Introduction to CO_2 Capture and Storage

Any use of fossil fuels necessitates the generation of carbon dioxide. However, release of the produced CO_2 to the atmosphere can be avoided if the CO_2 can be separated from other gases and sequestered within the earth's crust. Fundamental science and engineering principles indicate that such a system should be feasible and safe: the energy cost of preparing CO_2 for injection can be as low as a few percent of the heating value of the original fuel; and the very existence of oil and gas reservoirs is proof that buoyant fluids can be contained in the subsurface for millions of years.

Using today's technology, carbon dioxide capture and separation carries significant cost because chemical separations are both energy inefficient and capital intensive. Since injection of carbon dioxide has been safely carried out for many years, it is anticipated that CO_2 sequestration will be a safe technology for operators and neighbors of injection wells. However, it does carry a significant risk that leaks to the atmosphere that are not remediated would be worse for the environment than simply emitting the greenhouse gases in the first place. The costs and risks are not insurmountable, but research is required to make these concepts economically and technologically feasible.

Both carbon capture and carbon dioxide storage are being investigated by GCEP-funded scientists. Reservoir simulation tools for the new challenges posed by CO_2 storage were built in 2006. More recently, an analysis of reservoir seals was completed (2007). The following ongoing GCEP research activities are taking place in the area of Carbon Capture and Storage.

Professor Hamdi Tchelepi and his colleagues are developing a set of numerical methods that efficiently simulate the flow of fluids in the subsurface. Assuring long-term sequestration of CO_2 requires simulations on a set of length and time scales that go well beyond those investigated in the design of oil recovery processes, and hence they involve new computational challenges.

Researchers at the Energy Center of the Netherlands and the Technical University of Delft are collaborating on the development of membrane-reactor systems for the efficient production of hydrogen and/or power with simultaneous carbon capture. They have identified key process steps to ensure efficient operation, and they are working on the material systems required to enable such processes.

A research team from the Research Institute for Technologies for the Earth in Japan is developing novel membranes that are permeable to CO_2, but not to other gases. The researchers have investigated two types of membranes, carbon-based and inorganic, and have managed to control pore-size down to the sub-nanometer range while functionalizing the pore surfaces.

A team led by Professor Jerry Harris, with members from both Geophysics and Energy Resources Engineering, is investigating carbon sequestration in coal seams that are too deep to be mined. Coal can provide a long-term CO_2 storage option (because CO_2 adsorbs onto the coal surfaces) that might even be profitable if used to also generate enhanced coal-bed methane. However, the interactions between CO_2 and coal are poorly understood at all scales; this interdisciplinary team seeks to improve understanding of the adsorption behavior, flow performance, and material property variations with adsorption that control flow and that could be used provide the physical basis for monitoring of flow in the subsurface.