Chapter 12
Biological Nutrient Removal by Suspended Growth Systems

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ABSTRACT

Nutrients contribute to the wellbeing of water bodies. However, excessive enrichment of water bodies by nutrients could harm aquatic organisms. Some of the severe environmental problems caused by nutrients on water bodies include eutrophication and algal bloom. In children, consumption of nitrate-polluted water causes methaemoglobinemia. Consumption of food irrigated with nutrient-polluted wastewater has been associated with several health implications. These nutrients primarily originate from point and non-point sources. Several biological-suspended treatment systems have been developed to reduce nutrients to acceptable limits prior to discharge into water bodies. These treatment systems are associated with several merits and demerits. This chapter explores the implications of water body enrichment by nutrients and their impact on health, economy, and environment. Furthermore, some suspended growth treatment systems applied for the treatment of nutrient polluted wastewater were explored.

INTRODUCTION

Water is an essential commodity commonly used in almost all activities. Fresh water resources are the main source of water supply in many Countries. However, recent projections have indicated that by 2025, about 60% of the global population could suffer water scarcity (Seckler, 1998). Higher living standards, urbanization and population growth will increase the demand for good quality water. At the

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same time, sewage flows will increase and more irrigation water will be required in agriculture to meet the increasing demands for the growing populations. Environmental concerns such as wildlife refuges, recreation, scenic values and riparian habitats will also require more water (Bouwer, 2000; Qadir et al., 2007). As a result, a significant freshwater shortage could affect economic development, human health and well-being of many countries.

Wastewater treatment has been used to supplement limited freshwater resources in many countries. Various industries generate different contaminated wastewater which is characterized in terms of their physical, biological and chemical compositions. Three significant methods can be used to treat these wastewaters and they include primary, secondary and tertiary/advanced treatment methods. Primary methods are used to separate suspended solids, floating and settleable materials from water; secondary methods are used to remove biodegradable waste and some suspended solids while tertiary methods are used for the removal residual suspended solids after secondary treatment. Non-biodegradable contaminants present severe health and environmental challenges. Tertiary wastewater treatment processes can be used to treat these contaminants. However, most of these conventional methods are associated with some level of demerits and setbacks which affect their efficiency (Sagiv & Semiat, 2004).

Biological Treatment processes are aged long, well established techniques for wastewater treatment (EH Ezechi et al., 2015; Mann & Stephenson, 1997). They are primarily used for the removal of biodegradable compounds, organic matter and nutrients from wastewater. Its principle depends on the interaction of microorganisms with wastewater contaminants. It is reliable particularly in nutrient removal from wastewater (Obaja et al., 2005) and biogas production (Poh & Chong, 2009). It is a dynamic process because it could be configured in various designs according to the objective of the operator. It has numerous advantages such as low capital and operating cost, high organic matter removal efficiency and biogas production. The generation of highly polluted wastewater from various industries and the advent of emerging contaminants have continuously led to the modification of biological systems to meet the increasingly stringent discharge standards. Although a significant number of successes have been achieved with various system modifications, on-going efforts have focused on optimizing these systems to achieve greater benefits. The performance of these suspended growth systems has significant impact on the receiving water bodies. Thus, it is imperative that these systems achieve high nutrient removal from wastewater before discharge to avoid water body pollution.

From the availability standpoints, a higher percentage (97%) of the planet's water occurs as saltwater in the oceans, whereas two-third of the remaining 3% occurs as snow and ice in polar and mountainous regions. Liquid fresh water represents only about 1% of the global water. Consequently, about 98% of the liquid fresh water are present as groundwater while less than 2% occurs in the form of streams and lakes (Bouwer, 1978). These limited available water resources (lakes and rivers) are constantly exposed to the dangers of pollution from natural disaster such as flood and anthropogenic sources such as poorly treated wastewater effluents. These challenges require immediate operational re-adjustment to protect the limited water bodies from dangers of nutrient pollution. The objective of this chapter is to identify the primary sources of nutrients in waterbodies, highlight the environmental impacts of waterbody pollution and discuss the primary method of nutrient removal from wastewater. The discussion on nutrient removal from wastewater is limited to aerobic and anaerobic suspended growth processes earlier developed and the recent modified configurations.