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CORRELATION OF ENVIRONMENTAL MANAGEMENT AND INTENSIFICATION OF WASTEWATER TREATMENT IN THE CONTEXT OF ENSURING ENVIRONMENTAL SAFETY OF MACHINE-BUILDING ENTERPRISES

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The article examines the correlation between environmental management and the intensification of wastewater treatment, which is an important aspect of ensuring the environmental safety of a machine-building enterprise. Therefore, it is important to develop and implement an effective environmental management system, which includes pollution monitoring, planning measures to minimize emissions and discharges, and the implementation of environmentally friendly technologies.

The purpose of the work is to analyze and study the relationship between environmental management and the intensification of wastewater treatment and to develop recommendations for improving the efficiency of environmental management and wastewater treatment. The successful solution of these issues helped to develop an effective wastewater management strategy, increase the efficiency of wastewater treatment and reduce its costs, and also ensured the fulfillment of environmental standards and legal requirements, as a result of which significant results were achieved to improve environmental safety at the enterprise and to reduce the negative impact on the environment.

In the study of this correlation, there are several aspects that have scientific novelty: the use of new methods of intensification of wastewater treatment; studying the impact of environmental management on the efficiency of wastewater treatment and developing recommendations for improving the effectiveness of environmental management and wastewater treatment. The study in this field is important from both scientific and practical points of view. The implementation of environmental policy has a positive effect on the image of the enterprise, increases its competitiveness and ensures sustainable development. In addition, it promotes compliance with high standards of sustainable development, which is an important prerequisite for attracting new investments and market advantages.
Key words: Machine-Building Complex, Strategy, Sustainable Development, Environmental Policy, Environment, Pollutants, Effluents.

Взаємозв'язок екологічного менеджменту та інтенсифікації очистки стоків у контексті забезпечення екологічної безпеки машинобудівного підприємства. Босюк А.С., Шестопалов О.В., Сакун А.О., Тихомирова Т.С., Кулініч С.С.

У статті розглянуто питання взаємозв'язку між екологічним менеджментом та інтенсифікацією очистки стоків, яке є важливим аспектом забезпечення екологічної безпеки машинобудівного підприємства. Тому важливо розробити та впровадити ефективну систему екологічного менеджменту, яка містить у собі моніторинг за забрудненням, планування заходів з мінімізації викидів та скидів, впровадження екологічно чистих технологій.

Мета роботи полягає в аналізі та вивченні взаємозв'язку між екологічним менеджментом та інтенсифікацією очищення стоків та розробці рекомендацій щодо покращення ефективності екологічного менеджменту та очищення стоків, успішне вирішення цих питань допомогло розробити ефективну стратегію управління стічними водами, підвищити ефективність очищення стічних вод та зменшити витрати на їх очищення, а також забезпечило виконання екологічних нормативів та вимог законодавства, в результаті чого було досягнуто значних результатів для підвищення екологічної безпеки на підприємстві та зменшено негативний вплив на навколишнє середовище.

У вивченні цього взаємозв'язку є декілька аспектів, які мають наукову новизну: використання нових методів інтенсифікації очистки стоків; вивчення впливу екологічного менеджменту на ефективність очистки стоків та розробка рекомендацій щодо покращення ефективності екологічного менеджменту та очищення стоків. Дослідження даного напряму важливе як з наукової, так і з практичної точки зору. Реалізація екологічної політики має позитивний вплив на імідж підприємства, збільшує його конкурентоспроможність та забезпечує сталий розвиток. Крім того, це сприяє відповідності високим стандартам сталого розвитку, що є важливою передумовою для приваблення нових інвестицій та ринкових переваг. *Ключові слова:* машинобудівний комплекс, стратегія, сталий розвиток, екологічна політика, навколишнє середовище, забруднюючі речовини, стоки.

Introduction. Environmental management is a systematic approach to the management of environmental issues at the enterprise, which involves the implementation of policies, planning, control and improvement of processes in order to reduce the impact on the environment. The study of the impact of environmental management on the efficiency of sewage treatment and other indicators of the enterprise's environmental activity can help reveal new opportunities for reducing the impact on the environment and preserving natural resources.

With increasing environmental protection in various countries, businesses must maintain their financial

activities at a certain level of their environmental activity. Enterprises can reveal their environmental performance, create their own image and fulfill their social responsibilities by implementing an environmental accounting system [1]. In recent years, the green economy has attracted wide attention of the scientific community of the world as an important way of promoting environmental innovations and sustainable development of technologies [2].

The production of household waste and wastewater is an integral feature of human economic and household activity, and its management is a challenge for all societies and economies [3]. One of the most widespread environmental problems of economically developed countries is the pollution of reservoirs by sewage [4]. Rapid urbanization and industrialization have caused serious environmental pollution problems, which have created serious problems for ecosystems and economic development [5]. Analyzing strategic decisions regarding waste disposal and the use of renewable resources is critical to understanding how manufacturing firms can benefit from recycling process waste [6].

Literature Review. The analysis of existing approaches to the development of requirements for the quality of treated wastewater discharged into surface waters, with a special emphasis on the content of biogenic compounds, confirms the need for comprehensive regulation of water quality [7].

An important problem at many industrial enterprises, including the machine-building industry, is the generation of a large amount of wastewater contaminated with toxic substances, oil products, and heavy metals. The unpleasant smell of wastewater and its negative impact on aquatic ecosystems have even led to increased requirements for the treatment of industrial wastewater [8].

In turn, intensification of cleaning is a process of increasing the efficiency of wastewater treatment, which involves the use of new technologies and cleaning methods. This process is aimed at reducing the content of pollutants in water and ensuring compliance with standards for pollutants in the environment. Intensification of wastewater treatment can be implemented with the help of highly effective technologies that use not only mechanical, but also physico-chemical, biological and combined methods. Environmental management tools can include monitoring, planning and control of production processes, waste and pollution management, and implementation of green technologies. The use of the latest methods and technologies aimed at greening processes can help enterprises reduce the costs of energy supply and chemical reagents used in the process of wastewater treatment.

The issue of effective wastewater treatment is related to the problem of detoxification of water polluting substances, sludge dehydration, and disposal of wastewater sludge. Sludge is a semi-solid residual material formed as a result of sedimentation of suspended solids during wastewater treatment processes [9]. Sewage sludge can be treated as a waste to be disposed of, or as a resource to be put to good use [10].

A common scheme to clean sludges through an enterprise water circulation cycle is their clarification in radial thickeners or other sedimentation installations [11], which indicates the significant role of effective environmental management. Different methods for the intensification of a particle enlargement process are used in order to increase the deposition rate of suspended substances, for example by applying flocculants [11].

Current scientific literature describes techniques of using flocculants both as a separate reagent and in combination with inorganic polyelectrolytes [12]. Sometimes several flocculants are applied with different molecular weights [13] or a charge in the so-called «double flocculation process» [14]. However, there are still unresolved issues related to choosing the optimal quantity of a flocculant in the amount sufficient to clean a particular type of waste water.

The use of flocculants and methods of process intensification allows achieving a high rate of suspended solids deposition and is one of the important aspects of modern approaches to ecological wastewater treatment.

Research Methodology. Sewage sludge contains a significant amount of various organic and inorganic substances that can be used to obtain various products. For example, using sludge, you can get biogas, which can be used for energy production. It is also possible to extract various chemical substances from the sediment, which can be used in industry as raw materials for the production of various products. On the other hand, if the sludge is not properly disposed of, it can become a source of environmental pollution and negatively affect human health. There is a large gap between the volume of wastewater generated and the available treatment potential for domestic and industrial wastewater, which is mainly produced by small industrial plants [15]. Therefore, the use of sewage sludge as a resource can be beneficial and qualitatively change approaches to sewage treatment and sludge disposal.

Due to the fact that efficiency of aggregation due to flocculation depends on the concentration of the solid phase, it is necessary to constantly know the concentration of suspended solids in the cleaned sludge [16].

The presence of heavy metals in sewage sludge can cause soil pollution and have a negative effect on plant growth and soil microorganisms after application, depending on metal toxicity, concentration and bioavailability [17]. However, with the right approach to cleaning and using sludge as a resource, it can be used as a fertilizer for plants or for the production of bricks, asphalt and other construction materials. Therefore, it is important to pay due attention to wastewater treatment and the use of its resource potential in order to reduce the negative impact on the environment and use resources efficiently.

However, sludge with a high moisture content is often formed at enterprises, which is difficult to dehydrate,

requiring a lot of energy for dewatering by filtering or centrifugal twisting [18].

General recommendations for the use of flocculants are reduced to the selection of the type and concentration of flocculant for purification of a particular type of slime with a certain concentration and disperse composition [19].

Thus, the issue of increasing the environmental safety of industrial enterprises through the implementation of environmental management systems in the process of wastewater intensification is an urgent scientific and practical task.

Implementation of the producer's environmental responsibility cannot be achieved without proper management of production processes. Scientific management includes the entire process of applying the concept of environmental responsibility to production and enterprise management [20].

Improving environmental management and generally greening all production processes can significantly increase the efficiency of the enterprise. For example, it can contribute to reducing the costs of paying fines for environmental pollution, reducing fuel and electricity costs, increasing reputation and attractiveness for investors and consumers. In addition, ecological solutions can lead to savings of resources, which allows to reduce the costs of their purchase and processing. In general, the efficiency of the enterprise can increase qualitatively and quantitatively thanks to the greening of production processes, the implementation and popularization of environmental policy and the improvement of environmental management.

Results. During the analysis of the current environmental management system at one of the machine-building enterprises, a management strategy scheme was proposed, shown in fig. 1, which contains the following stages:

− analysis of the environmental situation at the enterprise, determination of the main sources of sewage pollution;

− development of an environmental management strategy with the aim of reducing discharges of harmful substances;

− determination of the optimal composition of equipment and technologies for the intensification of wastewater treatment;

− development and implementation of a wastewater quality monitoring program in order to determine the effectiveness of applied technologies and environmental management strategies;

− assessment of the effectiveness of measures implemented to increase the efficiency of wastewater treatment and reduce the negative impact on the environment;

− constant improvement of environmental management strategies and cleaning technologies in order to ensure the sustainable development of the machine-building enterprise.

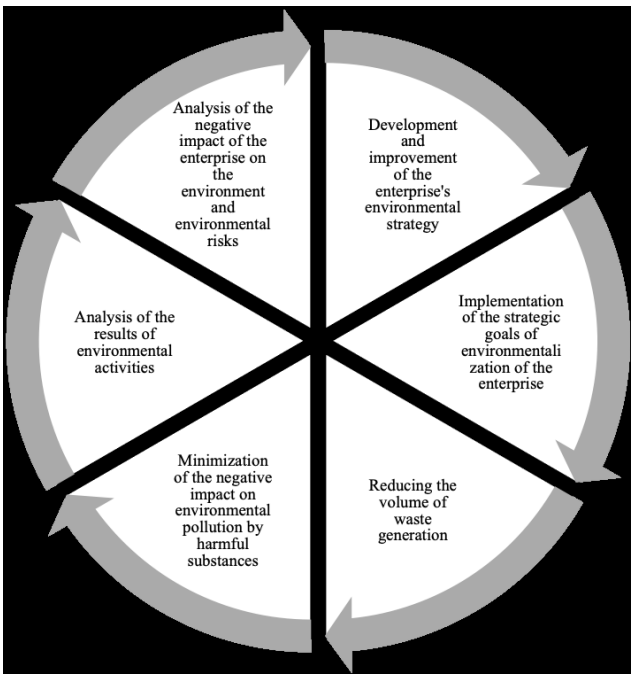

Fig. 1. Environmental responsibility management strategy

The proposed management strategy is a cyclical process, in which each stage is a prerequisite for the next, that is, one comes from the other. Starting with the development and improvement of the company's environmental strategy and the establishment of short-term strategic goals, the company carries out measures for greening, which leads to a reduction in the amount of waste and a minimization of the negative impact on the environment. The next stage is the analysis of the results of the environmental activities to assess how successfully the strategic goals have been achieved and to identify new problems and bottlenecks that need to be solved in the next cyclical stage. Then all stages are repeated again. Thus, each stage is the foundation for the next, and entire enterprises support this cycle.

Consider an example of the implementation developed in fig. 1 management strategy on the example of one of the machine-building enterprises. The prerequisite for the development of an environmental strategy is a comprehensive analysis of the enterprise's impact on the environment, an important element of which is the constant monitoring of the formation and entry into the environment of pollution in the form of solid, liquid and gaseous waste.

An important source of information for evaluating the efficiency of the water treatment system and identifying possible problems in the operation of this system are the results of laboratory analysis of wastewater samples of a machine-building enterprise. The results of laboratory analysis are an important component of environmental management, as they can be used to evaluate the effectiveness of measures taken to treat wastewater at the enterprise and provide an opportunity to identify problems and develop strategies for improving the environmental status of the enterprise.

In fig. 2 shows the schedule of the analysis of wastewater samples of a machine-building enterprise, where the parameters of wastewater quality of the main polluting substances at this production are indicated, such as: ammonium nitrogen, suspended solids, pH, oil products and chlorides, which indicate the presence of pollutants and their concentration in wastewater. Normative indicators for these substances are: ammonium nitrogen – 18.0 mg/dm^3; suspended substances – 300 mg/dm^3; hydrogen pH indicator – 6.5–9 mg/dm^3; petroleum products – 5.0 mg/dm^3; chlorides – 350 mg/dm^3.

From the analysis of the graph, it can be concluded that the wastewater samples of the machine-building enterprise contain variable concentrations of pollutants in different sampling periods. Such concentration fluctuations are associated with various production factors, such as an increase or decrease in the productivity of workshops depending on the volume of orders, a change in the supplier of raw materials, and others. Yes, from fig. 2, it can be seen that the level of ammonium nitrogen exceeds the norm in July 2019 and December 2020, which indicates the low efficiency of purification from nitrogen compounds. Also, excessive levels of suspended solids were found in the samples, which may indicate ineffective operation of settling tanks and other treatment facilities. The level of petroleum products close to the permissible norm indicates the presence of petroleum products in wastewater, which could have entered them as a result of repair of equipment or improper storage of materials, and the presence of chlorides in wastewater indicates the possible excessive use of chlorinated substances in production.

The results of sampling and analysis of water samples at the enterprise serve as an integral part of the environmental safety indicator and indicate the need to make changes to the program to achieve regulatory or improve existing results. Therefore, the results of the laboratory analysis of the samples indicate the need to improve the wastewater treatment system to reduce the content of pollutants and increase the efficiency of treatment.

The relationship between the results of laboratory analysis of wastewater samples and environmental management is that the results of the analysis allow to identify problems in the wastewater treatment system and potential ecological risks for the environment. This information can be used in the development of strategies and action plans to improve the environmental condition of the enterprise according to the scheme shown in Fig. 1.

The relationship between environmental management and environmental pollution attracts the attention of many scientists, and investments in environmental management have a significant impact on reducing the negative impact on the environment [21]. Effective environmental management is one of the potential keys to mitigating environmental pollution and preventing the occurrence of environmental risks. Therefore, it is extremely important to study the relationship between the effectiveness of environmental management of the enterprise, the sources of environmental hazards, the system of environmental protection measures and environmental pollution.

Therefore, we proposed to optimize the wastewater management strategy at the machine-building enterprise, which should include the following important tasks, the solution of which is necessary for the intensification of wastewater treatment systems:

1. Assessment of the level of sewage pollution and determination of the environmental hazard of their

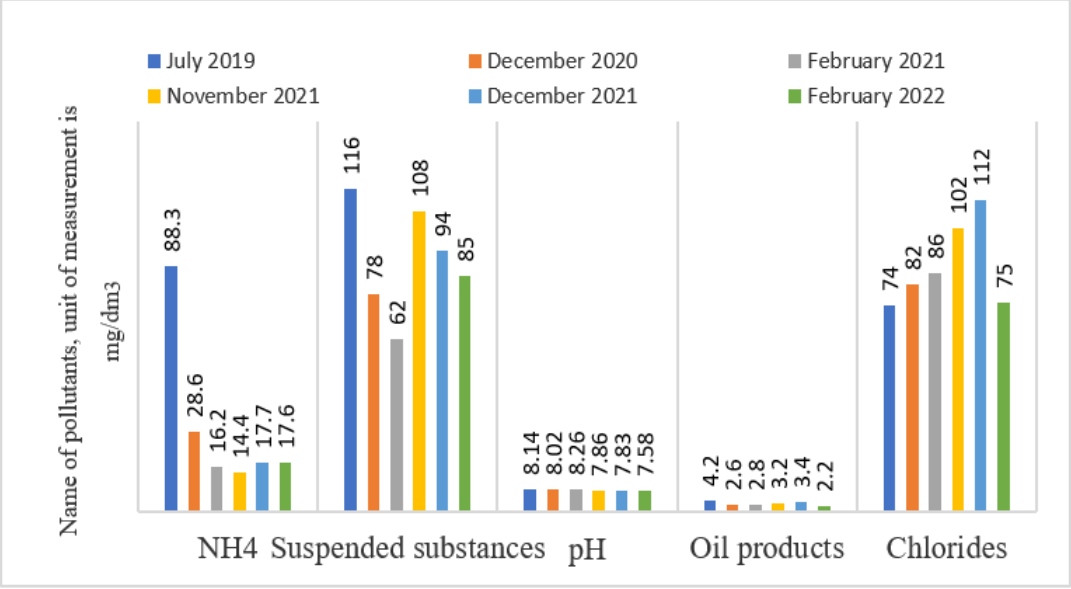

Fig. 2. Results of laboratory analysis of wastewater samples of the machine-building enterprise for 2019–2022

impact on the environment. To do this, you can use the methods of analyzing the chemical composition of water, biological tests and other modern methods.

2. Development of a wastewater quality monitoring system and determination of the efficiency of the applied technologies. Automated control and monitoring systems can be used for this.

3. Development of effective technological solutions for wastewater treatment. The choice of cleaning methods for each type of pollution should take into account the peculiarities of the composition of pollution from each production process, as well as fluctuations in the concentration of pollutants. Among the new methods, it is possible to single out methods of intensification of cleaning, for example, coagulation, flocculation, aggregate formation, electrochemical methods, ultrasonic. cavitation treatment, ozonation and others.

4. Development of an improved environmental management program and its implementation at the enterprise. The program should include the determination of strategic long-term goals and current local tasks regarding the reduction of discharges, the use of environmentally friendly materials and technologies, and the implementation of a monitoring and control system.

Conclusion. Thus, it can be argued that environmental management and intensification of wastewater treatment are not separate processes, but interrelated and integrated. The application of environmental management technologies can contribute to increasing the efficiency of the intensification of wastewater treatment, which in turn will lead to a decrease in the negative impact on the environment and the achievement of sustainable development of the enterprise.

So, the connection between environmental management and the intensification of wastewater treatment at enterprises of the machine-building complex is that environmental management should ensure the planning, control and optimization of production processes in order to prevent water pollution, and the intensification of wastewater treatment allows to reduce the negative impact of the enterprise on the environment At the same time, insufficient efficiency of liquid waste treatment requires changes and adjustments to the environmental management system. The degree to which the machine-building complex will lend itself to the overall greening of production depends on many factors, including the availability of political support, the availability of the latest technologies, the availability of specialized contractors and the ability of workers to adapt to new requirements. However, given the growing attention to issues of ecology and sustainable development around the world, it can be expected that the machine-building complex will also be forced to adapt to these requirements.

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