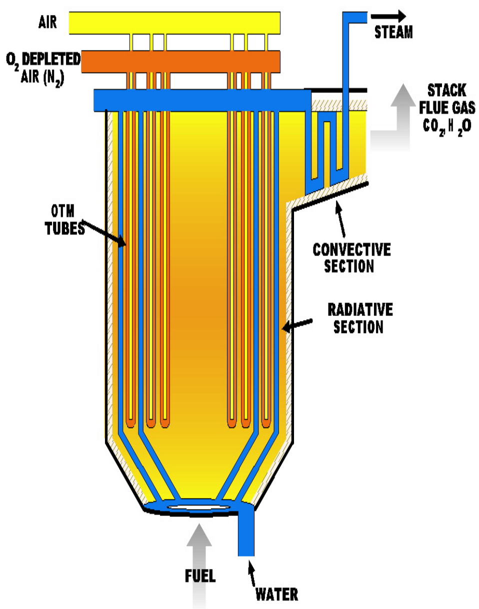
3.0 CAPTURING AND SEQUESTERING CARBON DIOXIDE

3.1. GEOLOGIC SEQUESTRATION

3.1.1 CO_2 CAPTURE AND SEPARATION

Technology Description



Oxyfuel Technology

Integrates air separation, using O2 Transport Membrane (OTM) and oxygen combustion

Fossil- and biomass-based energy conversion processes convert hydrocarbon materials (i.e., substances consisting mostly of carbon and hydrogen) into carbon dioxide and water while releasing energy. The goal of CO_2 capture and separation is to produce relatively pure CO_2 from these processes, preferably at pressures suitable for storage or reuse.

System Concepts

- *Post-combustion capture*. A chemical or physical separation process extracts CO_2 from the flue gas of a conventional air-fired combustion process. CO_2 is present in concentrations ranging from 3% to 12%. The focus is on technology for retrofitting or repowering existing power plants and industrial processes.
- *Oxy-fuel combustion*. Pure oxygen rather than air is charged to the combustion chamber, producing a flue gas of CO_2 and water. A portion of the CO_2 is recycled and mixed with the oxygen to absorb heat and control the reaction temperature.
- *Precombustion decarbonization*. The hydrocarbon feedstock is gasified to produce a synthesis gas made up primarily of hydrogen and carbon dioxide. The CO_2 is separated from the hydrogen before it is combusted or charged to a fuel cell.
- There are other advanced-system concepts in which fuel processing and CO_2 capture are integrated into a single stage using, for example, membranes or reduction-oxidation agents.

Representative Technologies

- The conventional technology for post-combustion capture (removing CO_2 from flue gas) is amine scrubbing. A solution of amine and water is contacted with flue gas. The amine and the CO_2 undergo a chemical reaction forming a rich amine that is soluble in the water. The rich amine solution is pumped to a desorber where it is heated, reversing the reaction and releasing pure CO_2 gas. The recovered amine is recycled to the flue-gas contactor.
- Other technologies for post-combustion capture include cryogenic distillation, polymer membranes, ceramic membranes, carbon absorbents, sodium absorbents, hydrides, and lithium silicate.

Technology Status/Applications

- Amine systems are used in numerous industrial applications to capture CO_2 from flue gas for use as a commodity chemical. Cryogenic and carbon absorbent systems have been built commercially.
- Other post-combustion capture technologies are being developed at the laboratory and pilot scale.

Current Research, Development, and Demonstration

RD&D Goals

- In the long term, reduce the cost of capture so that it increases the cost of energy services by 10% or less.
- By 2005, reduce the cost of capture by 50% in retrofit applications. Attainment of 2005 goals will be estimated based on technology performance in pilot-scale proof-of-concept demonstrations.
- Conduct large-scale demonstration of new technology by 2010.

RD&D Challenges

- CO_2 exists in air-combustion flue gas at low concentration, 3-12 volume percent.
- Flue gas contains reactive impurities that can adversely affect CO_2 capture systems.
- Transport and/or storage systems may require highly pure CO_2 product.
- Loss of CO_2 temperature and pressure across the capture system.

RD&D Activities

- Laboratory-scale experiments with advanced amines, ceramic membranes, high-temperature polymer membranes, vortex gas/liquid separator, ammonium bicarbonate, carbon absorbents, and electrochemical pumps.
- Pilot-scale tests with a novel oxy-fuel boiler, a CO_2/water hydrate process, a sodium-based CO_2 sorbent, and a metal reduction-oxidation power generation process.

Recent Progress

- During a short three-year period, a strong portfolio of research projects has been developed with more than 40% private-sector cost-share.
- The international community has been successfully engaged through participation in the International Energy Association Greenhouse Gas Programme, the CO_2 Capture Project with the European Commission and other international participants, and other collaborations with Canada, Australia, and Japan.

Commercialization and Deployment Activities

- Roughly 15 Mt/yr of CO_2 is captured from anthropogenic emissions sources in the United States and used as a commodity chemical.

Market Context

- Development of approaches for economically decarbonizing fossil fuels will allow the carbon-free production of electricity and hydrogen, and will take advantage of an existing fossil fuel infrastructure that accounts for more than 80% of the energy consumed in the United States and internationally.