R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

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Solid Sorbents for CO_2 Capture from Powerplant Exhaust Streams

Background

Current commercial CO_2 capture technology (e.g., gas absorption by solutions of carbonates and alkanolamines) is expensive and energy intensive. It is important to develop low-cost processes that utilize materials with high CO_2 adsorption capacity, high selectivity for CO_2, high diffusivity, high rates of adsorption, and high rates of regenerability.

Primary Project Goal

The primary goal of this research project is to develop regenerable sorbents that can capture CO_2 from coal combustion systems and are superior to existing commercial technologies.

Objectives

The major objective of this work is to develop solid regenerable sorbents that have high rates, high selectivity, high regenerablity, and high adsorption capacity for postcombustion CO_2 capture in suitable conditions. Specific objectives include:

- Develop sorbents for various reactor designs.
- Evaluate the feasibility of sorbent preparation in commercial-scale units and bench-scale reactor tests.
- Develop regeneration schemes to obtain a concentrated CO_2 stream.
- Optimize the sorbent formulation to improve sorbent performance.
- Conduct long-term tests to determine the chemical and physical stability of the sorbents.
- Study the effect of trace contaminants on the sorbent performance.
- Test the sorbent in a pilot-scale reactor unit.

NETL CO_2 sorbent extrudates prepared at a commercial facility (Süd-Chemie Inc.)

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Accomplishments

During the project, solid sorbents suitable for CO_2 capture from coal combustion gas streams were developed. Different types of sorbents are being evaluated for use. In one approach, liquid impregnated solid sorbents that capture CO_2 in the presence of water vapor at temperatures from 30–60 °C have been developed. In another approach, amines compounds capable of capturing CO_2 have been attached to various substrates, and the capture capacity for CO_2 has been measured in laboratory experiments. The sorbents showed better CO_2 capture capacities and lower regeneration temperatures than the conventional amine-based liquid solvent scrubbing process. A large-scale preparation of one of the sorbents at a commercial company was conducted successfully, and the sorbent showed promising results during bench-scale flow reactor tests with simulated coal combustion gas streams. The sorbent has CO_2 removal efficiency of 99% with good removal capacity. Continuing studies are quantifying how the sorbents perform in simulated operating cycles for both absorption and regeneration, with the goal of optimizing the sorbent performance for specific reactor configurations. A separate NETL study is evaluating the options for designing a reactor to use these sorbents in an actual reactor configuration.

Benefits

The majority of coal combustion power plants do not capture CO_2 and the current adaptable commercial processes are very expensive. Development of a cost-effective CO_2 technology is necessary to achieve the President's Global Climate Change Initiative with minimal increase in the cost of electricity from coal.