Introduction to CO_2 Capture and Separation

A fraction of anthropogenic CO_2 emissions can be avoided if the CO_2 produced from the conversion of fossil fuels is captured and diverted to a non-atmospheric repository. Traditionally, the CO_2 product of fossil fuel conversion has been well mixed with other conversion products (e.g. N_2, H_2O, O_2, etc.). Storage of CO_2 in the subsurface is more efficient if the CO_2 is a relatively pure stream. Integration of CO_2 separation technology into fossil fuel conversion systems would make possible recover of that CO_2.

Several ideas for CO_2 separation exist, although none has yet emerged as a clear leader in energy efficiency. One pathway is to selectively remove CO_2 from traditional flue gas. Or, it might be advantageous to separate O_2 from air prior to combustion, which would reduce the complications of isolating CO_2 from the resulting effluent. A third concept would separate H_2 from the fuel carbon prior to power generation. Variations on these themes exist, and more exotic configurations have been proposed.

Each of these CO_2 capture configurations requires mechanisms for gas separation. Methods now used to separate gases for CO_2 capture include solvent techniques, chemical adsorbents and membrane separations. All current technologies demand a significant energy input to regenerate the solvent or otherwise drive the separation. Thermodynamic analysis has shown that the minimum energy required to perform any of these processes is far less than the amount used by today's technology. Research enabling efficient, low-cost CO_2 capture technologies will be required if fossil fuels are to be part of a low greenhouse gas emissions energy system and will be useful during transitions to other energy resources.

Professor Schoonman of TU Delft and Dr. Jansen of ECN lead a GCEP project in carbon capture and separation. This project seeks to develop membrane reactors in which products of hydrocarbon chemical conversion are selectively removed from the vessel in parallel with the chemical reaction. They are exploring two types of membranes: H_2 selective membranes and CO_2 selective membranes.

Professor Yamada and his research group at RITE have undertaken a project to develop highly efficient and highly selective CO_2 separation membranes. They are examining advanced membrane materials with surfaces engineered at the sub-nanoscale.