the ENERGY lab

PROJECT FACTS

Carbon Capture

Pilot-Scale Evaluation of an Advanced Carbon Sorbent-Based Process for Post-Combustion Carbon Capture

Background

The mission of the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) Carbon Capture Research & Development (R&D) Program is to develop innovative carbon dioxide (CO_2) emissions control technologies for fossil fuel-based power plants. The Carbon Capture R&D Program portfolio of pre- and post-combustion CO_2 emissions control technologies and related CO_2 compression is focused on advancing technological options for new and existing power plants to enable cost-effective CO_2 capture for beneficial use or storage of CO_2 and ensure that the United States will continue to have access to safe, reliable, and affordable energy from fossil fuels. The DOE/NETL goal is to demonstrate second-generation technologies that can capture 90 percent of the CO_2 at less than $40 per metric ton (tonne) in the 2020–2025 timeframe. DOE is also committed to extend R&D support to even more advanced transformational carbon capture technologies that will increase the competitiveness of fossil-based energy systems beyond 2035.

Post-combustion CO_2 capture technologies are applicable to conventional pulverized coal (PC)-fired power plants, where the fuel is burned with air in a boiler to produce steam that drives a turbine generator system to produce electricity. The CO_2 is exhausted in the flue gas at atmospheric pressure and a concentration of 10–15 percent by volume. Post-combustion separation and capture of CO_2 is a challenging application due to the low driving force resulting from low pressure and dilute concentration of CO_2 in the waste stream, trace impurities in the flue gas that affect removal processes, and the parasitic energy cost associated with the capture and compression of CO_2. Carbon capture technologies developed under the DOE program may also be applied to natural gas power plants after addressing the R&D challenges associated with the relatively low concentration of CO_2 in the flue gas, typically 3–4 percent, of natural gas plants. Advanced adsorption-based capture systems show potential for reducing the overall costs associated with post-combustion CO_2 capture in PC-fired power plants due to a significant reduction in the regeneration energy as compared to conventional aqueous amine technologies.

Project Description

SRI International (SRI), along with their partners, will continue development of an advanced carbon sorbent (ACS) technology through pilot plant testing with actual flue gas. SRI's innovative, low-cost, low-energy, CO_2 capture technology is based on adsorption with a high capacity, attrition-resistant carbon sorbent.

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PARTNERS

ATMI, Inc.
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PROJECT DURATION

Start Date	End Date
10/01/2013	03/31/2018

COST

Total Project Value
$12,914,422

DOE/Non-DOE Share
$10,326,835 / $2,587,587

AWARD NUMBER

DE-FE0013123

The adsorption process has low activation energy and rapid cycling, which reduces capital and operating costs. The novel process configuration developed by SRI includes a continuous, falling micro-bead sorbent reactor that integrates the adsorber and stripper in a single vertical column, which provides a low pressure drop for gas flow and minimizes physical handling of the sorbent.

Under a previous DOE-funded project (DE-NT0005578), SRI conducted successful bench- and field-scale tests that verified their ACS sorbent-based process could capture 90 percent of the CO_2 in a flue gas stream and generate a relatively pure CO_2 stream ready for compression, pipeline transportation, and sequestration. Further testing and analysis is needed to enable a practical technology path to development at larger scales and, ultimately,commercialization of the capture process. The project team will design, build, and operate a 0.5 megawatt-electric (MWe) pilot plant at the National Carbon Capture Center (NCCC) to validate the sorbent process. The team will conduct continuous long-term testing under realistic conditions with flue gas from a PC-fired boiler to obtain design and performance data required for scale-up and commercialization.

Primary Project Goal

The primary project goal is to test SRI's innovative, post-combustion CO_2 capture technology by incorporating the advanced carbon sorbent-based process in a 0.5 MWe slip-stream pilot plant to make progress toward meeting or exceeding the DOE goal of demonstrating second-generation technologies that can capture 90 percent of the CO_2 at less than $40 per tonne in the 2020–2025 timeframe.

Objectives

The project objectives are to conduct parametric and long-term testing of the capture process with coal-fired flue gas to produce design and performance data; use the data for further development and commercialization of the process; assess the technical and economic feasibility of the process; and evaluate environmental, health, and safety (EH&S) risks.

Planned Activities

- Perform an initial techno-economic analysis based on the previous bench-scale integrated system tests and conduct an initial EH&S risk assessment of the process
- Optimize the sorbent formulation and manufacturing options
- Complete the process design optimization as well as the basic and detailed engineering and cost assessment of the 0.5 MWe slipstream pilot plant
- Complete pilot plant fabrication and site installation at the NCCC

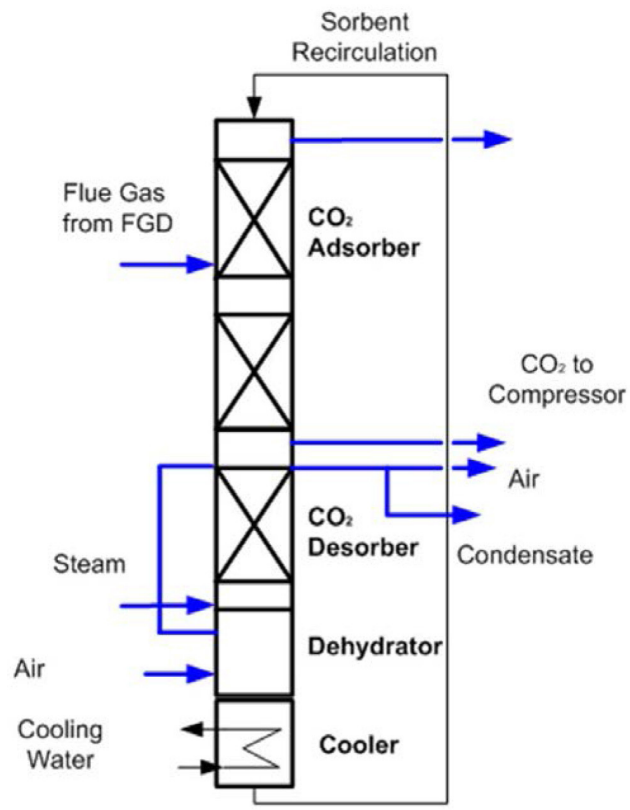

Diagram of the slipstream test unit

- Perform parametric testing to optimize performance and conduct continuous, steady-state operation for at least three months
- Update the techno-economic report and EH&S assessment
- Develop a commercialization plan to implement the CO_2 capture process in coal-fired power plants

Accomplishments

- Project awarded in October 2013
- Kick-off meeting held in December 2013

Benefits

Successful development of this technology will provide a cost-effective process for removing CO_2 from the flue gas of existing and new pulverized coal-fired plants that is suitable for use in enhanced oil recovery, chemical operations, or underground sequestration. Additionally, this technology has exhibited efficient CO_2 capture from dilute flue streams typical of natural gas-fired plants, enabling implementation of carbon capture beyond coal-fired power to all electricity generation from fossil fuels. Establishing the scalability and feasibility of this technology at pilot scale will enable a practical technology path to development at larger scales and, ultimately, commercialization of the capture process.