Chapter 2
Challenges in Pharmaceutical and Industrial Wastewater Treatment

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ABSTRACT

The treatment of industrial and pharmaceutical wastewater is a serious environmental problem because these contaminants are toxic and varied, endangering both

DOI: 10.4018/979-8-3693-8487-9.ch002

human health and aquatic ecosystems. The various difficulties involved in treating these complicated effluents are examined in this review paper. An increasing number of contaminants, including pharmaceuticals and endocrine-disrupting chemicals, are emerging, and the wastewater's complex chemical compositions, which combine organic and inorganic materials, are major issues. By using microorganisms to break down pollutants, bioremediation has become more effective through the development of microbial engineering. The analysis accentuates the need of constant efforts towards research and development, the dynamic nature of legislative and regulatory frameworks, the need for industry and government organizations to collaborate the public awareness. This thorough analysis emphasizes how urgently more research, funding, and legislative support are needed to create efficient and sustainable wastewater treatment techniques.

INTRODUCTION

Wastewater treatment is a crucial concern for the environment and public health, especially in the industrial and pharmaceutical sectors. The complicated and diverse nature of wastewater produced by various sectors presents considerable challenges in the treatment procedures, necessitating the implementation of innovative technological approaches and rigorous regulatory structures. The volume and complexities of the wastewater produced have grown along with global industrialization and pharmaceutical manufacture. The environmental effects of untreated or insufficiently treated wastewater, which may pollute water bodies, destroy aquatic ecosystems, and present significant health risks to humans, have become progressively alarming as a consequence (Massima Mouele et al., 2021).

Wastewater treatment techniques have evolved over centuries, with early approaches focused primarily on the elimination of apparent contaminants and the management of bad smells. Aqueducts and sewers are two of the primitive wastewater management systems that mediaeval civilizations like the Greeks and Romans developed. However, the treatment of industrial effluents was not addressed by these systems, which were primarily intended to prevent urban flooding. The 18th and 19th centuries witnessed the beginning of the Industrial Revolution, a period which made the release of industrial effluent a serious environmental problem. Large amounts of untreated wastewater were released by factories and manufacturing industries into rivers and lakes, causing significant environmental and public health issues (Lofrano & Brown, 2010). It was at this stage that the necessity for progressively advanced techniques for treating wastewater became evident. With the advent of biological treatment techniques like activated sludge in the late 19th and early 20th centuries, the development of contemporary wastewater treatment methods got underway.