Chapter 21
Membrane Technology for Treatment of Pharmaceutical Wastewaters: A Novel Approach

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ABSTRACT

It is estimated 90% of the available water resources will be expended in 15 years and by 2025, nearly 60% of the world population will have scarcity of water if the rate of consumption continues at its present level. The mounting use of pharmaceuticals, with enhanced production, have driven these industrial effluents into so-called emerging pollutants that have become a new environmental problem. Pharmaceutical wastewater, specifically categorized by complex components, are ending up polluting natural water bodies, making it necessary to remove such substances from the wastewaters to prevent harm to the natural environment. Amid options available for treating these effluents, biological processes are cost-effective and environmentally safe alternatives to chemical methods. One of the recent advances includes use of membrane technology. Among these, membrane bioreactor and reverse osmosis technologies are becoming advanced and promising options for wastewater treatment, and reuse at a reduced price is making it economically feasible.

DOI: 10.4018/978-1-7998-0369-0.ch021

INTRODUCTION

Fresh and potable water is becoming increasingly unavailable in most parts of the world. In the developing world, over one million people are without access to safe drinking water, 83% of which live in pastoral communities (UNICEF 2010). Clean drinking water is essential to human health and wellbeing (Naiman et al., 2011). Despite well-intended efforts, intervention attempts to sustainably lower these statistics have been largely unsuccessful. The water crisis is being faced by several underdeveloped zones of the world, on the other hand, industrialized nations face issues with reference to the quality of water for industrial and public use. Over 90% of the available freshwater resources are going to be consumed during the next coming fifteen years. Studies have found that 30% to 50% of rural water projects, whether water systems or wells, fail between 3- and 5-years following construction (Walters et al., 2015) and this has been linked to approximately 4 billion diarrhea outbreaks and over 5 million annual deaths worldwide (Sobsey et al., 2008, WHO 2009), mostly in developing countries, especially in rapidly expanding urban fringes, Poor rural areas and indigenous communities (Lipton, 1977 and Ryser et al. 2010). Waterborne diseases and related fatality are commonly associated with lesser developed nations and remote areas where municipal water system can be impractical in these settings (Shannon et al., 2010). Many studies have revealed that the significant causes of these clean water shortages are linked to the upsurge in industrial activities and the attendant pollution menace, improper management unfavourable policy implementation of water-related projects and alarming population growth (Ayandiran et al., 2018). Moreover, the demand for good quality water towards several purposes is continuously increasing, which has enhanced concerns on treatment and reuse of water meeting the strictest standards (Jyoti et al., 2013).

The rise in the pharmaceutical industry is driven by global needs. Enhanced environmental disturbances due to globalization and urbanization are the prime driving forces for mounting demand for improved medication as well as health supplements for every age group and geographical location. The overwhelming use of pharmaceuticals has become a challenge with reference to the effluents generated in their production. Concern towards the presence of pharmaceutical chemicals owes to the fact of their nature being lipophilic, non-biodegradable and affecting various biological activities (Bound & Voulvoulis, 2005; Houk, 1992; Velagaleti & Burns, 2006).

CHARACTERISTICS OF PHARMACEUTICAL WASTEWATERS

Water is a crucial raw material for pharmaceutical and chemical manufacturing. Persistent and good quality water supply is required for a varied range of operations including production, material processing, and cooling. This results in the generation of non-uniform waste streams at any point in the processing period (Frick et al., 2005). Furthermore, majority of pharmaceutical industries operate as a batch process using different raw materials as well as production processes resulting in the release of varied nature of wastewater (Rizwan et al., 2013; CAO et al., 2013; Guo et al., 2017). General characterization of pharmaceutical wastewater is presented in Table 1 (Rong-Rong et al., 2003).

Various processes in the pharmaceutical manufacturing include manufacturing, extracting, processing, purification and packaging of biological and chemical materials in the forms of solid or liquid for use as medication by humans and animals (Jozala et al., 2016). Majority of wastewaters from a pharmaceutical industry originate from the processes of synthesis and formulation of drugs (Kessler, 2010).