PROJECT facts

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

Gasification Technologies

06/2007

A NOVEL SORBENT-BASED PROCESS FOR HIGH TEMPERATURE TRACE METALS REMOVAL FROM COAL-DERIVED SYNGAS

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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), that may be regulated in power plants and can act as poisons for fuel cells or catalysts used in downstream chemical manufacturing processes.

This project will develop a chemical sorbent-based process to remove all trace metal contaminants (including Hg, As, Se, and Cd) from coal-derived syngas in a single process step at high temperature (500ºF). High temperature removal will greatly improve the overall efficiency of the power cycle, because cold gas clean-up systems inherently have to condense the water vapor in the syngas, thus reducing power cycle efficiency by roughly 10% on a relative basis.

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 have already demonstrated parts of the concept, including the ability of the Hg sorbent to operate without deterioration for at least 40 consecutive absorption/regeneration cycles, that the expendable sorbent has an exceptionally high absorption capacity for Ar and Se, and that simultaneous removal of Hg and other trace contaminants from simulated coal-derived syngas is achievable.

Primary Project Goal

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

PARTNERS

TDA Research, Inc.

COST

Total Project Value
$375,000

DOE/Non-DOE Share
$300,000 / $75,000

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Objectives

The objectives of the project are to:

- 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
- Determine the impact of other impurities in the coal-derived syngas on the operation of the sorbent

Accomplishments

TDA collaborated with Southern Company Services, Inc. to demonstrate the performance of its multi-contaminant clean-up system (treatment capacity of 400 scfh of syngas) during two slipstream demonstrations using actual coal-derived syngas from a pilot-scale transport gasifier at the Power Systems Development Facility (PSDF) located in Wilsonville, Alabama. The prototype system used three sorbent reactors enabling multiple tests to be performed at different temperatures.

Throughout a test campaign conducted in November 2006, two of the sorbent beds were intermittently tested over a nine (9)-day period. The actual test duration was 96 hrs (4 days) due to gasifier shutdowns.

- Bed I (480 g sorbent) treated 1,095 lb (14,830 scf) of syngas
- Bed II (480 g sorbent) treated 1,035 lb (14,020 scf) of syngas

During these tests, the sorbent removed all Hg in the syngas at a temperature of 260ºC (500ºF), achieving a near 100% removal efficiency as confirmed by on-line analysis. The chemical analysis of sorbent samples removed from different locations in the bed is underway to determine the Ar, Se, Cd, and other trace contaminant accumulation in the sorbent bed.

To assess the full benefits, two new and smaller (80 g each) sorbent beds were evaluated in a second test campaign conducted at the PSDF in April 2007. Over 200,000 scf of syngas was treated. Sorbent samples from the beds are being analyzed to determine the absorption capacity for trace metals.

Benefits

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

Prototype test system used in the field evaluations at PSDF

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