

ANNOTATION

for the academic degree of Doctor of Philosophy (PhD)

The specialty 6D060800 – «Ecology»

SHYNAR BAIMUKASHEVA KHABIBULLIEVNA on the topic of dissertation work " Research and optimization of biological processes for the removal of toxic ingredients from municipal wastewater of Zhanaozen city "

The relevance of research.

One of the most urgent problems of nature protection in our time is cleaning and utilization of polluted wastewater. In many countries of the world, this topic is becoming very relevant. Water deficit and efficient use of water resources are very important for our country. Due to its geographical location, Kazakhstan belongs to the number of countries with limited water resources. According to scientists, the trend of desertification in the country increases every year. For example, for the period from 1990 to 2020, the amount of land used for irrigated agriculture in all regions of the country decreased from 2.5 million hectares to 1.7 million hectares, of which only about 1.2 million hectares are currently used. Today, mechanical, physico-chemical, biological and many other methods of cleaning city wastewater are known. In recent years, the method of biological purification using the vital activity of various hydrobionts and hydrophytes in bioponds and aeration tanks is considered to be an ecological technology gaining momentum in the world. However, there is no universal approach or technology established for all natural anthropogenic situations. Therefore, each natural region, production and economic situation presents special requirements for the construction of water treatment technology. In connection with this, in 2017, a special decree of the President of the country approved and implemented the State Program for the Development of the Agricultural Complex of the Republic of Kazakhstan for 2017-2021. An important step in the management of water resources of the city of Zhanaozen is the development and implementation of the general development plan until 2025.

Mangistau region is considered a particularly water-deficient region of the country. In particular, there is a very limited supply of drinking water necessary for the needs of local residents. The need for drinking water is solved by desalination of the salt water of the Caspian Sea in artificial installations and the use of underground water reserves. According to statistics, the population and the total number of enterprises are growing from year to year. Thus, by 2025, the water deficit in the Mangistau region may reach 95 thousand cubic meters per day. The relevance of this issue is directly related to the rapid development of the oil and gas industry in the Mangistau region of Kazakhstan. In many technological chains of oil production, water is used in large quantities, resulting in water resources polluted by various production wastes. These wastewaters should not enter the surrounding ecosystem, and it is very important to study ways of their ecologically safe treatment. The specified topical issues justified the main purpose of my research work.

Purpose of research - to optimize methods of biological treatment of municipal and domestic wastewater of Mangistau region, city of Zhanaozen using the vital activity of local higher aquatic plants and to create an economically effective and ecologically clean method of wastewater treatment of agricultural production.

The main objectives of research:

- assessment of the ecological state of water resources of the city of Zhanaozen, identification of the main sources of water resources, causes of mineralization of groundwater;
- based on the results of hydrogeological and geoecological studies, submit proposals for solving the ecological problem caused by the high degree of mineralization of underground waters;
- determination of the influence of the degree of pollution of the water environment on the active biocenosis of sediments;
- to study the possibility of increasing the resistance to the toxicity of the water environment with an active wastewater treatment system and increasing the degree of water purification;
- creation of a method of biological treatment of municipal and domestic wastewater of the city of Zhanaozen using the vital activity of higher aquatic plants.

Object of research: Mangistau region, water resources extracted from the underground reservoir of the city of Zhanaozen and transported from the Volga River, waste water of the city's wastewater treatment complex and oil production, water resources that migrated in the underground soil crust.

Subject of research: Hydrochemical and hydrogeological characteristics of reservoirs in the city of Zhanaozen play an important role in ensuring water supply and sustainable ecosystems. Studying the composition of biogenic elements in water allows to assess its quality and impact on the environment. All these aspects together form a complex approach to the management and optimization of water resources, ensuring effective water treatment and balanced use of water systems in the city of Zhanaozen.

Research methods: scientific research was conducted in the period 2019-2023. using a number of well-known methods of detection, analysis, evaluation: sampling and analysis of water was carried out in accordance with the following State industry standards (GOST): MSS 18826. -73, 4388-72, 18293-72, 18309-72, 4245-72, 3351-74, 4979-49, 4151-72 and 18293-73, Statistical processing of the data obtained as a result of the study was carried out by calculating the average arithmetic values and determining the levels of standard deviation $0.95 > P > 0.80$. Quantitative data were obtained as a result of experiments performed in 3 and 5 repetitions using the Excel application on an IBM Pentium personal computer.

Scientific novelty of research: On the complex of wastewater treatment. *Ceratophyllum echinatum*, *Zostera sp.*, *Tripolium pannonicum*, , as well as algae *Cladofora glomerata*, *Chlorella vulgaris* and common reed *Phragmites australis* of the local region were used for the first time in Janaozena for wastewater treatment. It is proposed to introduce biological treatment. The method, consisting of four-stage

bioponds, is based on the ability to remove up to 97.87% of 20 eutrophic hydrobiont organisms, organic and mineral compounds-pollutants.

Provisions issued for the defense of dissertation work:

The results obtained in the course of research are confirmed by retrospective, gravimetric, atomic absorption, analytical methods and statistical processing of experimental data. Special certified methods, standard GOST RK, were used to perform planned research works and chemical laboratory experiments. The equipment and materials used in the research meet the requirements of the regulatory and technical documentation.

The main principle recommended for protection:

- "Water resources of the city of Zhanaozen comprise the Tuesu-Sauskan underground waters and surface waters of the Volga River. They also include water storage tanks of the city's wastewater treatment plant, tanks for wastewater, oil-contaminated water, and seawater used to fill underground voids. "The process of gas production in the city of Zhanaozen leads to a decrease in the output of water from the wastewater treatment complex to $78.45 \pm 1.85\%$. Consequently, this results in the mineralization of groundwater in the territory, with a purity level of $86.95 \pm 2.42\%$." This process causes water pollution of the catchment basin as a result of long-term operational activities;
- the scientific justification of filling underground voids with water in the city of Zhanaozen is a key aspect of solving environmental problems related to hydrogeological processes. This approach not only prevents possible negative consequences of hydrogeological changes, but also contributes to the improvement of the ecosystem and provides a sustainable source of water for urban consumption. Such innovative solutions can significantly increase the environmental sustainability and viability of urban infrastructure.
- the study of the biocenosis of active mud in the household-communal wastewater treatment complex of the city of Zhanaozen revealed the presence of 85 types of microorganisms. It is noted that the excessive loading of toxic impurities has a negative effect on the composition of the biocenosis. The saprob index of wastewater, equal to 1.87 ± 0.3 , indicates a high degree of water purification, reaching $85.0 \pm 8.0\%$. However, increasing the saprob index to 2.55 ± 0.1 increases the degree of water purification to $72.8 \pm 7.1\%$. With long-term toxicity of wastewater, the removal of sensitive forms of biocenosis from the active sediment is observed, which leads to an increase in the saprobic index of water to 3.07 ± 0.3 and a decrease in the degree of purification to $55.5 \pm 5.1\%$. In the context of the optimization of the wastewater treatment process, a method was proposed, consisting in the use of 0.08% carboxylic acids. This leads to the enrichment of the species composition of active biocenosis with 85 to 105 species due to the stimulation of enzyme production. A decrease in the number of filamentous bacteria and an increase in the resistance of the biocenosis to the toxic environment of wastewater are accompanied by an increase in the degree of water purification to 95.62%. These results emphasize the effectiveness of the use of carboxylic acids in the

operation of the wastewater treatment complex and open perspectives for improving the environmental sustainability of this process.

- method of biological treatment based on the activity of local deposits of hornwort (*Ceratophyllum echinatum*), zoster (*Zostera* sp.), astragalus common (*Tripolium pannonicum*), hydromacrophytic plants and algae *Cladophora* (*Cladofora glomerata*), *Chlorella* (*Chlorella vulgaris*) and common reed (*Phragmites australis*) for complex wastewater treatment city of Zhanaozen. The implementation of a four-stage scheme in a biopond increases the degree of wastewater treatment to 97.87% and completely cleans the water environment from eutrophic microorganisms-hydrobionts.

Theoretical and practical significance of research results.

The presented study acquires a high theoretical value in the light of the analysis of ecological conditions of low-water and polluted water ecosystems in the arid climate of the oil-producing regions of Kazakhstan. Determining the causes of environmental problems in these areas becomes an important step towards understanding their scale and possible solutions. The results obtained during the research work, as well as the developed conceptual ecological standards, provide valuable theoretical material that can be implemented in special training courses for future specialists in hydrogeology, geoecology and ecology at the bachelor's and master's level. In addition, these results can be used when creating textbooks and educational-methodical complexes.

The practical significance of the study is shown in the recommendations for solving environmental problems of the city of Zhanaozen, resulting from the conducted research process. These recommendations have potential value for solving similar problems in other regions of the country, where water resources are limited. Thus, this work not only contributes to the theoretical understanding of ecological aspects, but also provides concrete practical recommendations, enriching the knowledge base for the development of effective strategies for sustainable development in similar conditions.

Approval work. The results of the research were presented at the international scientific and practical conference "Geological and technological aspects of the development of hard-to-recover hydrocarbon deposits" (Aktau, April 18, 2019); Science was presented at scientific and practical online conferences dedicated to the Worker's Day (Aktau, April 17-29, 2020)., The International Scientific and Practical Conference K. PhD, Associate Professor Makhambetova R. K. on the topic "Water safety: problems and solutions" (Aktau, April 29, 2022), dedicated to 60 years.

"Additionally, the main provisions of the dissertation were extensively discussed at the Academic Council of the Faculty of Engineering from 2023 to 2024, as well as at meetings of the Department of Ecology and Geology."

Publications of research work:

Based on the materials of dissertations, 12 works have been published, including: 1 publication in journals included in the Scopus database, 1 publication in the Web of Science database, 2 publication in scientific publications proposed by the Committee for Quality Assurance in Science and Higher Education, the rest of the articles have been published at international scientific and practical conferences. 1

monograph has been published, approved by the Academic Council of the Caspian University of Technology and Engineering named after Sh. Yesenova, utility model of the Republic of Kazakhstan No. 8401 07.02.2023, received a patent "Method of phytomeliorative purification of polluted water" (Appendix A). Utility model of the Republic of Kazakhstan No. 8510 04.07.2023, the patent "Method of biological purification of contaminated water" (Appendix B) was obtained.

Author's contribution. In the course of experimental and control works, orientation studies, as well as production experiments, the author directly participated in the process, regulatory parameters and ensured the exact observance of the methodology. His active participation contributed to increasing the reliability of the data obtained and the quality of the conducted research.

Dissertation on volume and structure:

"The dissertation consists of an introduction, 4 chapters, conclusions, appendices, and a bibliography comprising 160 titles. "The work is presented on 129 pages with 43 drawings and 20 tables.