Abstract
Development and Evaluation of a CO\textsubscript{2} Capture System Using Hollow Fiber Membranes for Industrial Emissions Applications †

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Membrane technology has emerged as a selective and efficient option for carbon dioxide (CO\textsubscript{2}) capture. However, challenges arise in processing high industrial flows with the same effectiveness as mature technologies. Therefore, studying the process efficiency under real conditions is essential. Membranes of a polymeric nature are promising candidates for implementation on industrial scales.

In this context, this study aims to assess a CO\textsubscript{2} capture system using synthetic and real gases from the textile and cement industry on an experimental scale using a polysulfone hollow fiber membrane contactor, with the goal of developing a pilot-scale system. The experiments were conducted by varying parameters such as the pressure, CO\textsubscript{2} concentration and flowrate. As a result, higher permeate flux values were obtained at the maximum experimental concentration of 12% CO\textsubscript{2} in the feed stream, with a value of 472.54 cm\textsuperscript{3} cm\textsuperscript{-2} s\textsuperscript{-1}.

Additionally, a CO\textsubscript{2} permeance value of 90.98 GPU was achieved along with a CO\textsubscript{2}/N\textsubscript{2} selectivity of 11.37; these values closely approach the Robeson upper bound.

Measurements conducted with gases from the textile industry with a CO\textsubscript{2} concentration of 0.5% reaffirmed the results obtained with synthetic gases of a low permeate flux. In contrast, measurements with gases from the cement plant showed promising results. Also, it was demonstrated that oxygen has a significant impact on the separation efficiency, as it competes with CO\textsubscript{2} for transport sites in the membrane, reaching concentrations of up to 40% compared to the 0.5% CO\textsubscript{2} concentrated in the permeate for textile gases.

In conclusion, tests conducted with gases at higher CO\textsubscript{2} concentrations, such as those from the cement industry, reaffirm the technical feasibility of CO\textsubscript{2} capture using commercial membranes. However, further research is recommended to explore alternative configurations and materials to improve the process purity and efficiency.

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