

## Introduction to CO<sub>2</sub> Capture and Separation

A fraction of anthropogenic CO<sub>2</sub> emissions can be avoided if the CO<sub>2</sub> produced from the conversion of fossil fuels is captured and diverted to a non-atmospheric repository. Traditionally, the CO<sub>2</sub> product of fossil fuel conversion has been well mixed with other conversion products (e.g. N<sub>2</sub>, H<sub>2</sub>O, O<sub>2</sub>, etc.). Storage of CO<sub>2</sub> in the subsurface is more efficient if the CO<sub>2</sub> is a relatively pure stream. Integration of CO<sub>2</sub> separation technology into fossil fuel conversion systems would make possible recover of that CO<sub>2</sub>.

Several ideas for CO<sub>2</sub> separation exist, although none has yet emerged as a clear leader in energy efficiency. One pathway is to selectively remove CO<sub>2</sub> from traditional flue gas. Or, it might be advantageous to separate O<sub>2</sub> from air prior to combustion, which would reduce the complications of isolating CO<sub>2</sub> from the resulting effluent. A third concept would separate H<sub>2</sub> from the fuel carbon prior to power generation. Variations on these themes exist, and more exotic configurations have been proposed.

Each of these CO<sub>2</sub> capture configurations requires mechanisms for gas separation. Methods now used to separate gases for CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> selective membranes and CO<sub>2</sub> selective membranes.

Professor Yamada and his research group at RITE have undertaken a project to develop highly efficient and highly selective CO<sub>2</sub> separation membranes. They are examining advanced membrane materials with surfaces engineered at the sub-nanoscale.