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Performance Evaluation of Microbial Desalination Cells with Different Anode Surface Area on Phenol Removal and Energy Harvesting

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Extended Abstract

There is wide concern about phenol pollution, where many forms of industrial effluent contain organic chemicals, including phenol, which is known to be particularly harmful to ecosystems [1]. Industries such as oil refining, pesticide production, petrochemicals, and coke production are significant sources of phenol in wastewater discharge. Phenol is a major environmental concern since it is toxic to living things, even in trace amounts and can cause severe health problems to the skin, eyes, lungs, liver, kidneys, and central nervous system [2]. As a result, phenol in surface water has strict limits imposed by international authorities. Phenol has an inhibitory effect on the microorganism used in biological treatment. Chemical oxidation, osmosis, ion exchange, electrochemical techniques, membrane filtration, precipitation, and coagulation are among the technologies studied for their potential to remove phenol from wastewater. However, they also have drawbacks, such as high costs and harmful by-products [3]. The desalination of brackish and saltwater water is also essential for human consumption and certain industrial processes. Most current desalination methods, including reverse osmosis and thermal treatment, are associated with high costs due to the massive amount of energy required for their operation [4]. Bioelectrochemical systems, which include microbial fuel cells (MFC) and microbial desalination cells (MDC), are considered sustainable technologies [5]. The MDC is a desalination and power generation system. It is estimated that 2 kWh could be generated from treating 1 m^3 of domestic wastewater using MDC. The anode and cathode chambers of a typical MDC are separated by anion and cation exchange membranes at certain distances, creating a third chamber, the desalination chamber, distinct from the dual chambers of microbial fuel cells.

Concerning the cost-effective methods for desalination and phenol removal, MDC may be a viable option since it generates energy that can be captured and used later. The performance of MDC is susceptible to a wide range of key factors. The anode's surface area is one of these factors. The removal efficiencies of contaminants and the amount of energy harvesting are both directly related to the amount of electrogenic microorganisms present in the system. Therefore, this research aimed to examine the impact of the anode surface area on the energy harvesting and desalination rates in the middle chamber, as well as the efficiency with which phenol was removed in the anode chamber. Our research team proved the sustainability of MDC for the removal of phenol in previous research. In this study, we continue studying enhancing the phenol removal in MDC systems, specifically, obtaining a correlation between the anode surface area and MDC performance under different operating conditions; various phenol and salt concentrations were investigated. Results showed that doubling the anode's surface area improved the performance of MDC in terms of voltage generation by 45%, phenol removal by 24%, and desalination rate by 9%. Our future work will study the suitability of microbial desalination cells in small sanitation systems in developing countries such as Egypt, where many of these developing countries suffer from a lack of sanitation services [6].

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