UDC 628.3

MODERN ACHIEVEMENTS AND DEVELOPMENT DIRECTIONS IN WASTEWATER TREATMENT : CURRENT TECHNOLOGY REVIEW

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The problem statement. Wastewater treatment is a crucial task in the modern world, where environmental sustainability and the responsible use of water resources are recognized as key aspects of preserving the environment and ensuring hygiene standards. This paper examines modern achievements and current trends in the development of wastewater treatment technologies.

Research Findings. One of the key trends is the utilization of biological methods for treatment. Developments in biofiltration, activated sludge, and phytosanitation allow for the efficient removal of organic and bacterial contaminants. Biological methods have emerged as key components in modern wastewater treatment processes due to their efficiency in removing organic and bacterial contaminants [1].

Membrane technologies constitute another important sector. Improvements in microfiltration and osmotic processes ensure the removal of even the smallest pollutants, ensuring high-quality treated water.

Green technology emerges as a cornerstone in the industry's development. The use of renewable energy sources and environmentally friendly treatment methods is a trend aimed at reducing environmental impact and ensuring the energy efficiency of systems.

In the realm of renewable energy application in wastewater treatment systems, several promising initiatives are currently underway:

Utilizing solar panels for electricity generation in treatment facilities. This enables the use of solar energy to power electrical equipment, reducing external power consumption and greenhouse gas emissions.

Harnessing the flow of wastewater for hydroelectric power generation. Turbines and generators installed in sewer pipes are set in motion by the water flow, generating electricity.

Anaerobic treatment plants produce biogas, including methane, during the decomposition of organic matter. This biogas can be used for heating and electricity generation, promoting internal energy self-sufficiency [2].

Utilizing the thermal energy generated during the treatment process for heating or other energy needs. This approach optimizes the use of thermal energy that was previously released into the atmosphere.

Implementing energy feedback systems that allow more efficient management of energy needs in treatment facilities based on loading and operational conditions.

The adoption of these technologies not only ensures energy self-sufficiency in wastewater treatment systems but also reduces reliance on traditional energy sources, contributing to the reduction of emissions and the creation of a more sustainable energy balance.

Automation and process monitoring are recognized as crucial for supporting the efficiency of treatment systems. The use of modern information technologies allows for the timely identification of issues and maximization of performance.

Conclusion. The adoption of advanced technologies in wastewater treatment systems represents a significant step towards achieving sustainability goals. By promoting energy self-sufficiency, reducing emissions, and enhancing operational efficiency, these technologies contribute to creating a more resilient and environmentally friendly infrastructure. However, continued investment in research, development, and implementation is essential to further improve the effectiveness and affordability of these technologies. Ultimately, by embracing innovation and leveraging the power of technology, we can build a more sustainable future for generations to come.

Modern wastewater treatment technologies have achieved significant success in ensuring the efficiency and sustainability of water resource utilization. Development directions include green technologies, the use of renewable energy sources, and automation process aimed at improving the quality of treated water and minimizing environmental impact. The overview of current achievements and trends in wastewater treatment reflects the rapid progress in this vital technology field [1−4].

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