Assessing Reverse Electrodialysis Performance: Comparative Analysis of Power Generation Using Rivers from KwaZulu-Natal and Local Seawater

Mfanelo P. Mbokwana[a,*], Peterson T. Ngema[a], Kaniki Tumba[b], Nkululeko Nkosi[b]

Abstract—The global urgency to address climate change highlights the necessity for clean energy sources. Africa, amidst a climate crisis, sees potential in its coastlines for sustainable energy. However, South Africa faces a paradox, relying on coal for power despite global efforts. This exacerbates environmental concerns and leads to persistent load shedding, highlighting the need for a delicate balance between energy demands and sustainable solutions. Bridging this gap is crucial for both South Africa and the global initiative against climate change. Salinity gradient energy emerges as a noteworthy alternative, holding significant potential for a cleaner and sustainable future. Among the extensively researched techniques for harnessing this energy, Reverse Electrodialysis (RED) is notably prominent. In this study, we evaluated the performance of a Reverse Electrodialysis stack using water samples from rivers in KwaZulu-Natal and local seawater from the Indian ocean. The rivers sampled include Umgeni, Umzimkhulu, and Umkomaas. The experiment investigated the impact of varying feed water temperature (25–40 ℃) and flow rate (900–1550 mL/min) on a RED system, focusing on Open Circuit Voltage (OCV) and power density. The conductivity of the river water samples ranged from 821 to 1849 µS/cm, with Umgeni exhibiting the lowest conductivity and Umkomaas the highest. The highest recorded power density and OCV were 9 W/m^2 and 4.64 V, respectively, observed with the Umgeni water sample. Results indicate that temperature had a more significant effect on OCV and power density than flow rate, with the highest measurements consistently corresponding to higher temperatures in all cases. Notably, Umgeni water sample showed elevated internal resistance, likely attributed to its higher levels of divalent ions. These findings provide valuable insights into the performance variations among the river water samples.

Keywords— Reverse Electrodialysis, KwaZulu Natal Rivers, Open Circuit Voltage, Power Density

[a]Department of Chemical Engineering, Green Engineering Research Group (GERG), Cemical thermodynamics, Durban University of Technology, Steve Biko Campus, Durban, 4001, South Africa

[b]Department of Chemical Engineering, Materials and Separations Research Group (TMSRG), Mangosuthu University of Technology, uMlazi, Durban, 4031, South Africa

*Corresponding author: Mfanelo Mbokwana

https://doi.org/10.17758/IICBE6.C1124101