

ANNOTATION

for the academic degree of Doctor of Philosophy (PhD)
The specialty 6D060800 – «Ecology»
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on the topic of dissertation work

««Environmental aspects of improving the process of purification of oil-containing industrial wastewater LLP «JV» CASPI BITUM»»

The relevance of research.

Wastewater from oil refineries and oil refineries is considered toxic and dangerous to the environment and human health, since their composition is complex, capable of forming other compounds, undergoing changes over time, and the stability of most organic compounds and the strength of chemical bonds make it difficult for them to biologically and chemically oxidize.

In order to reduce the negative impact on the environment, wastewater is sent to treatment facilities, after the process of reducing the amount of toxic compounds, it is sent for discharge into ponds or artificial reservoirs.

Considering that the level of pollutants in discharged waters is brought only to a level not exceeding the concentration of pollutants (background concentration) already formed in water bodies, it is allowed to discharge high concentrations of pollutants in evaporation ponds, the concentration of petroleum hydrocarbons is 30-80 times, ammonia (NH₄⁺) more than 25 times, solutes 6 times, biochemical oxygen demand 6 times and surfactants more than 5 times.

Thus, the allowable concentrations of pollutants in wastewater from oil refineries in Kazakhstan have been exceeded. In this case, when water is released into the ponds, only the background concentration of this place is taken into account.

For the treatment of heavily polluted waters, coagulation or sedimentation methods are generally recommended. Sulfide compounds are used as precipitating reagents, and aluminum/iron sulfates are used as coagulants. In these cases, deposits of significant volume and weight are formed. Next, a small amount of remaining impurities are purified by adsorption with activated carbon, zeolite, and the like.

These cleaning methods are multi-stage, each stage is designed to remove different impurities. In addition, at these stages of purification, sediments are formed that require neutralization, and the need arises for the regeneration of sorbents. Therefore, work done for one purpose causes the following problems.

Most research papers do not consider the possibility of recycling in technological processes. Considering that water is the only consumable resource, it is important not only to purify it in accordance with the requirements, but also to develop methods of purification in order to use it in other necessary areas.

The problem under consideration is also relevant for wastewater treatment of the bitumen processing plant in Aktau.

Purpose of research. Creation of an energy-saving, environmentally efficient treatment method adapted to the wide variations in the composition of wastewater generated in the production process during evaporation in a solar plant, which allows increasing the yield of treated recycled water for further use in irrigating green spaces.

The main objectives of research:

- Study of water consumption and wastewater systems of a bitumen plant located near the city of Aktau and analysis of the current wastewater treatment system;

- analysis of the existing wastewater treatment system in «Caspi Bitum» LLP on the basis of theoretical and experimental data and study of ways to improve the efficiency of wastewater treatment;

- experimental determination of the degree of water purification in a laboratory installation operating on the basis of evaporation, simulating the distillation process taking place in a solar installation;;

- study of optimal technological parameters of ozonation;

- testing of a pilot solar plant for wastewater treatment;

- study of the ecotoxicity of a complex of harmful substances present in the treated water of a bitumen plant using biotesting methods.

Object of research: wastewater from a bitumen plant discharged into an evaporation pond, solar plant, crops for biotesting of treated water.

Subject of research: hydrochemical characteristics of the water of the evaporation pond and the composition of nutrients in the water, the quality of wastewater from the bitumen plant, the potential for sunlight in the region, the composition of water obtained from solar energy. (used in evaporation) and ozonation, ecotoxicity of plants.

Research methods:

Determination of the content of measured substances in wastewater according to State Standard 26449.1-85, COD - according to ST RK 1322-2005, BOD - according to ST RK ISO5815-1-2010, iron content according to State Standard 26449.1-85, oil products - according to State Standard 26449.1-85.

When sampling surface waters according to to State Standard 17.1.5.05-85 «Nature Protection. Hydrospher» Water samples for laboratory analysis (chemical) were taken using a Patalas bathometer.

The chemical analysis of the selected water samples was carried out according to the approved measurement procedures. Chlorides and sulfates were determined by ion chromatography on a Shimadzu LC-20A chromatograph. Phenol content was analyzed on an AGILENT 6890 gas chromatograph (USA) with a mass selective detector.

In solar wastewater treatment, a closed-volume solar treatment plant was used. The device uses an effect focused on the «dew point» or moisture condensation on the inner surface of the coating. The solar plant uses the effect of «dew point», or condensation of moisture in the inner surface of the plant, to treat wastewater using solar energy.

The biotesting method was used to study the ecotoxicity of treated water.

Scientific novelty of the research: development of an energy-saving method for obtaining purified water suitable for production technology and horticulture through integrated wastewater treatment using a solar plant.

Principles for defending a dissertation work:

- results of assessment of the impact of the evaporation pond on the environment, where wastewater is discharged
- determination of the elemental composition of wastewater and their hazard class, substantiation of the need for their treatment;
- technological parameters and optimal conditions for wastewater treatment by evaporation in a solar battery and oxidation of light fractions of organic compounds;
- solar installation and wastewater treatment technique for studying the properties of inorganic and light organic compounds during evaporation and oxidation by ozone;
- results of plant biotesting to assess the environmental toxicity of treated water and study its effect on plant viability.

Practical significance of the obtained results: given the limited water resources of our region and the degree of demand for water, the results achieved in the dissertation work are of great practical importance. The results are used in oil producing and processing enterprises, as well as in wastewater treatment at a bitumen plant.

The author participated in the dissertation work: experimental determination of the degree of water purification at a laboratory facility simulating a solar device, the study of the ecotoxicity of harmful substances in the purified water of a bitumen plant using biotesting methods.

Communication of work with other research works.

Dissertation work within the framework of the state grant "Young Scientist" of the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan in 2022-2024. No. AP15473356 was implemented as part of the project "Development of a solar installation for the treatment of wastewater from a bitumen plant."

Approbation of work.

The results of the study were presented at the «I International Yesenov Readings» international scientific and practical conference held within the framework of the Program of modernization of public consciousness «Orientation to the future: Rukhani Zhangyru» (Aktau, October 18-19, 2018); VIII International Scientific and Practical Conference «Issues of sustainable development of the regions of the Republic of Belarus and neighboring states» (Mogilev, 2019); at the international scientific and practical conference «Geological and technological aspects of the development of deposits of hard-to-recover hydrocarbons» (Aktau, 18 January 2019); at the international scientific and practical conference «The Caspian in the XXI century: regional and global problems, cooperation and security», dedicated to the 70th anniversary of Professor G.Zh. Kenzhetaev (Aktau, 2020); at the I International Scientific and Ecological Forum «Environmental Protection and Rational Use of Natural Resources» (Nur-Sultan, 2020). In addition,

the basic principles of the dissertation were widely discussed at the Academic Council of the Faculty of Engineering in 2022-2023, at meetings of the Department of Ecology and Geology.

Research publications: based on the dissertation materials, 12 papers were published, including: 1 publication in journals included in the Scopus database, 3 articles in scientific publications recommended by the Committee for Quality Assurance in Science and Higher Education, 1 article in the journal of the Higher Attestation Commission of the Republic of Poland, other articles published in International Scientific and Practical Conferences. The patent of the Republic of Kazakhstan for utility model № 8181 dated 06/16/2023 "Method of wastewater treatment" was obtained.

Scope and structure of the dissertation: The dissertation consists of an introduction, 5 chapters, a conclusion, 8 appendices and 184 references. The work is presented with 21 figures and 31 tables on 136 pages.