


Chapter 12

Water Treatment and Sustainable Chemistry: A Review

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ABSTRACT

Water treatment is a cornerstone of public health and environmental protection, yet the challenges of increasing global water demand, pollution, and climate change necessitate innovative and sustainable solutions. This review explores advancements in sustainable chemistry for water treatment, emphasizing green methodologies and resource-efficient technologies. Key approaches include the development of biodegradable adsorbents, nanomaterials, and photocatalysts for contaminant removal. These innovations reduce reliance on harmful chemicals and improve the efficiency of processes such as adsorption, membrane filtration, and advanced oxidation. Emerging strategies like bio-inspired and waste-to-resource technologies highlight

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the potential for circular economy integration in water treatment.

1. INTRODUCTION

Importance of water treatment in global sustainability

Water treatment plays a crucial role in advancing global sustainability by ensuring access to clean and safe water, promoting public health, supporting ecosystems, and enabling economic development. As the global population grows and environmental challenges intensify, effective water treatment systems become essential to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 6, which focuses on clean water and sanitation for all. Access to clean water is fundamental to human health and well-being. Contaminated water is a leading cause of waterborne diseases, such as cholera and dysentery, which disproportionately affect vulnerable populations, especially in developing countries. According to the World Health Organization (WHO), over 2 billion people globally lack access to safe drinking water, contributing to significant health and economic burdens. Advanced water treatment technologies, such as filtration, disinfection, and desalination, remove harmful pathogens, pollutants, and contaminants, reducing the prevalence of disease and improving quality of life. By prioritizing water treatment, communities can safeguard public health and enhance resilience to health crises (United Nations, n.d.). Water treatment is also vital for preserving ecosystems and maintaining biodiversity. Pollutants from industrial discharges, agricultural runoff, and untreated sewage can degrade aquatic habitats, harm wildlife, and disrupt ecological balance. Effective treatment processes, including biological and chemical treatments, help mitigate these impacts by removing pollutants before they reach natural water bodies. Additionally, the reuse of treated wastewater can alleviate pressure on freshwater resources, promoting water conservation and supporting ecosystems during periods of scarcity (World Health Organization (WHO), 2019). Economic development is closely tied to water quality and availability. Industries such as agriculture, energy, and manufacturing rely heavily on water as a critical resource. Contaminated or inadequate water supplies can hinder industrial operations, reduce agricultural productivity, and limit energy generation. Water treatment enables the sustainable use of water resources by ensuring that water meets quality standards required for various applications. For example, in agriculture, treated wastewater can be used for irrigation, reducing the reliance on freshwater and enhancing food security. In urban settings, efficient water treatment systems support infrastructure development and attract investments, driving economic growth. Moreover, water treatment contributes to climate change mitigation and adaptation. As climate change exacerbates water

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