THE PROBLEM OF WASTEWATER TREATMENT

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ABSTRACT. Rapid industrialization and urban growth in Uzbekistan have significantly increased the volume and complexity of wastewater, creating serious environmental and public health risks. In addition to conventional pollutants, wastewater now contains microplastics, pharmaceuticals, and oil products that are difficult to remove using outdated treatment facilities, many of which were built decades ago. This article analyzes key challenges in wastewater treatment, including technological obsolescence, insufficient monitoring, and non-compliance with discharge standards. Various treatment methods are reviewed, with emphasis on physico-chemical approaches such as coagulation and flotation, which demonstrate higher efficiency. Modernization of facilities, adoption of advanced technologies, and rational water use are essential to improve treatment performance and reduce environmental impact.

DISCUSSION

In the last decade, one of Uzbekistan's most pressing problems has become environmental pollution and its rapid increase. This is primarily associated with the fast track development of the country, great amount of investments being poured into the development of the production facilities and the growth of real-estate construction, which triggered growing capacity of industrial enterprises, subsequently generating hazardous waste. The need for wastewater treatment (industrial and storm-water) is driven by the presence of harmful impurities that pose a danger to the environment, ecosystems, wildlife, and human health.

Rapid technological progress, economic growth, urban population increase, and industrial expansion have led to increased volumes and changing compositions of wastewater. Alongside traditional organic and inorganic components, new pollutants such as micro-plastics, pharmaceuticals, and oil products have emerged, making wastewater treatment increasingly complex.

Wastewater treatment methods include mechanical, chemical, physico-chemical, biological, and electrochemical approaches. Each method targets specific pollutants and is often combined to achieve compliance with environmental standards.

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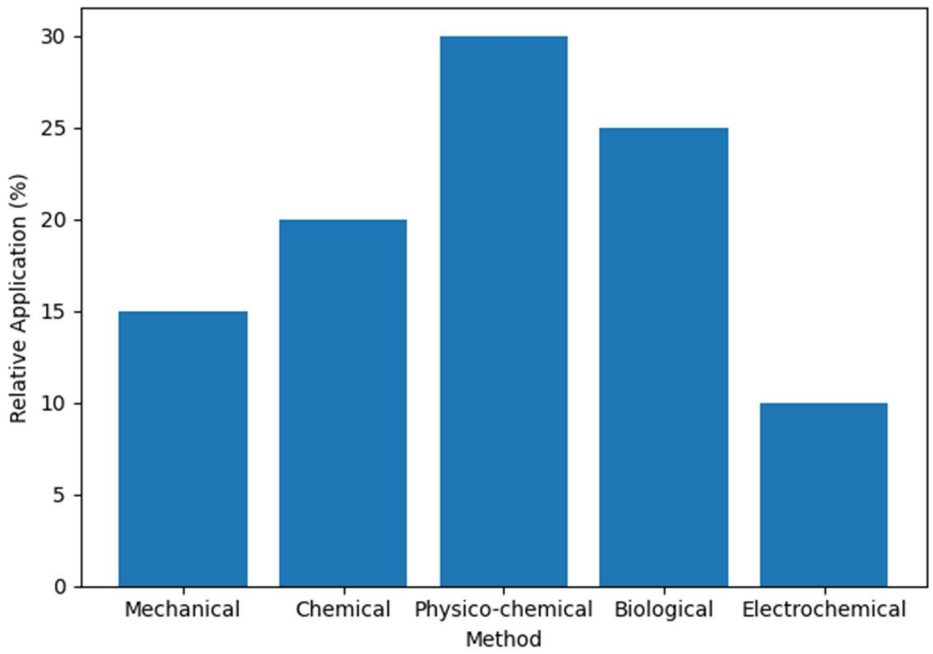


Figure 1. Wastewater Treatment methods

After passing through several stages of filtration, biological and chemical treatment, wastewater should be brought into compliance with established standards—at least in theory [1,2].

In practice, however, numerous cases have been revealed where untreated or insufficiently treated wastewater is discharged into the environment, creating serious threats that can escalate into ecological disasters on local or even national scales. In several instances where the arguments arised between some of the largest production companies in Uzbekistan and the Ministry of Ecology has proven this over and over again.

As a result, high-quality wastewater treatment became a critically important task. Alongside traditional organic and inorganic components, previously unknown substances now appear in wastewater. These effluents are difficult to treat, often creating the impression that even modern and properly functioning equipment is ineffective. The main reason for this seems to be lack of control by the responsible government offices, lack of bold decisions to establish strict and thoroughly thought-through legislative framework which will keep the heads of such production facilities responsible for untreated wastewater throws into the common canals and rivers or even into the underground water facilities. Combined with deficiencies in monitoring mechanisms, this situation becomes critical for country [3,4].

Other wide range of problems in environmental protection are directly related to the design and operation of wastewater treatment facilities. It is essential to design

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systems capable of removing nearly all pollutants from liquid waste. One might note that majority of the waste-water treatment facilities in the country and in the established production plants are being operated since the Soviet times which points to the fact that they are now old, can not fit to capture today's pollutants and to fully treat the effluents.

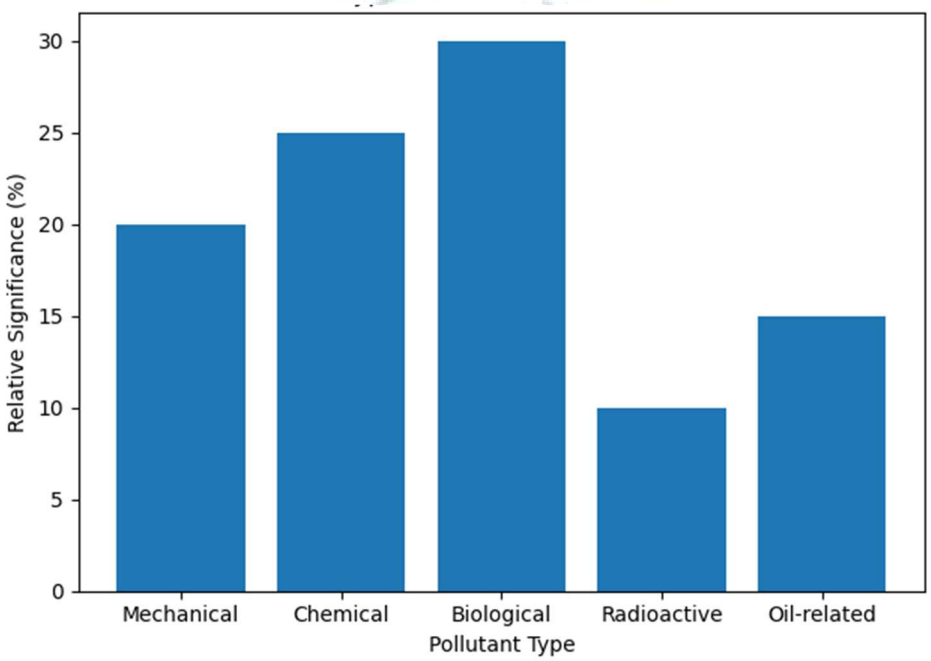


Figure 2. Mine Types of wastewater pollulants

Experts in wastewater and sewerage systems highlight the challenge of selecting appropriate treatment methodologies for domestic and municipal wastewater treatment plants. Scientists and engineers have developed many effective methods for treating wastewater, including mechanical, physico-chemical, chemical, biological, and combined approaches [5,6].

One major challenge is the correct selection of reagents that react with the pollutants to be removed. These reagents must also be environmentally safe. Developers match reagents to pollution sources, test their compatibility, and assess safety. Ultimately, another challenge arises—finding suitable locations for safely discharging treated water.

The design of treatment systems is based on understanding the types of pollutants present in wastewater. Modern industry introduces the following contaminants into wastewater:

Mechanical impurities: leaves, sticks, stones, paper, and sanitary waste. These are generally harmless but require proper processing and disposal.

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Chemical pollutants: generated by pharmaceutical, chemical, textile, and printing industries. These substances are hazardous and require specialized treatment methods.

Biological and radioactive contaminants: particularly dangerous, as they may contain bacteria and microorganisms capable of causing epidemics. Special treatment facilities with multiple monitoring systems are required.

The most hazardous waste originates from oil refineries and nuclear power plants. These wastes contain substances whose long-term effects on nature and human health are not yet fully understood.

Oil forms a dense film on the water surface that is extremely difficult to remove. Pollution of this kind can persist for decades, destroying flora and fauna and endangering human health. In some cases, due to legal violations or inadequate treatment capacity, oil products and other hazardous substances are illegally discharged into water bodies, causing ecological disasters.

The complexity of wastewater pollution has led to the development of multiple treatment methods, each with specific characteristics:

Mechanical treatment removes large debris using sand traps, filters, and separators.

Chemical treatment neutralizes pollutants through reactions with chemical reagents.

Physico-chemical treatment removes dispersed and inorganic impurities and breaks down hard-to-oxidize organic compounds using coagulation, oxidation, sorption, extraction, and electrolysis.

Biological treatment relies on microorganisms that decompose pollutants in biofilters, biological ponds, and aeration tanks.

Aeration tanks are advanced treatment systems consisting of several compartments where wastewater undergoes accumulation, filtration, biological disinfection, and final purification. Mechanical pre-treatment is usually required before biological processes.

Selecting an optimal treatment scheme is crucial due to the complex composition of wastewater and strict discharge standards. These standards include maximum permissible discharges (MPD) and maximum permissible concentrations (MPC).

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Economic and technical assessments are essential when choosing treatment technologies. Closed-loop water systems are economically advantageous but time-consuming. Therefore, some treated water is still discharged into natural bodies, making compliance with concentration limits critical.

Wastewater is considered treated only when pollutant levels meet regulatory requirements verified at monitoring points. Treatment efficiency depends on background pollution levels and requires continuous monitoring.

Physico-Chemical Treatment as an Effective Solution

Recently, physico-chemical methods have gained priority, as mechanical and biological treatments alone are often insufficient. Coagulation and flotation are widely used, especially when combined with flocculants.

Common reagents include aluminum sulfate, aluminum hydroxychloride, and iron salts. Proper dosing, pH control, and intensive mixing are essential. Automated dosing systems and electromagnetic mixers have shown promising results. Flotation is widely used to separate suspended particles and oils by introducing air bubbles that attach to contaminants and bring them to the surface as foam or sludge, which is then removed. Electroflotation and electrocoagulation technologies are increasingly used, based on gas bubble formation during water electrolysis. Due to the diversity of wastewater components, no universal treatment method exists. Sludge is classified as mineral, organic, or biological (activated sludge). Flotation and centrifugation are commonly used for sludge thickening, though each method has limitations.

CONCLUSION

Key problems in wastewater treatment

- Mismatch between wastewater characteristics and treatment plant design parameters
- Failure to meet discharge standards
- Hydraulic and organic overloading of treatment facilities

The main causes include:

- **Changes in wastewater composition and volume**
- **Technological obsolescence of treatment facilities**
- **Insufficient monitoring and inefficient water use**

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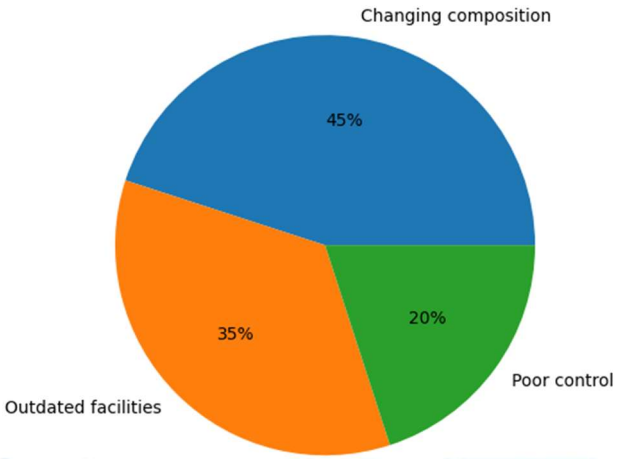


Figure 3. Main causes of wastewater treatment problems

Recommended Measures

- Comprehensive modernization of wastewater treatment plants
- Adoption of advanced chemical, biological, physico-chemical, and electrochemical technologies
- Rationalization of water consumption
- Precise reagent selection and controlled mixing

These measures can significantly reduce the environmental impact of human activities.

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