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Development of electrically conductive membrane contactor for anti-fouling in the carbon dioxide stripping process

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ABSTRACT

Carbon capture utilization & storage (CCUS) process is a promising technology for reducing greenhouse gas emissions. However, the biggest challenge in commercializing CCUS is reducing energy consumption during the CO2 stripping stage. Membrane contactors have been developed to reduce energy consumption and improve CO2 stripping performance. However, traditional polymer-based membranes are vulnerable to damage by combustion residues such as oil and grease. To address this problem, electrically conductive membranes (ECMs) have been developed to enable efficient electrochemical reactions for anti-fouling purposes. This study investigated the anti-fouling performance of an electrically conductive membrane contactor (ECMC) for CO2 stripping. Surface modification with a two-layered ECM resulted in the superior electrical conductivity and CO2 stripping flux compared to other ECMs. Electrostatic repulsion effectively mitigated fouling by 92.1 % compared to non-charged ECMC by preventing the attachment of oil and grease, but it was not observed a significant effect in high oil and grease concentrations. The electrochemical oxidation process when applying a high voltage improved anti-fouling performance, and the O2 sweep gas mode greatly maintained the CO2 stripping flux at 95.2 % with high oil and grease concentrations. Furthermore, the feasibility of the ECMC was demonstrated by comparing the predicted total energy consumption per CO2 amount under actual operating conditions. In conclusion, ECMC improved the energy efficiency of CO2 stripping by providing high anti-fouling performance in CCUS.

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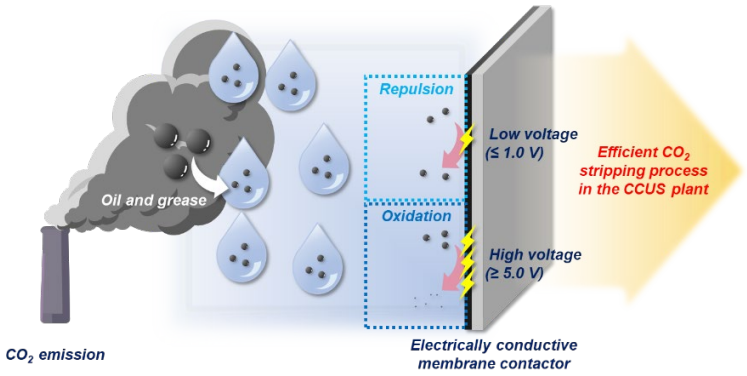

Fig. 1. Graphical abstract of this study

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