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Carbon Dioxide Extraction from Flue Gas

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Current methods for separation and capture of carbon dioxide (CO_2) from mixed flue gas streams are difficult and costly. To meet stated greenhouse gas reduction targets it is necessary to develop novel, faster, more efficient and less costly approaches.

We have been exploring a next generation enzyme catalyzed, contained liquid membrane, hollow fiber design for the extraction of CO_2 from mixed gas streams. In this presentation we continue to explore features of the chemical engineering design strategy with the goal of optimizing performance, i.e., increasing both permeance and selectivity as much as possible. We report here various studies of liquid membrane flow and reactor design, gas flow rate and liquid membrane flow rate.

The data indicate a clear benefit of liquid membrane flow with permeance increasing with flow rate in a saturation-like relationship. This behavior was particularly marked for CO_2 though it was still visible, if far smaller in amplitude, for N_2 and O_2. These data hold for longitudinal flows and are expected to hold, albeit more strongly, for transverse flows as well.

Part of this study addressed the issue of optimal salt and buffer selection. We find that while there is a beneficial effect of salting out in reducing N_2 and O_2 permeance there is also an unexpected optimum in bicarbonate capacity that can be used to advantage. In addition there are buffer related performance differences that can be related to the slope of the buffer-pH curve and to the magnitude of the buffer participation in the transfer of CO_2 equivalents.

The improvement due to flow can be attributed to fiber surface area recruitment as, at low flow rates, only a portion of the fiber appears to participate effectively in the mass transfer process. Thus, calculations that assume full fiber participation necessarily decrease the apparent performance efficacy.