливом на навколишнє середовище.

Ключові слова: *гідроабразивна обробка, ресурс обладнання, знос, тиск води, абразивний матеріал, оптимізація, ефективність.*

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ANALYSIS OF RESOURCE CHARACTERISTICS OF USED HYDROABRASIVE MACHINES

The article analyzes the resource features of hydroabrasive machines, which are widely used in modern industry for processing various materials. The key factors affecting the service life of the main components of the equipment, such as water pressure, consumption of abrasive material, quality of water and abrasive, as well as the intensity of operation, are considered. The main nodes subject to the greatest wear and tear are identified, and ways to optimize their resource to increase the efficiency and economy of the technological process are proposed. This extended abstract is devoted to an in-depth analysis of the resource characteristics of water-abrasive machines, which are becoming more and more common in various industries due to their versatility and ability to process a wide range of materials. The study covers key aspects related to resource efficiency, operating cost optimization and environmental impact.

Key words: *hydroabrasive treatment, equipment resource, wear, water pressure, abrasive material, optimization, efficiency.*

Introduction. Water-abrasive cutting technology (AWG) has gained significant popularity in various industries due to its versatility, ability to process a wide range of materials without thermal effects, and high precision. However, the effective operation of hydroabrasive machines depends on understanding and managing their resource characteristics.

A water-abrasive machine consists of several key components, each of which is subject to wear and tear during operation. The main ones are: a high-pressure pump, it creates a flow of water under high pressure, which is necessary for the formation of a cutting jet. The resource of the pump depends on the working pressure, water quality, intensity of operation and regularity of maintenance. The resource of the pump depends on the working pressure, water quality, intensity of operation and regularity of maintenance. High pressure leads to faster wear of seals, valves and other internal elements. The mixing head (nozzle) mixes a high-speed jet of water with an abrasive material. The nozzle and mixing chamber are subject to the greatest wear.

The nozzle is made of hard materials such as sapphire or diamond. Nozzle wear occurs due to the abrasive effect of particles, erosion and cavitation. An increase in the diameter of the nozzle leads to a decrease in cutting accuracy and an increase in water consumption [1]. The mixing chamber is usually made of tungsten carbide or other wear-resistant materials.

Wear occurs due to the intense abrasive effect of particles moving at high speed. An increase in the internal diameter or the appearance of internal defects leads to the dispersion of the jet and a decrease in its cutting ability. The abrasive material supply system provides a dosed supply of abrasive to the mixing head. The wear of the elements of this system (dosers, hoses) depends on the type and fraction of the abrasive, as well as on the intensity of supply.

The water transportation and purification system ensures the supply of clean water to the high-pressure pump and the removal of the spent mixture. Water quality (presence of solid particles, chemical composition) significantly affects the resource of the pump and other elements of the system.

The life of the listed components is affected by the following main factors: water pressure, higher pressure provides a higher jet speed and more intensive processing, but at the same time leads to faster wear of the pump and elements of the mixing head. Abrasive material consumption, increasing the abrasive flow increases the cutting performance, but also increases the abrasive wear of the nozzle and the mixing chamber. Water quality, the presence of solid particles in the water can lead to abrasive wear of the pump and nozzle.

The chemical composition of water can cause corrosion of metal elements. The quality of abrasive material, hardness, shape and fraction of abrasive particles affect the intensity of wear of the mixing head. Contaminated or poor-quality abrasive can lead to clogging of the nozzle and damage to other elements of the system.

The intensity of operation, duration and frequency of use of the machine directly affect the total resource of its components. Regularity and quality of technical maintenance, timely replacement of worn parts, cleaning of filters, checking the tightness of connections and other preventive measures significantly extend the service life of the equipment.

Setting the task. Analysis of wear of the main nodes and assessment of their resource. The most critical resources are the nozzle and the mixing chamber. Their wear directly affects the quality of the cut (width, accuracy, roughness) and productivity.

The wear of the nozzle is manifested in an increase in its diameter and a change in the shape of the outlet opening. This leads to an expansion of the jet, a decrease in its energy and a deterioration in the quality of the cut. The resource of the nozzle depends on the material of manufacture, working pressure and water quality.

Sapphire nozzles usually have a shorter life compared to diamond nozzles. Wear of the mixing chamber is manifested in an increase in the internal diameter, the appearance of erosion potholes and other defects on the internal surface. This leads to dispersion of the abrasive-water jet, reducing its coherence and cutting ability.

The resource of the mixing chamber depends on the material, consumption and quality of the abrasive, as well as on the speed of the jet. Estimating the service life of these components is a difficult task, as it depends on many operational factors. Equipment manufacturers often provide approximate life values, but actual life can vary greatly.

For a more accurate assessment, it is necessary to regularly monitor the condition of the components, measure the diameter of the nozzle, control the inner surface of the mixing chamber and analyze the quality of the cut. The resource of the high-pressure pump is also an important parameter that affects the overall performance of the machine. Wear of seals and valves leads to loss of pressure and reduced efficiency. Regular maintenance and the use of quality water are key factors in extending the life of the pump.

Results and their discussion. To increase the efficiency and economy of hydroabrasive technology, it is necessary to take measures to optimize the resource of the equipment used. The main ways include: selection of optimal cutting modes: Selection of water pressure and abrasive consumption in accordance with the type and thickness of the processed material allows to reduce the load on the machine components and reduce their wear.

Use of high-quality consumables: the use of clean water with an appropriate filtration system and high-quality abrasive material with an optimal fraction significantly reduces abrasive wear. Regular and high-quality maintenance: timely replacement of worn parts (seals, filters, nozzles, mixing chambers), cleaning of the system and control of operating parameters ensure stable operation of the equipment and extend its service life [2].

Equipment condition monitoring, regular visual inspection, measurement of key parameters (pressure, flow rate, nozzle size), as well as analysis of the quality of the cut make it possible to timely detect signs of wear and carry out necessary repairs. Implementation of automatic control and diagnostics systems modern hydroabrasive machines can be equipped with systems that monitor the state of key components in real time and warn of possible malfunctions.

Training and qualification of personnel, correct operation of equipment and timely detection of problems by operators is an important factor to ensure long-term and efficient operation of the machine.

Conclusions. Analysis of the resource characteristics of water-abrasive machines is important to ensure the efficient and economically beneficial operation of this technology.

The life of the main components of the equipment depends on many factors, including the operating pressure, the consumption and quality of the abrasive, the quality of the water, the intensity of operation and the quality of maintenance. Optimizing the resource of hydroabrasive machines is achieved by choosing the optimal cutting modes, using high-quality consumables, regular maintenance, monitoring the condition of the equipment, and implementing modern control and diagnostic systems.

Further research can be directed to the development of new wear-resistant materials for key components of hydroabrasive machines and improvement of methods for diagnosing their condition. Hydroabrasive machines are a powerful and versatile tool for processing a wide range of materials. Their key advantages include the high quality of the cut, the absence of thermal effects, economic use of the material and environmental friendliness.

Despite some limitations, the continuous development of the technology makes waterjet cutting more and more attractive for various industries where precise, high-quality and flexible processing of materials is required. To achieve maximum efficiency, it is necessary to take into account specific production requirements, correctly select equipment and consumables, as well as ensure proper maintenance of machines.

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