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ENERGY GENERATION BY REVERSE ELECTRODIALYSIS USING ION SELECTIVE MEMBRANES

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Abstract: The aim of this work is to conduct a systematic study of a technology to generate electrical power from mixing salt water and fresh water. The current global scenario has motivated the new environmentally friendly and more immediately available source of energy. Renewable energy can be captured from the mixing of salt water and fresh water in reverse electrodialysis. The salinity difference between these waters can act as a power source with the use of ion selective membranes. The source of energy is the chemical energy associated with the solvation of salts. The energy could be released when two streams with different concentration are brought in contact. wherever two solution of different salinity exist, a salinity gradient energy can be obtained. The ion selective membranes allow either cations or anions to migrate, a potential difference is created when water with a different concentration is at either side of this membrane. With the help of electrodes ionic current is converted into an electrical current. By adapting this technology the alternative and sustainable source of energy can be obtained.

Keywords : **Reverse Electodialysis, Salinity gradient, chemical energy**

INTRODUCTION

Historic consumption of energy resources has shown significant dependence on traditional fuels and a lack of contribution from renewable fuels. In 2006, global consumption percentages for various energy resources were: petroleum-based liquids, coal, natural gas, hydro-electric, nuclearelectric, and renewable techniques. Renewable energy production is lacking due to the state of their development, inadequate investing, and required scale for significant power production. Despite these drawbacks, contributions from renewable power production must increase in order to satisfy the limits and demands of the future. Renewable systems acquire natural fuel from ambient environments and numerous mechanisms have been proposed. Heat, thermal electricity, and photovoltaic power systems harness energy from influxes of solar radiation; wind farms utilize turbine systems to convert mechanical energy into electrical power.

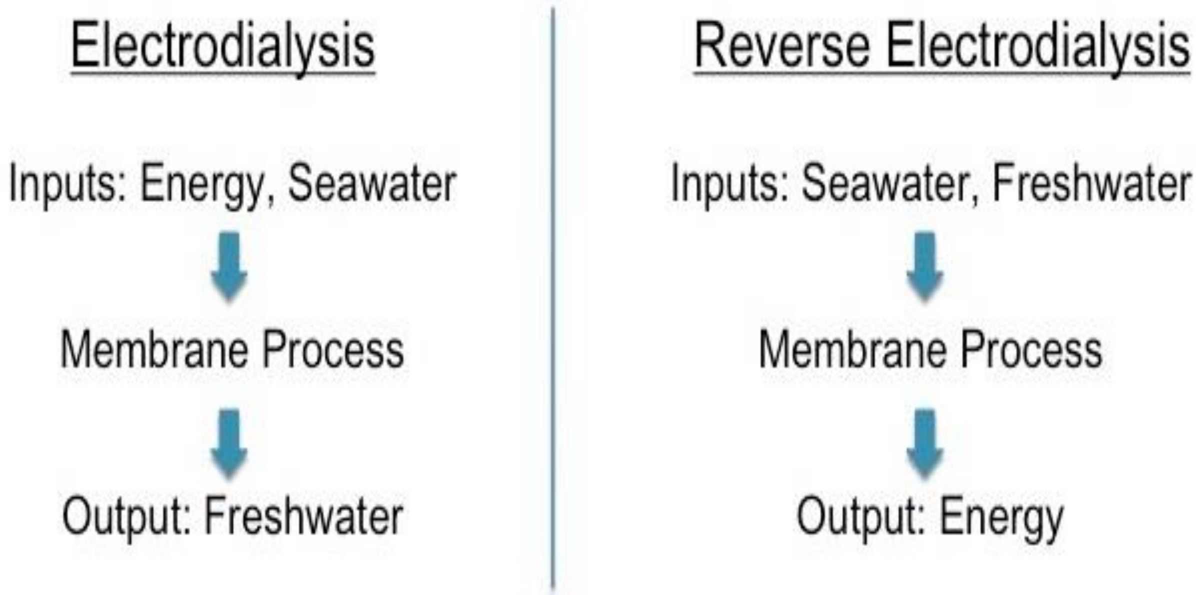

Figure 1: Conceptual flow for ED and RED membrane processes

EXPERIMENTAL APPROACH

Distinct flow ports were designed on the top and bottom of each spacer. When several spacers were aligned in a repeating, inverted fashion, flow routes were established for two separate solutions within the membrane stack. Flow barriers diverted each feed to alternating control volumes which created the concentration gradient across each membrane. An additional outer membrane was required to seal the exterior cell in the membrane stack. The outer membranes served to maintain selective barriers between the membrane stack and electrode compartments. The charge of the outermost ion exchange membrane had an effect on the transport of the redox couple used in the electrode rinse solution. CEMs had an overall negative charge and attract cations, thus the redox couple must be anionic. During the energy generation process, electrode rinse was circulated through each electrode compartment to convert ionic current into electron current.

$$\text{Cathode: } 2H_2O\ (l) + 2e^- \rightarrow H_2\ (g) + 2OH^-\ (aq)$$
$$\text{Anode: } 2Cl^-\ (aq) \rightarrow Cl_2\ (g) + 2e^-$$
$$\text{Net: } 2H_2O\ (l) + 2Cl^-\ (aq) \rightarrow H_2\ (g) + Cl_2\ (g) + 2OH^-\ (aq)$$

GENERAL PROCEDURE

Under zero-current conditions, the open circuit voltage (OCV) of the membrane module represents the maximum potential difference that can be achieved from the RED system. At the laboratory scale, measuring OCV is directly proportional to power density (W/m^2) which is the primary parameter used to assess power generation capacity. The solution flow rates influenced the hydrodynamic resistance within the mixing compartments. Hydrodynamic resistance contritbuted to the overall internal stack resistance which should be minimized for maximum OCV. At low flow rates, concentration polarization occurd at the membrane-solution interface. The resulting phenomena inhibited ion diffusion and thus a higher internal resistance and lower concentration gradient for salt and water flux.

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CONCLUDING REMARKS

The objective of this study was to observe RED performance with respect to various flow conditions. The results of the flow rate tests are presented above. Overall, variations in flow rate affected the initial, transient stage of power generation. During the transient stage, solutions had not had adequate time to fill the flow compartments, thus faster flow rates would have shorter transient stages. In the later, steady state power generation stage, each flow rate produced very similar OCV levels. Overall the results from the flow studies did not provide any significant conclusions, but highlighted several issues: Higher flow rates promoted turbulent mixing conditions within the mixing compartments which reduced the effects of membrane polarization to maintain ideal diffusive conditions at the membrane surface.

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