PROJECT facts

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

Gasification Technologies

05/2006

NOVEL TECHNOLOGIES FOR GASEOUS CONTAMINANTS CONTROL

Description

Gasification is the cleanest and most thermally efficient way to convert the energy content of coal and other carbonaceous feedstocks into more useful products such as electricity, hydrogen, clean fuels, and value-added chemicals. The product of gasification – synthesis gas (commonly called "syngas") – is a mixture of hydrogen (H_2) and carbon monoxide (CO) and represents the building block from which all of these valuable products are generated. Developing reliable and cost-effective gasification technologies can ensure that the U.S. energy requirements will be met using coal as an abundant, low-cost, and domestic resource.

One major roadblock in market penetration of gasification technologies is that the use of coal and other carbonaceous feedstocks in a gasifier produces several gaseous contaminants, including hydrogen sulfide (H_2S), carbonyl sulfide (COS), ammonia (NH_3), hydrogen cyanide (HCN), hydrogen chloride (HCl), arsine (AsH_3), mercury (Hg) and alkali vapors. If allowed to remain in the syngas, these contaminants can damage downstream process equipment as well as cause serious harm to the environment. To remove these contaminants, highly efficient and cost-effective technologies are needed to retain the high cycle thermal efficiency inherent to gasification. To this end, Research Triangle Institute (RTI) and its industrial partners are developing sorbent-based processes that remove the above contaminants from coal-derived syngas. They also are being designed to remove these contaminants at moderate temperatures (i.e. 450 to 700 °F).

One of the main components of this project is the High Temperature Desulfurization System (HTDS). HTDS is a sorbent-based technology that may eventually replace amine systems as the primary method for H_2S and COS removal (desulfurization) from syngas. This system has the major advantage of removing sulfur species at temperatures of 450 to 700 ºF, unlike existing amine systems where required cooling of the syngas results in large economic and thermal penalties.

The key to maximizing the advantages of HTDS is to have a sorbent that is both regenerable and robust enough to withstand the system's harsh operating conditions. As part of the current project, RTI has developed and commercialized a specialized, zinc oxide- (ZnO) based breakthrough desulfurization sorbent (named "T-2749,") that meets these criteria. In 2004, R&D Magazine recognized "T-2749" with an R&D 100 Award.

In addition to sulfur removal technologies, this project is actively involved in developing processes to remove the other contaminants found in coal-derived syngas, including a sorbent-based process that removes NH_3 at temperatures of 400 to 500 ºF; disposable sorbents designed for fixed-bed operation and used to treat HCl, arsine, and Hg vapors at 400 to 600 °F; and membrane systems for separation of H_2S and CO_2 from the syngas stream.

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This research program is focused on developing these technologies and large-scale demonstrations at Eastman's coal gasification facility and moving closer to near-zero emissions coal-fired power generation. The desulfurization process, if successfully demonstrated, would be primed for commercial demonstration and implementation within the next three to five years.

PARTNERS

Research Triangle Institute (RTI)

Eastman Chemical Company

Membrane DuPont Air Liquide (MEDAL)

University of Texas

North Carolina State University

Prototech Company

SRI International

Kellogg, Brown, and Root

ChevronTexaco

Süd-Chemie, Inc.

COST

Total Project Value
$20,320,372

DOE/Non-DOE Share
$15,326,608 / $4,993,764

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Primary Project Goals

The overall goal of this project is to demonstrate syngas cleaning technologies that are thermally efficient and cost effective for treating H_2S, COS, NH_3, Hg, arsine and alkali vapors in pilot plant testing with coal-derived syngas. The specific goals are to:

- Demonstrate the removal of sulfur species (H_2S and COS) to <60 parts per billion volume – ppbv levels using a combination of sorbent and membrane-based technologies.
- Demonstrate NH_3 removal technologies (process and sorbent) that achieve less than 10 parts per million volume (ppmv) of the contaminant in the treated syngas stream.
- Demonstrate removal to < 10 ppbv levels for HCl, AsH_3, and Hg vapors using inexpensive, disposable materials.
- Lead to gas cleanup capital cost reductions of $60-80/kWe and cycle efficiency improvements of >1 efficiency points.

Accomplishments

- Designed, built, and tested the HTDS pilot test unit capable of processing 16,000 standard cubic feet per hour (scfh) of syngas at 1,000 pounds per square inch gauge (psig) and 600 to 900 °F.
- Demonstrated H_2S and COS reduction in coal derived syngas from 8,300 ppmv (dry basis) to below 2 ppmv (analytical detection limit).
- Scaled up sorbent production to 8,000 lb batch.
- Identified reverse selective membrane materials where H_2S is 40 times more permeable than H_2.
- Demonstrated ability of regenerable ammonia sorbent to reduce NH_3 concentrations from 500 ppmv to less than 40 ppmv in a simulated syngas bench scale testing system.
- Identified two leading candidates capable of removing mercury from simulated syngas at temperatures between 400 and 570 °F.

Eastman Company's High Temperature Desulfurization System

Benefits

This combination of technologies has the potential of achieving near-zero emissions of all targeted pollutants and may replace conventional amine systems that are currently used for syngas cleanup. This project has the potential to improve coal gasification technology for producing electricity, hydrogen, liquid fuels, and chemicals allowing the U.S. to become less dependant on foreign sources of these products.