

Capacitive deionization for water desalination using $\text{Na}_3\text{Fe}_2(\text{PO}_4)_3$ /activated carbon composite electrodes

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DOI: <https://doi.org/10.1016/j.jelechem.2025.119252>

Abstract

Water desalination technologies are attracting growing global attention as critical solutions to address water scarcity torturing mankind worldwide. Capacitive deionization (CDI) is an emerging desalination technology that offers multiple advantages, including low voltage operation and diverse material options for electrode synthesis. In this work the $\text{Na}_3\text{Fe}_2(\text{PO}_4)_3$ (NFP) is composited with the activated carbon (AC) to synthesize AC/NFP composites and tested in water desalination. The characterization results from several techniques reveal the successful composite synthesis. When tested in CDI experiments for brackish water desalination much higher salt removal capacity of around 22.0 was attained by AC/NFP 1:2 compared with 18.65 mg/g of AC electrode. Also, the synthesized AC/NFP 1:2 retain satisfactorily performance efficiency when cycled for twenty runs. However, owing to low resistance at the electrode-electrolyte interface the AC is more energy efficient as it exhibits much low energy consumption of about 0.056 kWh/m^3 compared with the AC/NFP 1:2 cell attained 0.15 kWh/m^3 . This study reveals a trade-off between performance and efficiency: while the AC/NFP 1:2 cell exhibits higher salt removal capacity, it consumes significantly more energy than the AC electrode, which demonstrate superior energy efficiency.