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Abstract

This paper reports a life cycle analysis of a combined CO_2 capture and conversion "all-in-one" membrane reactor system. The reactor is composed of a high-temperature mixed electronic and carbonate-ion conductor (MECC) membrane for CO_2 capture and a solid oxide electrolysis cell (SOEC) for CO_2/H_2O co-reduction. The results show that the parasitic energy (PE) using MECC membrane to capture CO_2 is 321 kJ for every kilogram CO_2 captured, less than half of the consumption of the stat-of the-art MEA plant. The energy efficiency of the combined system can reach 82%. A cost analysis further shows that the cost of electricity dictates the price of synthetic fuel produced by the reactor at a lower SOEC area (lower capital cost), while both electricity cost and SOEC capital cost play an important role for higher SOEC area (higher capital cost). Finally, the synthetic fuel produced from Ag-based MECC and NiO-based MECC capture/conversion systems are comparable to that of biomass derived liquids (carbon neutral) when the electricity cost is < \$0.059/kWh and < \$0.096/kWh, respectively.