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Performance of a RED system with ammonium hydrogen carbonate solutions

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The continuous increase of global energy requirements has raised the interest towards the development of new technologies to recover waste heat. Thermodynamic cycles are traditionally employed to convert heat into power but they can work normally with heat sources at medium-high temperatures. The use of closed-loop salinity gradient power (SGP) technologies has been recently presented as a viable option to generate power using low grade heat, by coupling a SGP unit with a thermally-driven regeneration process in a closed loop where artificial solutions using different salts and solvents can be adopted for the conversion of heat-into-power. Among these, the closed-loop reverse electrodialysis (RED) process presents a number of advantages such as the direct production of electricity, the extreme flexibility in operating conditions and the recently-demonstrated large potentials for industrial scale-up.

Ammonium hydrogen carbonate is a salt suitable for such closed-loop reverse electrodialysis process thanks to its particular properties. At temperatures above 40-45°C, it decomposes into a gaseous phase containing NH_3 and CO_2. Thus, the use of NH_4-HCO_3 solutions for feeding a RED unit would allow their easy regeneration (after the power generation step) just using waste heat in a purposely designed regeneration unit. Up to now, three different applications have been proposed in the literature for the exploitation of NH_4-HCO_3 in "SGP-engines": ammonia-carbon dioxide osmotic heat engine, thermal-driven electrochemical generator (TDEG) and microbial reverse electrodialysis cell (MRC). This work aims at presenting a preliminary experimental investigation for the case of NH_4-HCO_3 in a RED-closed-loop system. Laboratory tests have been carried out to find the best condition maximizing the power density and process performances of a RED unit by investigating a number of operating parameters such as fluid velocity, feed solutions concentration and temperature, flow rates ratios, etc.

Keywords: Reverse electrodialysis, Salinity gradient power, SGP heat engine, Waste heat, Ammonium hydrogen carbonate

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Lab-scale investigation of a pressure retarded osmosis module fed by "non-conventional" salinity gradients

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Power generation from salinity gradient is a viable alternative to produce energy from renewable sources. Pressure retarded osmosis (PRO) has been proposed so far for the exploitation of