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Evolution of Seawater Desalination and Petroleum Refinery Wastewater Treatment in a Microbial Desalination Cell

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Petroleum refining, not only consumes large quantities of water but also generates large quantities of wastewater. Large quantities of petroleum refinery wastewater are generated worldwide, approximately 3.5–5 m^3 of wastewater generated per ton of crude oil processed. This wastewater is considered as a major source of environmental pollution. Various chemical and biologically based technologies have been developed for the treatment of petroleum refinery wastewater such as reverse osmosis, membrane filtration, electrocoagulation, anaerobic tank, anaerobic baffled reactor, aerated filter and bio-contact oxidation. In the last decade, biological treatment methods of petroleum refinery wastewater were developed because of the high cost of chemical treatment methods and these methods are also more environmental friendly.

In this study, we demonstrate for the first time that it is possible to remove salt from saltwater and generate electricity while using petroleum refinery wastewater as an anodic substrate in the three chamber microbial desalination cell (MDC). MDC insinuates a new method for treating petroleum refinery wastewater and concurrently salt removal from seawater with bioelectricity generation. MDC was developed from microbial fuel cell (MFCs) concept. In this device, desalination and wastewater treatment are conducted in one system. MDC has an enormous potential as a low-cost desalination process with wastewater treatment and other benefits. MDC is a new technique in which saltwater can be desalinated without using any external energy source. The exoelectrogenic-bacteria are used in MDC reactor to oxidize biodegradable substrate in the anodic chamber and transfer the produced electrons to the anode electrode.

In this study, petroleum refinery wastewater was treated in MDC using three different initial salt concentrations of 5 g/l, 20 g/L and real seawater in desalination chamber along with two separate catholyte (phosphate buffer solution

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and acidified water). All the three chamber MDC operations were carried out in batch mode. The maximum % COD removals of 71 and 64 were obtained using initial salt concentration of 20 g/L with MDC operated with acidified and phosphate buffer solution as catholyte respectively. The maximum desalination efficiency of 19.9% and 19.1 % were obtained in MDC operated with real seawater using PBS and acidified water as catholyte respectively. The scanning electron microscope images investigation confirmed the presence of microbial biofilm on the anode electrode and anion exchange membrane surface. The MDC performed better with acidified water compared to PBS as catholyte. The above obtained results demonstrated the feasibility of using MDC technologies to generate bioelectricity, seawater desalination and simultaneously treat complex petroleum refinery wastewater, although further studies are required to scale up and optimize the process. The MDCs are emerged as a self-energy driven device for wastewater treatment and seawater desalination at the lab scale. But still MDCs needs further research before it can be implemented at large scale.

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