HIGH EFFICIENCY CAPTURE OF CO_2 FROM MIXED GAS STREAMS

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Abstract

The economic capture of CO_2 from mixed gas streams for purification and/or use in CO_2 sequestration remains a substantial hurdle to the widespread application of greenhouse gas remediation. We have developed technologies to help address this need. Our technology development program devised reactors for the efficient removal of CO_2 from Human Space Flight crew environments (e.g. space shuttle, space station, and spacesuit). More recently it has involved the study of CO_2 removal from natural gas, and as described here the CO_2 capture from a wide variety of sources. We have generated an enzyme based contained liquid membrane (EBCLM) reactor as the technological basis for a family of CO_2 removal and capture devices.

The EBCLM works as follows: CO_2 in a mixed gas stream diffuses across a microporous hydrophobic membrane to contact an aqueous buffered enzyme solution. The enzyme, carbonic anhydrase (CA – EC 4.2.1.1), greatly increases solvation via catalytic hydration of CO_2 resulting in the formation of bicarbonate. Bicarbonate diffuses across the liquid membrane. At the permeate side gas-liquid interface CA catalyzes the dehydration reaction and CO_2 is released to the sweep gas stream having diffused through a second microporous hydrophobic polymer membrane.

This technology can provide very high selectivities (α-values of 2,500, 1,200, and 200:1 versus nitrogen, oxygen, and methane, respectively) and permeance values in excess of $3*10^4$ cm^3 cm^{-2} s^{-1} $cmHg^{-1}$ ($2*10^{-6}$ moles m^{-2} s^{-1} kPa^{-1}). Captured gas concentrations as high as 80% CO_2 can be obtained with feed gas concentrations as low as 0.1% CO_2. This continuous process design is suited to CO_2 removal from air, CO_2 delivery to greenhouses and the capture of CO_2 from stack gas. The system is stable, does not require high temperatures or pressures, and is insensitive to feed or sweep gas relative humidity. It has run for periods as long as 2 weeks without attendance and without failure though we anticipate lifetimes of 3 months to 1 year in the near term.