PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

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CARBON DIOXIDE CAPTURE FROM FLUE GAS USING DRY REGENERABLE SORBENTS

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Background

Currently available commercial processes to remove CO_2 from flue gas streams are costly and energy intensive. RTI International is heading a research team to develop an innovative process for CO_2 capture that employs a dry, regenerable sorbent. The process is cyclic in that the sorbent captures CO_2, is regenerated to yield a concentrated stream of CO_2, and is then recycled to capture additional CO_2. The proposed process can be used to remove CO_2 from the flue gases of coal- and natural gas-fired power plants.

RTI's CO_2 removal process uses a sodium carbonate-based sorbent. Sodium carbonate is converted to sodium bicarbonate through reaction with CO_2 and water vapor. The sorbent is regenerated using a thermal swing and produces a gas stream containing only CO_2 and water. The water is then removed by condensation to produce a pure CO_2 stream for subsequent use or sequestration.

Primary Project Goal

The goal of this project is to develop a simple, inexpensive process to separate CO_2 as an essentially pure stream from a fossil-fuel combustion system using a regenerable, carbonate-based sorbent process.

Objectives

To develop a technology that is:

- Applicable to both coal- and natural gas-fired power plants.

([1]RTI International is a trade name of Research Triangle Institute)

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PERFORMANCE PERIOD

08/31/2000 to 06/30/2007

COST

Total Project Value
$2,533,406

DOE/Non-DOE Share
$2,026,724 / $506,682

- Applicable as a retrofit to existing plants.
- Compatible with the operating conditions in current power plant configurations.
- Relatively simple to operate.
- Less energy intensive than currently available technologies.
- Less expensive than currently available technologies.

Benefits

This technology will provide conventional coal-fired power plants, natural gas-fired plants, and advanced power generation systems with a less costly and less energy intensive process to remove CO_2 from flue gas.

Accomplishments

RTI has achieved the following accomplishments over the entirety of this project:

- A relatively low-cost, novel, solid absorbent material for CO_2 capture has been identified and prepared by a catalyst manufacturer utilizing its production processes. The manufacturer-grade sorbent, developed first in RTI's laboratory, has been well characterized, analyzed, and tested throughout various phases of this project.
- The sorbent's capacity for 90 percent CO_2 capture has remained stable and consistent over 1000 hours of testing.
- The sorbent has shown little to no physical degradation over 1000 hours of fluidization and cycling in various reactor systems.
- RTI's novel sorbent was able to capture greater than 90 percent of the CO_2 present in both simulated flue gas in the laboratory and actual, fossil-fuel (coal and natural gas) combusted flue gas at a field test site.
- A novel process configuration (RTI's Dry Carbonate Process) has been developed for CO_2 capture based on RTI's novel sorbent material.
- A lab-scale version of RTI's Dry Carbonate Process was designed and constructed for small-scale demonstration testing. This test unit is capable of treating 300 to 450 standard cubic feet per hour of flue gas and can circulate sorbent material between a range of 25 to 250 pounds per hour.

- The lab-scale Dry Carbonate Process was fully integrated within a fossil-fuel combustion facility and tested for nearly 250 hours in order to test the process under actual flue gas conditions. With the assistance of ARCADIS, Inc., RTI was able to install the test unit at the Multi-Pollutant Control Research Facility at the U.S. Environmental Protection Agency's site in Research Triangle Park, NC. EPA's MPCRF is a 4M Btu per hour multi-fuel fired facility capable of firing coal, lignite, and natural gas.

- RTI observed little or no negative effects to the sorbent-capture performance due to the presence of contaminants in the flue gases.

- RTI performed various "trip" tests of the test unit (e.g., the flue gas was stopped, the sorbent circulation was stopped, etc.) to prove that the system was robust and reliable. RTI was able to get the unit "on line" with minimal effort after these trip tests.

- Preliminary economic analyses show that a commercial embodiment of the Dry Carbonate Process has potential to be significantly less costly and less energy intensive than conventional CO_2 capture technologies (i.e. amine-based technologies).

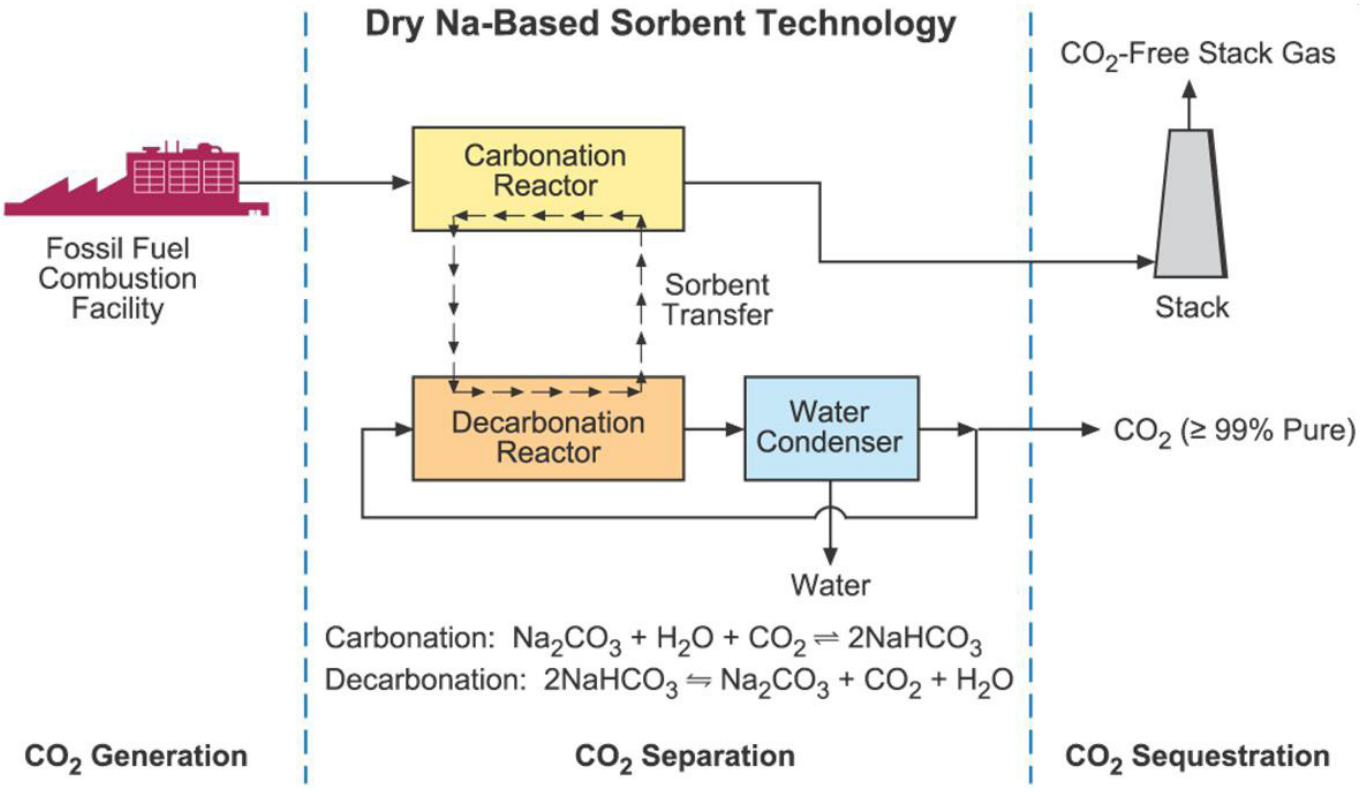

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Figure 2. The lab-scale demonstration unit of RTI's dry-carbonate process