

Chapter 16

Challenges and Future of Biotechnology–Driven Wastewater Treatment for Sustainable Industrial Management

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ABSTRACT

Wastewater treatment using biotechnological approaches provides environmental-friendly ways of treating industrial effluents for pollution control and resource realization. The capability of microbial consortia, enzymatic machinery and genetically modified microorganisms to metabolize high molecular weight compounds including heavy metals, synthetic chemicals and toxic organic substrates outlines this approach. However, there are issues with the concept being implemented such as operation problems, problems with scalability, and the question of exactly how friendly genetically modified species are to the environment. The new technologies include metagenomics, synthetic biology, and hybrid systems of bio and physical treatment that generally improve treatment efficacy and pollutant removal.

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INTRODUCTION

Globalization and rapid industrialization and urbanization have increased the generation of wastewater at a very high rate and thus a global concern. Industries, ranging from pharmaceuticals, textiles, agriculture, manufacturing and many more, release millions of gallons of wastewater containing diverse and challenging pollutants like heavy metals, organic compounds, bacteria, and viruses as well as traces of pharmaceuticals. This problem is worsened by the increasing population in urban areas due to the high amounts of domestic wastewater that are produced in the urban areas, which contain high concentrations of nutrients, oils, grease as well as microplastics. Wastewater flow and content have therefore increased and are becoming more complex posing serious hazards to water bodies such as pollution, eutrophication, and degradation of aquatic ecosystems. Also, many developing parts of the world do not have the necessary infrastructure to handle this wastewater, and the discharge of such water treats or poorly treats water and thus poses severe public health risks to consumers since they provide drinking water. The above challenge is made even more complex by the global water scarcity problem, hence the need to integrate water resources management. Having clean water being becoming scarce daily, it is wise to treat wastewater so that it can be reused adequately. The lack of response to these wastewater challenges, therefore, poses serious environmental and socio-economic risks such as loss of biodiversity, poor yields in agricultural activity, and negative effects on the health of people. To address these risks, there is the urgent need to develop and apply improved wastewater treatment technologies that address the range of pollution loads that contemporary industries and expanding populations produce and that profitably utilize water in a sustainable way. (Poustie et al., 2020)

Energy is the force needed to accomplish work, and it can be utilized efficiently on numerous occasions, it also leads to wastage of energy making it a restrictive factor in the society. Chemicals are accession in all sectors, and they play a vital role in the process of producing goods. Chemicals used extensively contribute to pollution and most of the used substances are not recovered hence becoming Historical and conventional techniques that have been used in wastewater management include, primary sedimentation, activated sludge processes, and chemical treatment. However, these methods possess several serious drawbacks which limit their applicability in solving modern tasks connected with wastewater. This is one of the major demerits of conventional treatment process since most of them are power intensive. For instance, activated sludge systems demand high energy input on aeration- a process that is critical in breaking down organic matter by aerobes. This aspect not only adds to the expenses incurred by these plants but also impacts on the environment with a major chunk of it going to energy use. Also, conventional convectional process has many drawbacks in which some of them include use of chemical reagents like

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