the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Carbon Dioxide Capture from Integrated Gasification Combined Cycle Gas Streams Using the Ammonium Carbonate-Ammonium Bicarbonate Process

Description

Current commercial processes to remove carbon dioxide (CO_2) from conventional power plants are expensive and energy intensive. The objective of this project is to reduce the cost associated with the capture of CO_2 from coal based gasification processes, which convert coal and other carbon based feedstocks to synthesis gas. The main constituents of synthesis gas are hydrogen (H_2) and CO_2, and these two compounds should be separated prior to utilization in order to support clean energy goals. Therefore, the scientific achievement of developing a low cost method to both separate the CO_2 stream from other materials and capture the CO_2 within the system remains an active area of research and development (R&D). This project aims to develop an innovative, economical CO_2-capture technology to support clean energy objectives to produce clean power from coal using the gasification process.

The CO_2 removal technology is based on the use of an aqueous ammoniated solution containing ammonium carbonate, which is able to absorb large quantities of CO_2 from shifted syngas. Major advantages of this technology are as follows:

- Low cost and thermally stable reactive solution
- Reactive solution that has a high CO_2 loading capacity
- Optimum operating pressure, including CO_2 output stream, expected to be between 200 and 700 pounds per square inch, resulting in lower compression costs than conventional technologies

The first phase of the project will involve testing the technology on a bench-scale batch reactor to validate the concept and to determine the optimum operating conditions for a small pilot-scale reactor. Assuming this bench-scale testing is successful, the second phase will include designing and building a small pilot-scale test system and performing tests using real shifted syngas from a sufficient pilot plant scale gasifier, where a slip stream can be tested. One example of such an existing pilot scale unit is the Great Point Energy gasifier that is located in Brayton Point, Massachusetts.

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PARTNERS

Great Point Energy

PERIOD OF PERFORMANCE

9/30/2009 to 6/30/2011

COST

Total Project Value
$ 4,498,007

DOE/Non-DOE Share
$ 3,421,404 / $ 1,076,603

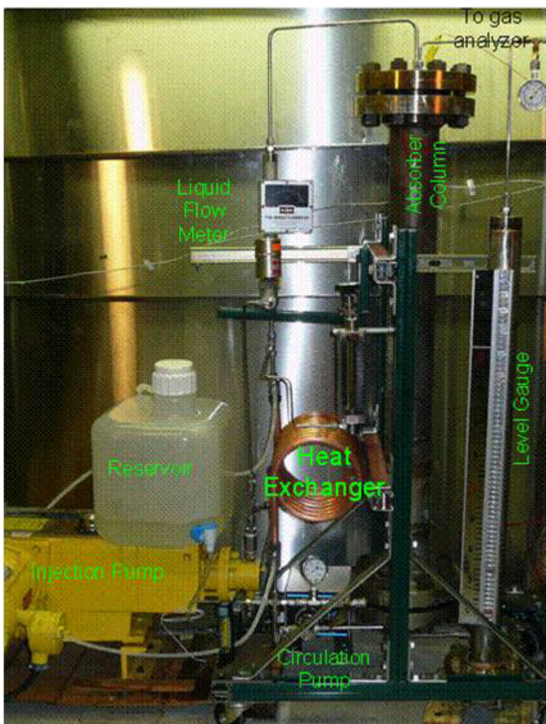
Technology success will be based on two primary factors:

1. Whether the technology shows the potential to meet the Department of Energy's (DOE) performance goals of reducing CO_2 emissions by 90 percent with no more than a 10 percent increase in the cost of electricity and mitigating sulfur to ultra-clean levels

2. A favorable economic comparison to conventional technologies and other technologies under development

Primary Project Goal

The overall goal of the proposed program is to develop an innovative, low-cost CO_2-capture technology for integrated gasification combined cycle-based power plants that are based on absorption on a high-capacity and low-cost aqueous ammoniated solution.



Batch scale absorber system

The following are specific objectives of the project:

- Test the technology on a bench-scale batch reactor to validate the concept and to determine the optimum operating conditions for a small pilot-scale reactor

- Design, build, and perform tests using a small pilot-scale reactor capable of continuous integrated operation

- Perform a technical and economic evaluation on the technology

DOE Performance Goals	
Contaminant	**Maximum After Cleanup**
Sulfur (total)	50 parts per billion
CO_2	>90 percent**
** With contribution to <10 percent increase in cost of electricity	

Accomplishments

Since the start of this project in October 2009, the project has accomplished two significant milestones. The first critical milestone involved the completion of batch absorption and regeneration tests with pure gases. The absorption efficiency increased with the increasing temperature from 25^{o} to 50^{o} C due to increased reaction kinetics, but it decreased at higher temperatures due to thermodynamic equilibrium limitation. This result allows the absorber to operate at a moderate temperature of 50^{o} C at which the solution has a high CO_2 capacity. Furthermore, it allows the operation of an absorber without the use of refrigeration.

The second substantial milestone that has been completed deals with the completion of batch scale testing of absorption and regeneration with mixed gases. During this testing, the CO_2 and H_2S absorption rates were determined as functions of temperature, pressure, and the solution and gas compositions. From regeneration experiments, the data obtained enabled the optimum regeneration conditions for the release of CO_2 and H_2S, exclusively, to be determined.

Benefits

Low CO_2-emission coal power will effectively respond to the dynamic challenge of supplying the nation's electricity requirements while simultaneously decreasing the contribution of coal-based electrical power to atmospheric CO_2.