the ENERGY lab

PROJECT FACTS

Gasification Technologies

A Novel Sorbent-Based Process for High Temperature Trace Metals Removal from Coal-Derived Syngas

Description

Gasification converts coal and other heavy feedstocks into synthesis gas (syngas) that can be used either as a fuel for highly efficient power generation cycles or converted into value-added chemicals and transportation fuels. However, coal-derived syngas contains a myriad of trace contaminants, such as mercury (Hg), arsenic (As), selenium (Se), and cadmium (Cd), which may be regulated in power plants and can act as poisons for fuel cells or catalysts used in downstream chemical manufacturing processes.

In a Small Business Innovative Research (SBIR) Phase II project, TDA Research, Inc. (TDA) developed a high temperature, expendable sorbent for removing catalyst poisons (As and Se) from coal-derived syngas, and in a second SBIR Phase II project, TDA developed a high temperature, regenerable sorbent for removing Hg. Unlike commercially available sorbents that physically adsorb Hg and must operate at near ambient temperature, TDA's sorbent operates at an elevated temperature and removes trace metals by forming chemical complexes and amalgams. The SBIR projects previously demonstrated the following parts of the concept are achievable: (1) the ability of the Hg sorbent to operate for at least 40 consecutive absorption/regeneration cycles without deterioration; (2) an exceptionally high absorption capacity of the expendable sorbent for As and Se; and (3) the simultaneous removal of Hg and other trace contaminants from simulated, coal-derived syngas.

This project developed a chemical sorbent-based process capable of removing all trace metal contaminants from coal-derived syngas in a single process step at a high temperature (500 °F). High temperature removal will significantly improve the overall efficiency of the power cycle, because cold gas clean-up systems inherently condense the water vapor in the syngas, consequently reducing power cycle efficiency by roughly 10 percent on a relative basis.

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PARTNERS

TDA Research, Inc.

Southern Company Services, Inc.
Power Systems Development Facility

University of North Dakota Energy and Environmental Research Center

COST

Total Estimated Cost
$656,938

DOE/Non-DOE Share
$525,000 / $131,938

U.S. DEPARTMENT OF ENERGY

Primary Project Goal

The primary goal of this project was to develop a novel gas cleaning technology for removing multiple trace metals (e.g., Hg, As, Se, and Cd) from coal-derived syngas at a high temperature.

In order to meet the project goal, the following objectives were developed:

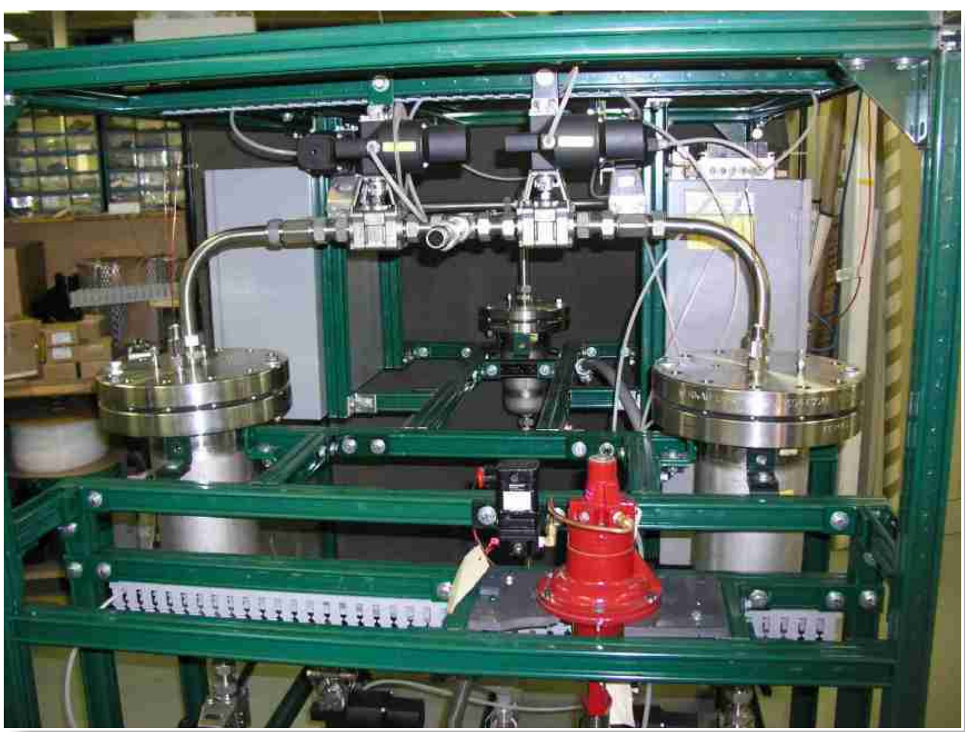
- Design, build, and install a field prototype test unit on a slipstream at a gasification facility.
- Evaluate the performance of the prototype unit when feeding actual coal-derived syngas.
- Analyze the removal mechanisms of the trace metals.

Accomplishments

TDA collaborated with Southern Company Services, Inc. to demonstrate the performance of its multi-contaminant, clean-up system using actual syngas derived from high sodium, Falkirk lignite produced at the pilot-scale transport gasifier at the Power Systems Development Facility (PSDF) located in Wilsonville, Alabama. Expanded testing with syngas derived from SUFCo bituminous coal and Oak Hills lignite at the University of North Dakota Energy and Environmental Research Center's (UNDEERC) Transport Reactor Demonstration Unit in Grand Forks, North Dakota, showed that the sorbent was effective in removing Hg. The tests also demonstrated effective regeneration by applying a combination of mild temperature and pressure swing and reuse of the sorbent. Test durations of insufficient length prohibited the ability to obtain conclusive results for As, Se, and Cd. Based on a preliminary engineering and cost analysis, TDA estimated the cost of Hg removal from coal-derived syngas as $2,995/lb (assuming that this cost also includes the cost of removal of all other trace metal contaminants).

Benefits

The successful development of a chemical sorbent-based process to remove trace metal contaminants from coal-derived syngas at high temperatures in a single process step will improve the overall efficiency of the power cycle. This process should also reduce the amount of sorbent required relative to currently available options, reducing costs for replacement sorbent and waste disposal as a result.



Prototype Test System Used in the Field Evaluations at PSDF