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CO_2 Capture via Facilitated Liquid Membranes

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Gas Separations

Separation of flue gas carbon dioxide (CO_2) from natural gas, petroleum or coal fired furnaces is difficult and expensive. However, it is central to the approach proposed for post-combustion cleanup, i.e., capture, pipeline, and geologic storage. Given the huge volumes involved and the low cost of energy, the figures of merit required for a successful design are the cost of energy and the cost of CO_2 avoidance.

Selective extraction of carbon dioxide (CO_2) from flue gas was achieved by means of our enzyme-catalyzed, contained liquid membrane (CLM) permeator. Measurements were made from analog (ersatz) and actual flue gas feed streams. The CO_2 concentration ranged from 0.05-20% in air, and 6%-13% in natural gas or propane combustion product. Feed gas source or composition did not affect CO_2 permeance. The solubility of each non-reactive gas in the solvent liquid alone determined the specific permeance and thus the selectivity.

The permeator was tested for as long as 50 days, under conditions of deliberate upset, to characterize its ability to recover as a means of characterizing its robustness. Performance following upset was similar to that before the event. The operation was stable in streams containing NOx or SOx.

We used these data to carry out process engineering analyses for gas composition, flow rates, and pressure at critical sites in our candidate commercial design. The test set is EPRI case 7C, for a coal burner, and case 1C, for a natural gas burner. Our target was at least 90% CO_2 removal and >90% purity in the compressed gas outlet stream. For coal (natural gas) feed streams containing 13.8% (3.5%) CO_2 the permeate, returned to the stack, contains 1.6% (0.4%) CO_2, while the dry compressed product is 92.6% (86.3%) CO_2 for a given permeator design. However, the dry compressed product concentration values can be altered as needed allowing for trade-offs between capital cost (system size) and operating cost (energy usage). More efficient CO_2 recovery will increase dry compressed product concentration while decreasing capital and operating cost.