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Evaluating microbial desalination kinetics and efficiency at various substrate loadings and initial salinity

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Abstract

The importance of desalination technologies and research is increasing every year, as a significant number of countries do not have adequate drinking water supplies or their distribution does not allow for sufficient supply. By reducing the salt concentration of sea and brackish waters (e.g. using reverse osmosis), it is possible to produce water suitable for consumption and agricultural usage. Nowadays more research is being published that uses bioelectrochemical systems (BES) for desalination, especially microbial desalination cells (MDC).

In this study, a comparative evaluation of the effect of different substrate and initial NaCl concentration on the desalination kinetics and efficiency is presented. In addition, the membrane-related voltage losses in MDC are analysed. The mesurements with the three different substrate concentration (C_{Ac}= 2.5, 5.0 and 7.5mM acetate) resulted in different desalination efficiency with 35 gL^{-1} NaCl solution using mixed culture three-chamber MDC. The higher loading of acetate resulted in higher current density, but the current generation kinetics was inversely proportional to C_{Ac}. Evaluating the effect of the initial NaCl concentration (15, 20, 25 and 35 gL^{-1}) on the MDC performance showed that it determined the desalination kinetics significantly only at the early stage of the operation. Initial salinity had a significant effect on the NaCl removal during the 24 h batch cycles. At 35 gL^{-1}, up to 42 % removal could be achieved compared to ~ 27 % in case of C_{NaCl}=15 gL^{-1}. Meanwhile, final desalination rates were independent of C_{NaCl}. Current efficiencies decreased from 40-100% to 20-35% during the operational cycle. Resistance and loss analysis revealed that mass transfer resistance was the dominating factor of MDC operation, and at low C_{NaCl}=15 gL^{-1} more severe concentration polarization occurred.

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