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ASSESSMENT OF PRODUCTION WASTEWATER CONDITION AND MAIN METHODS OF TREATMENT REALIZATION

ӨНДІРІСТІК АҒЫНДЫ СУЛАРДЫҢ ЖАЙ-КҮЙІН ЖӘНЕ ОЛАРДЫ ТАЗАРТУДЫҢ НЕГІЗГІ ӘДІСТЕРІН БАҒАЛАУ

ОЦЕНКА СОСТОЯНИЯ ПРОИЗВОДСТВЕННЫХ СТОЧНЫХ ВОД И ОСНОВНЫХ МЕТОДОВ ИХ ОЧИСТКИ

Abstract. *This article discusses the problem of assessing the condition of wastewater of production plants and the main methods and ways of their treatment. The main pollutants in the wastewater of production facilities and their impact on the environment are considered. The importance of wastewater quality assessment for ensuring environmental safety of production and preserving the environment is discussed. The main pollutants in the wastewater of production facilities and their impact on the environment are considered. The article presents various wastewater treatment technologies, including physico-chemical and biological methods. It also considers the impact of various pollutants on the state of water resources and possible ways to reduce them. The issues of construction of local treatment facilities at the production site are covered. The necessity of providing wastewater treatment before discharge into water bodies is considered and various treatment technologies are discussed, along with the advantages and disadvantages of each. Overall, the article provides an overview of current wastewater treatment methods and technologies and the importance of utilizing them to improve the environment.*

Keywords: *industrial wastewater, treatment, filtration, pollutants, organic pollution, collection methods, wastewater sample analysis, local treatment plants.*

Аңдатпа. *Бұл бапта өндірістік кәсіпорындардың сарқынды суларының жай-күйін бағалау проблемасы және оларды тазартудың негізгі әдістері мен тәсілдері қаралады. Бұл бапта өндірістік кәсіпорындардың сарқынды суларының жай-күйін бағалаудың маңыздылығы және оларды тазартудың негізгі әдістері қаралады. Өндірістік кәсіпорындардың сарқынды суларындағы негізгі ластаушы заттар және олардың қоршаған ортаға әсері қаралды. Өндірістің экологиялық қауіпсіздігін қамтамасыз ету және қоршаған ортаны сақтау үшін сарқынды сулардың сапасын бағалаудың маңыздылығы талқылануда. Өндірістік кәсіпорындардың сарқынды суларындағы негізгі ластаушы заттар және олардың қоршаған ортаға әсері қаралды. Физикалық-химиялық және биологиялық әдістерді қоса алғанда, ағынды суларды тазартудың әртүрлі технологиялары ұсынылған. Сондай-ақ әртүрлі ластаушы заттардың су ресурстарының жай-күйіне және оларды төмендетудің ықтимал жолдарына әсері қаралды. Өндірістік алаңда жергілікті тазарту*

құрылғыларының құрылысы туралы айтылды. Сарқынды суларды су қоймаларына ағызу алдында тазарту қажеттілігі қаралады, тазартудың әртүрлі технологиялары, олардың әрқайсысының артықшылықтары мен кемшіліктері талқыланады. Тұтастай алғанда, мақалада сарқынды суларды тазартудың заманауи әдістері мен технологияларына шолу және оларды қоршаған ортаның жай-күйін жақсарту үшін пайдаланудың маңыздылығы ұсынылған.

Түйін сөздер: *өнеркәсіптік ағынды сулар, тазарту, сүзу, ластаушы заттар, органикалық ластаушы заттар, жинау әдістері, ағынды сулардың сынамаларын талдау, жергілікті тазарту қондырғылары.*

Аннотация. *В данной статье рассматривается проблема оценки состояния сточных вод производственных предприятий и основные методы и способы их очистки. В данной статье рассматривается важность оценки состояния сточных вод производственных предприятий и основные методы их очистки. Рассмотрены основные загрязняющие вещества в сточных водах производственных предприятий и их влияние на окружающую среду. Обсуждается важность оценки качества сточных вод для обеспечения экологической безопасности производства и сохранения окружающей среды. Рассмотрены основные загрязняющие вещества в сточных водах производственных предприятий и их влияние на окружающую среду. Представлены различные технологии очистки сточных вод, включая физико-химические и биологические методы. Также рассмотрено влияние различных загрязняющих веществ на состояние водных ресурсов и возможные пути их снижения. Освещены вопросы строительства локальных очистных сооружений на производственной площадке. Рассматривается необходимость очистки сточных вод перед сбросом в водоемы, обсуждаются различные технологии очистки, преимущества и недостатки каждой из них. В целом в статье представлен обзор современных методов и технологий очистки сточных вод и важность их использования для улучшения состояния окружающей среды.*

Ключевые слова: *промышленные сточные воды, очистка, фильтрация, загрязняющие вещества, органические загрязнения, методы сбора, анализ проб сточных вод, локальные очистные сооружения.*

Introduction. Industrial wastewaters are one of the main sources of environmental pollution. They contain various chemical substances, toxic compounds and microorganisms that can cause serious harm to nature and human health. Therefore, it is important to assess the condition of wastewater and develop methods of its treatment.

Assessment of production wastewater condition includes analysis of physico-chemical and biological parameters of water. Concentrations of pollutants, acidity values, temperature, odor and other characteristics are determined. These data make it possible to understand the degree of water contamination and determine the necessary treatment measures.

To ensure effective treatment of industrial wastewater, it is also important to take into account seasonal changes and fluctuations in contaminants. For example, during rains, the amount of contaminants entering the wastewater may increase, requiring additional treatment measures. In addition, it is necessary to pay attention to possible external sources of pollution, which may affect the quality of wastewater and require additional treatment measures. It is also necessary to take into account the specifics of the contaminants that are present in a particular production process. For example, biological methods may be used to remove organic contaminants, which are based on the activation of living organisms to decompose harmful compounds. It is also important to consider possible toxic substances that require specialized cleaning methods to prevent their release into the environment.

To improve the efficiency of wastewater treatment, it is also advisable to implement systems for recycling and reuse of treated water in production processes. This will reduce the consumption of water resources, reduce the load on treatment facilities and save money on fresh water procurement. This approach helps to save resources and reduce the negative impact of production on the environment, which is in line with the principles of sustainable development and responsible business conduct.

Compliance with regulatory requirements and water quality standards is also an important

aspect in selecting wastewater treatment methods. Violation of these requirements can lead to fines and sanctions from regulatory authorities, as well as possible risks to human health and the environment. Therefore, it is necessary to strictly comply with all norms and standards when designing and operating wastewater treatment plants.

The main methods of realization of wastewater treatment include physical-chemical, biological and complex methods. Physico-chemical methods include filtration, coagulation, sedimentation and other processes aimed at removing pollutants from water. Biological methods are based on the use of living organisms (bacteria, algae) to purify water from organic matter. Complex methods involve the combination of several treatment techniques to achieve optimal results.

In addition, the selection of wastewater treatment methods must take into account the economic component. Some treatment methods may be more costly than others, so it is important to conduct a cost analysis and select the optimal combination of methods that will provide effective treatment at the lowest possible cost. Continuous improvement of treatment technologies and the search for new innovative solutions are also key environmental challenges.

Finally, special attention should be paid to controlling the treatment processes and monitoring the quality of treated water. Regular analyses and inspections will allow timely identification of possible deviations and problems in the operation of treatment facilities, which will allow promptly taking measures to eliminate them and prevent possible emergencies. Thus, an integrated approach to the assessment and treatment of production wastewater is a key element in ensuring environmental safety and sustainable development of industry.

Assessment of industrial wastewater and application of appropriate treatment methods play an important role in preserving environmental safety and human health. It is necessary to continuously improve treatment and waste management technologies to minimize negative environmental impact and ensure sustainable industrial development.

Methods and Materials. Methods for collecting and analyzing wastewater samples include:

Spot samples (Figure 1): used to analyze the main pollutants and compare them to maximum allowable concentrations.

Periodic sampling: divided into time-dependent, flow-dependent and volume-dependent samples. Time-dependent samples are taken in a certain volume with time fixation, flow-dependent samples are taken at a constant flow rate, and volume-dependent samples are taken in a certain sample volume without taking time into account (Desmidt, Ghyselbrecht, ZHang, Pinoy, Bruggen, Verstraete, Rabaey, Meesschaert, 2015).

Continuous sampling: divided into two types - constant and non-continuous water flow. The constant flow allows to obtain data on water quality composition, while the non-permanent flow allows to determine the indicators of large volumes of water and is a more accurate method.

Serial sampling: samples are taken at different locations and depths or at the same depth but at different locations.

Composite Sample: consists of several samples obtained by one of the continuous methods.

Before applying a particular type of wastewater collection and analysis, it is necessary to categorize wastewater according to the main types of contaminants 1-4.

Industrial wastewater is divided into mineral content, organic matter and mixed contaminants (Vasilenko, Nikiforov, Lobukhina, 2019). For some wastewaters it is necessary to determine their epidemiological hazard, which may consist in the fact that their composition may include not only helminths and E. coli bacteria, but also pathogens of such serious and dangerous diseases as anthrax, sappe and others. Such wastewater can include wastewater from slaughterhouses, leather factories, and agricultural complexes.

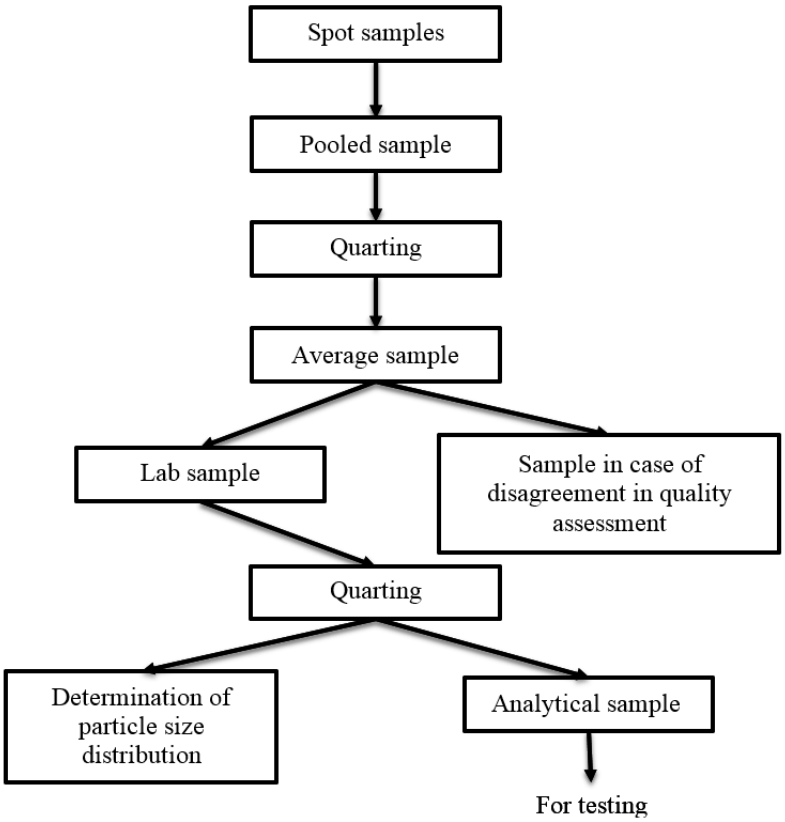


Figure 1. Sampling and sample preparation scheme
Note – compiled by the authors based on «Water supply and sanitary engineering» (Kevbrina, 2019)

In addition, wastewater has different pH reactions of the aquatic environment, which also affects the preparation, sampling of wastewater and selection of the approved methodology for the determination of its main polluting components. At the same time, wastewaters are subdivided into slightly acidic, with pH in the range from 6 to 6.5; slightly alkaline, for which these values lie in the range from 8 to 9 and neutral, which are in between 6-7.

There are strongly acidic and strongly alkaline effluents, the pH range of which lies beyond slightly acidic and slightly alkaline. The concentration of contaminants in wastewater is also significant in sampling, as different analytical methods can be used to determine the contaminants. Wastewater is subdivided by the degree of contamination into high, medium and low concentration wastewater.

In production technologies of one and the same enterprise can be formed wastewater with completely different characteristics, including radically different in the concentration of pollutants, the reaction of the medium, as well as the phase composition and nature of pollutants.

If the technological process used at the enterprise involves the formation of such local effluents, radically different in their physical and chemical characteristics, it is necessary to focus on sampling before they enter the general sewer (Koganovskiy, Klimenko, 2013).

Some industrial effluents have elevated concentrations of substances in the colloidal solution state, in the form of finely suspended, or emulsified phase. The main problem in almost all operating wastewater treatment plants is the slowing down of the wastewater flow to be treated, which is usually caused by poor distribution of inflow and discharge.

When analyzing the operation of existing wastewater treatment facilities, it is necessary to assess the possibilities of treatment of the main wastewater flow with their help (Belov, Kevbrina, Aseyeva, Gavrilin, Gazizova, Potentsial, 2012). If a large hydraulic load on the hydraulic separation of solid and liquid phase is detected, the possibility of installing additional equipment should be considered, as well as averaging the volume of incoming industrial wastewater.

Industrial enterprises discharge wastewater into water bodies only after its treatment in treatment facilities. The section of the reservoir from the place of effluent discharge is conditionally divided into zones: 1) initial dilution, in which the effluent flow velocity (v_c) is significantly higher than the water flow velocity ($v_п$); 2) basic dilution, in which the effluent mixing is due to turbulent diffusion; 3) self-cleaning zone, which is not taken into account in the calculations.

Total effluent dilution is defined as the product of the multiples of the initial and main dilutions ($n_н$ and n_o) resulting from mixing of effluent in zones 1 and 2.

The value of $n_н$ is determined by the formula:

$$n_H = \frac{0.248}{m} d^2 \left(\sqrt{m^2 + 8.1\left(\frac{1-m}{d^2}\right)} - m\right) \quad (1)$$

where: d – is the ratio of the calculated jet diameter to the outlet diameter; m is a dimensionless coefficient, the value of which is found by the formula:

$$m = \sqrt{\frac{P_p}{P_c} + \frac{v_n^2}{v_c^2}} \quad (2)$$

where: P_p and P_c – are the densities of water and SW fluxes, respectively, usually equal to one.

The value of n_o is considered as the inverse of the mixing coefficient γ determined by the formula:

$$\gamma = \frac{1 - e^{\sqrt[3]{\ell_f}}}{1 + \frac{Q_{min}}{Q_{max}} e^{\sqrt[3]{\ell_f}}} \quad (3)$$

where: ℓ_f – is the distance from the NE outlet to the water use site along the fairway, m.

It should be noted that for biological treatment facilities for industrial wastewater are very significant factors (Kozlov, Bogomolov, Kevbrina, Nikolayev, Kolbasov, 2014):

– variability in the flow rate of wastewater,

– high, or on the contrary, too low content of organic matter in the effluent,

– dissolved oxygen concentration,

– mixing conditions that determine the degree of contact between wastewater contaminants and activated sludge microorganisms,

– content of biogenic elements, primarily nitrogen and phosphorus,

– the content of toxic substances present in the effluent,

– strong changes in the composition of the wastewater,

– the temperature and reaction of the medium,

– development of harmful microorganisms that contribute to the swelling of activated sludge and suppression of beneficial bacteria, which include filamentous bacteria and fungi.

Causes of ineffective wastewater treatment include:

– inadequate aeration,

– residence time of the effluent at the biological treatment stage,

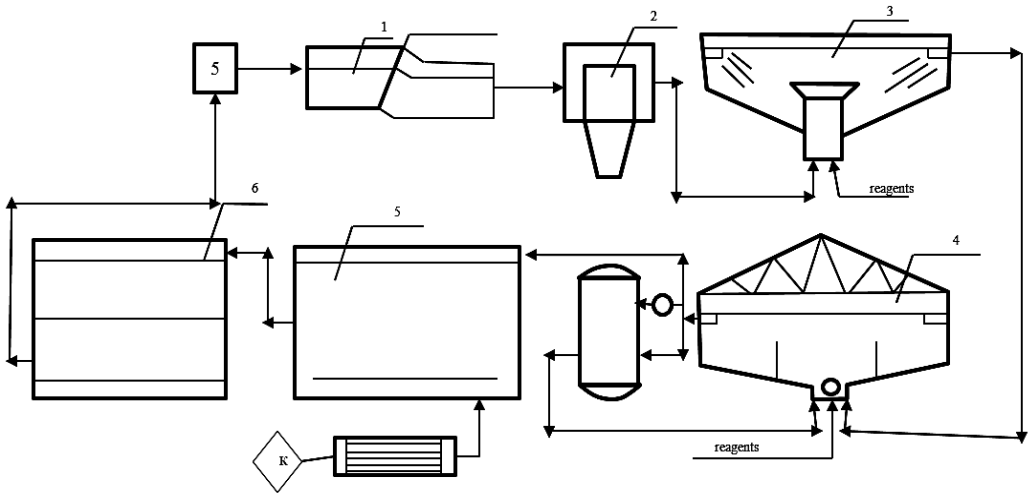
– or incorrect selection of equipment at the stage of solid phase separation of pollutants.

Other factors limiting the quality of wastewater treatment include the appearance of stagnation in the processes of biochemical oxidation of succulent water, leading to the formation

of non-deposited solid phase of pollutants, as well as the release of gases that have a pronounced odor and cause deposits that prevent the normal operation of equipment (Hammer, 2017).

Figure 2 shows the schematic diagram of technological wastewater treatment.

1) RD-600 type crusher grates
2) Tangential sand trap
3) Radial settling tank with thin layer blocks
4) Radial flotator (pressure)
5) Contact chamber
6) Double-layer filter



1) RD-600 type crusher grates
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Figure 2. Scheme of technological wastewater treatment

Note – compiled by the authors based on "Efficiency of microfiltration on disk filters for detention of suspended solids of biologically treated wastewater"(Kozlov, 2014)

Local wastewater treatment plants: the key to sustainable development.

Local wastewater treatment plants play an important role in the water management system, providing wastewater treatment at the local level (Zhukov, 2018). These facilities can be either part of individual residential buildings or an element of infrastructure of small settlements or enterprises.

Local wastewater treatment plants usually include several stages of treatment:

1. Mechanical cleaning: removal of coarse solids and sludge.
2. Biological treatment: the use of microorganisms to decompose organic pollutants.
3. Chemical cleaning: neutralization of harmful chemicals.

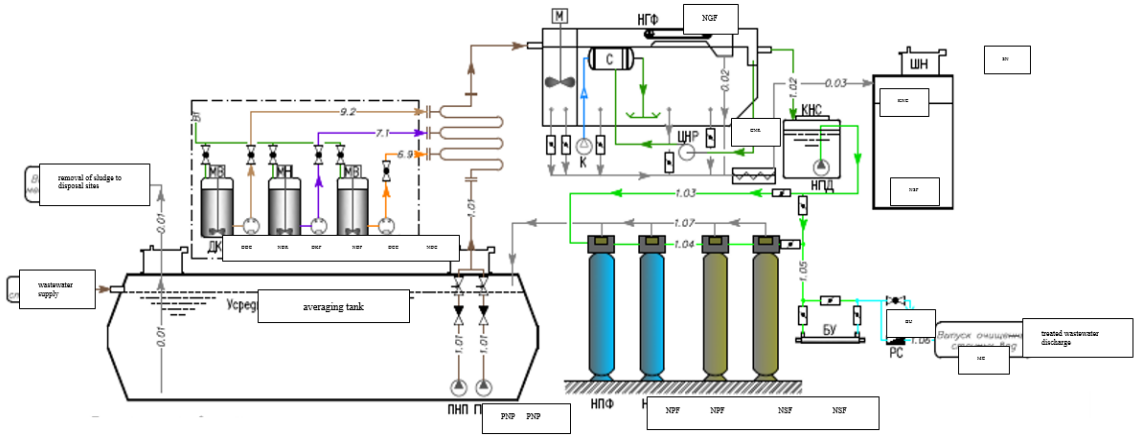
The advantages of localized wastewater treatment plants are:

– Resource savings: less need for centralized treatment plants and wastewater transportation;

– Flexibility: adaptability to specific conditions and needs;

– sustainability: reducing dependence on centralized systems and increasing water use efficiency.

Results. The article considers in detail the issue of installation of industrial wastewater treatment plant, or otherwise - local treatment plant, at production facilities in order to remove contaminants and the possibility of discharging water from technological processes without harming the environment (Evilovich, 2011). The treatment processes are fully automated and require minimal maintenance (Fig. 3). The implementation of treatment facilities, recycled water supply, which allows enterprises to save significant funds, as well as the use of membrane bioreactors has been studied. The use of membrane bioreactors significantly reduces the area of treatment facilities, and the high degree of automation of processes makes the treatment facilities easy to operate (Paramonova, 2015). This kind of treatment facilities have high efficiency due to the full development of technological solutions and accurate selection of the necessary equipment.



PNP	Submersible feed pump	SN	Sludge storage
NGF	Floor horizontal	MS.	Flow meters meters
C	saturator	MB	Mixer high cleaner
K	compressor	MN	Mixer
CNR	Centrifugal pump	DDC	Dispersed colloidal reagents
M	Mixer	DKF	compressor flocculator
KNS	Pumping station	DCC	compressor
NAP	Submersible aftertreatment pump	NDR	Dispenser pump
NPF	sand filter	NDF	Pump-dosing flocculator
NSF	Floor sorption filter	NDC	Dispenser pump
BU	Bacteriological plant		

Figure 3. Technological scheme of wastewater treatment facilities

Note – compiled by the authors based on "Efficiency of microfiltration on disk filters for detention of suspended solids of biologically treated wastewater"(Kozlov, 2014)

Values of estimated concentrations of pollutants after treatment facilities are given in Table below and meet the requirements for water of fishery water bodies (Order of the Minister of Ecology and Natural Resources of the Republic of Kazakhstan "Water quality standards and maximum permissible concentrations of harmful substances in the waters of water bodies of fishery importance", SanPiN 2.1.5.980-00 "Hygienic requirements for the protection of surface waters").

Table 1. Concentrations of pollutants at the outlet of the treatment plant

Name of indicators	Units of measurement	Quantity, not more
BOD full.	mgO /L_2	3
Suspended solids	mg/l	3
Ammonium nitrogen (N-$NH)_4$	mg/l	0,39
Nitrate nitrogen (N-$NO)_3$	mg/l	9,1
Nitrate nitrogen (N-$NO)_2$	mg/l	0,02
SPAV	mg/l	0,1
Phosphates (by P)	mg/l	0,2
Fats	mg/l	-
pH	-	6,5-8,5
Note – compiled by the authors based on "Water supply and sanitary engineering" (Kevbrina, 2019)		

The introduction of local treatment facilities at industrial enterprises is necessary from the point of view of compliance with the norms of legislation in the field of wastewater disposal, according to which enterprises are obliged to have and properly operate local treatment facilities and provide preliminary treatment of wastewater discharged into the centralized wastewater disposal system. The greatest effect is achieved at enterprises whose production effluents contain environmentally hazardous substances (Gudkov, 2013). Implementation of complete treatment plants of block-modular type is especially appropriate in severe climate conditions and in the absence of the possibility of capital construction directly on the site.

The following effect is achieved from the introduction of local treatment facilities at industrial enterprises:

– fulfillment of legislative norms in the field of wastewater disposal;

– reduction of payments for wastewater discharge, sludge removal, etc;

– increasing the economic and technological independence of enterprises.

Conclusion. High standards of water quality, both in industrial and natural water bodies, are essential to ensure human health and well-being, biodiversity and ecosystem stability. Therefore, it is necessary not only to improve existing wastewater treatment methods, but also to invest in the development of new technologies that can effectively combat pollution and ensure sustainable use of water resources.

Local wastewater treatment plants are an important tool for achieving sustainable water management. They contribute to preserving the ecological balance, improving water quality and enhancing the quality of life of the population. The development and implementation of new technologies in this field offers great prospects for improving the environmental situation and economic development of regions.

Effective assessment of wastewater condition and implementation of wastewater treatment methods are an integral part of sustainable production development. Only by joint efforts of the state, enterprises and population can we preserve water resources of our planet for future generations. Therefore, it is important to continue research and implement new technologies to ensure clean water and a healthy environment.

Conflict of interest. The authors declare that there is no conflict of interest.

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"Notification of the use of generative AI and technologies using it in the process of writing the manuscript". The authors did not use tools of artificial intelligence services in the preparation of this paper.

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