Coupling High-Efficient Redox Flow Desalination and Rejected Brine Towards Mineralization of CO2

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Both the disposal of rejected brine and CO2 emission are the most significant challenges associated with the desalination process. Herein, we present an integrated approach that utilizes a redox flow battery (RFB) employing potassium ferrocyanide/ferricyanide species with a low voltage (0.4 V) to drive the system. The rejected brine was then subjected to mineralization reactions with CO2 and the alkaline basalt from Penghu Island. This study investigated the effects of voltage, salt removal rate, recovery rate, energy consumption, and CO2 mineralization. The seawater feed (conductivity: 46.6 mS/cm) can be continuously desalinated to 0.5 mS/cm in the diluted stream, while it increases to 149.0 mS/cm in the concentrated stream. This resulted in a high charge efficiency of 94.0%, energy consumption of 6.3 kWh/m3, and a high recovery rate of 80.0%. The innovation of this system lies in the fact that the recovery rate in the RFB can be adjusted to increase the concentration of ions in the rejected brine for rapid and permanent CO2 storage. In the CO2 mineralization experiments, the changes in Ca2+, Mg2+ and pH values in the solution suggest the formation of CaCO3, MgCO3. It was also evident from Energy-dispersive X-ray spectroscopy measurements. During a 96-hour period, the rejected brine captured 13.7% of the saturated carbon dioxide in the solution, whereas seawater only captured 0.9%. This demonstrates that CO2 mineralizes into carbonates much faster in the rejected brine. The low operating voltage required in the RFB system can be powered by solar energy. The combination of RFB and CO2 mineralization could result in carbon-negative seawater desalination, enhancing storage security and sustainability.

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