Efficient CO_2 Separation by Enzyme-Based Facilitated Transport

M.C. Trachtenberg, J.-J. Ge, R. M. Cowan, M.L. McGregor
The Sapient's Institute / Cook College / Rutgers University
New Brunswick, NJ

Selective extraction of carbon dioxide (CO_2) has broad application. We have explored the ability of the enzyme carbonic anhydrase (E.C. 4.2.1.1) to catalyze the absorption and desorption of CO_2 from a variety of mixed gas streams. The reactor operates continuously and is capable of significant enrichment in a single pass. The concentration of CO_2, the gas mixture, the solubility of the component gases and the partial pressure difference for each gas in the mixture give the enrichment. For CO_2 at 0.1% in air under hard vacuum the dry gas permeate CO_2 concentration has been calculated to exceed 60% in a single pass.

This membrane system design operates over a range of CO_2 concentrations from below ambient to above that in stack gas (<0.035% - >10%). At pCO_2 of 0.1% the permeance is $3*10^{-4}$ cm^3 cm^{-2} s^{-1} $cmHg^{-1}$ and selectivity vs. nitrogen, oxygen and methane are 2,500, 1,200 and 200:1, respectively. Operation is independent of both feed and sweep gas relative humidity. The system can be operated in two modes – simple enrichment and autoenrichment. In the simple enrichment mode separation is achieved by means of CO_2 partial pressure difference with no transmembrane total pressure differential. In the autoenrichment mode we can use the same gas stream for both the feed and the sweep. In this application the CO_2 partial pressure difference derives from a total transmembrane pressure differential, (e.g., by use of a vacuum assisted sweep). This approach allows a large number of field operations of varying size and sophistication.