НАУЧНЫЙ ЖУРНАЛ
НАУКА И МИРОВОЗЗРЕНИЕ

УДК-665.73

DEVELOPMENT OF TECHNOLOGY FOR REMOVING BENZENE FROM THE WASTEWATERS OF THE NATURAL GAS TO GASOLINE PLANT IN AHAL REGION OF TURKMENISTAN

Bekdurdyyeva Svetlana

student of the Oguzhan Engineering Technologies University of Turkmenistan
Ashgabat, Turkmenistan

Hudayberdiyeva Enejan

Supervisor: Lecturer of the Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Abstract

The presence of benzene in industrial wastewater is a significant environmental and health concern, particularly in petrochemical and natural gas processing industries. In the Ahal region of Turkmenistan, natural gas to gasoline plants generate wastewater that contains high levels of benzene, a carcinogenic substance. This article focuses on the development of a technology aimed at removing benzene from the wastewater of these plants. We explore various treatment methods, including physical, chemical, and biological approaches, and propose an optimized system for effective benzene removal. The article also discusses the environmental implications, technological feasibility, and economic considerations involved in implementing the proposed treatment technology in Turkmenistan's industrial setting.

Introduction

The Ahal region of Turkmenistan is home to several natural gas processing facilities, including plants that convert natural gas into gasoline. These facilities often produce wastewater as a byproduct, which contains a range of contaminants, with **benzene** being one of the most concerning. Benzene, a volatile organic compound (VOC), is toxic to both humans and aquatic life, and its presence in wastewater poses significant environmental and health risks.

The treatment of industrial wastewater containing benzene is a priority for both environmental protection and regulatory compliance. Removing benzene from wastewater requires an effective, efficient, and cost-effective technology.

This article aims to develop a comprehensive technology for the removal of benzene from the wastewater generated by the natural gas to gasoline plant in the Ahal region, focusing on the identification of suitable treatment methods and the optimization of existing technologies.

Overview of the Ahal Region's Natural Gas to Gasoline Plants

Natural gas to gasoline plants in the Ahal region of Turkmenistan play a crucial role in the country's economy by converting natural gas into gasoline and other petroleum products. However, the conversion processes generate wastewater containing various organic and inorganic pollutants, including benzene.

The primary sources of wastewater in these plants include:

- Cooling water systems

- Process wastewater from refining and distillation units

- Runoff from storage and handling of chemicals

Given the importance of the industry to the national economy, ensuring the safe treatment and disposal of wastewater is critical to maintaining both environmental sustainability and public health.

Environmental and Health Risks of Benzene in Wastewater

Benzene is a highly toxic compound that can cause severe health problems when humans or wildlife are exposed to it, even at low concentrations. The risks associated with benzene in wastewater include:

- Health Risks to Humans: Benzene exposure can lead to a range of health issues, including **leukemia**, **anemia**, and **nervous system damage**. Long-term exposure to benzene can result in chronic health conditions.

- Ecological Impact: Benzene is harmful to aquatic ecosystems, as it is toxic to fish and other aquatic organisms. Even low concentrations of benzene can disrupt ecosystems, affecting biodiversity and water quality.

- Regulatory Compliance: The presence of benzene in wastewater violates many environmental regulations that limit the amount of hazardous substances in industrial effluents. Compliance with these regulations is necessary to avoid fines and operational shutdowns.

Thus, addressing the benzene contamination in wastewater is both an environmental and regulatory priority for the natural gas to gasoline plants in the Ahal region.

Methods for Removing Benzene from Wastewater

Various methods are available for removing benzene from wastewater. These methods can be broadly categorized into physical, chemical, and biological treatment technologies. The choice of method depends on factors such as the concentration of benzene, the volume of wastewater, the available budget, and the environmental impact.

Physical Methods

- Adsorption: Adsorption involves the use of materials like activated carbon or zeolites to capture and remove benzene from wastewater. Adsorption is highly effective for low to moderate concentrations of benzene, but it requires frequent regeneration or replacement of the adsorbent materials.

- Air Stripping: Air stripping involves the use of aeration to volatilize benzene from water. The contaminated air is then treated using carbon adsorption or other methods. This method is effective when the benzene concentration is high but may require significant energy input.

Chemical Methods

- Oxidation: Oxidation processes, such as ozonation or chlorination, involve the introduction of powerful oxidants to break down benzene into non-toxic byproducts. However, these processes can generate hazardous byproducts and require careful handling of chemicals.

- Chemical Precipitation: Chemical precipitation is used to remove benzene in the form of **complex compounds** with certain chemical agents. While this method can be effective for certain types of contaminants, it is generally less suitable for volatile organic compounds like benzene.

- Advanced Oxidation Processes (AOPs): AOPs, such as hydrogen peroxide combined with UV light or ozone, can break down benzene molecules into simpler, less harmful substances. These processes are highly effective but may be costly and energy-intensive.

Biological Methods

- Bioremediation: Bioremediation uses microorganisms to degrade organic pollutants like benzene. Specialized bacteria can metabolize benzene as a carbon source, converting it into harmless byproducts. However, bioremediation typically requires careful control of environmental conditions (such as temperature, pH, and oxygen levels) and is most effective for low concentrations of benzene.

- Constructed Wetlands: Constructed wetlands, which use plant roots and microbial action to treat wastewater, offer a sustainable and low-cost solution for removing organic pollutants like benzene. Though effective for small-scale applications, they may not be suitable for large-scale industrial plants.

Proposed Technology for Benzene Removal in the Ahal Region

Based on the available methods and the specific needs of the natural gas to gasoline plant in the Ahal region, a hybrid treatment system that combines physical, chemical, and biological methods is proposed for the removal of benzene from wastewater. This system aims to maximize the removal efficiency while minimizing operational costs and environmental impact.

Phase 1: Primary Treatment (Air Stripping and Adsorption)

- Air Stripping will be used as a primary treatment to volatilize benzene from the wastewater. This method is cost-effective and will help remove the majority of the benzene from the effluent.

- The air containing benzene will then pass through an activated carbon filter to adsorb the remaining volatile compounds, including benzene.

Phase 2: Secondary Treatment (Advanced Oxidation)

After the primary treatment, advanced oxidation processes such as ozonation will be employed to break down any remaining benzene and organic compounds in the wastewater. This will ensure that the treated water meets regulatory standards for discharge.

Phase 3: Tertiary Treatment (Bioremediation)

To further reduce the residual benzene concentrations, a bioremediation step will be introduced. This will involve introducing specialized microorganisms capable of metabolizing benzene. The bioremediation process will be optimized to work under controlled conditions, ensuring maximum degradation of the toxic compound.

Monitoring and Optimization

Continuous monitoring of key parameters, such as pH, temperature, dissolved oxygen, and benzene concentration, will be essential to ensure the system is operating efficiently. Automated systems will be installed to adjust process parameters and optimize performance.

Economic and Environmental Impact

The proposed technology for benzene removal in wastewater offers several benefits:

Environmental Benefits

- Reduced Pollution: The treatment system will significantly reduce benzene concentrations in the effluent, thereby minimizing the environmental impact on water bodies and aquatic ecosystems.

- Sustainable Practices: The hybrid system incorporates both physical and biological methods, contributing to more sustainable and eco-friendly wastewater treatment practices.

Economic Considerations

- Cost-Effectiveness: Although the initial investment in the treatment system may be significant, the long-term savings from avoiding fines for environmental violations and improving operational efficiency will outweigh the costs.

- Energy Efficiency: The combination of air stripping, adsorption, and biological treatment ensures that energy use is minimized, making the system more cost-effective in the long run.

Conclusion

The development of an efficient and cost-effective technology for removing benzene from wastewater is crucial for ensuring the environmental sustainability of the natural gas to gasoline plant in the Ahal region of Turkmenistan. The proposed hybrid treatment system, combining air stripping, advanced oxidation, and bioremediation, offers a viable solution for removing benzene and other organic pollutants from wastewater. By implementing this technology, the plant can comply with environmental regulations, reduce its ecological footprint, and contribute to the long-term sustainability of the region.