PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

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NOVEL TECHNOLOGIES FOR GASEOUS CONTAMINANTS CONTROL

Research Triangle Institute

Description

During gasification of a carbonaceous feedstock, some of the fuel-bound contaminants naturally present in carbonaceous materials convert into gaseous impurities, such as H_2S, COS, NH_3, HCN, HCl, and alkali. Research Triangle Institute (RTI) is working on a hybrid process for sulfur removal consisting of a bulk sulfur removal process and a polishing sulfur removal process. The team members actively involved in the bulk sulfur removal research are Membrane DuPont Air Liquide, North Carolina State University, and RTI. The bulk sulfur removal process is being developed with polymer membranes engineered to specifically remove H_2S, CO_2, and H_2O from syngas. In the polishing sulfur removal process, RTI is collaborating with the Prototech Company to develop regenerable ZnO-coated monoliths for removing any remaining sulfur to sub-ppm levels. These monoliths will achieve the same sub-ppm-level sulfur removal available with disposable commercial ZnO-based materials, but unlike these materials the monolith can be regenerated for repeated use. For chloride removal, RTI is working with SRI International for the development of an inexpensive disposable sorbent. Ammonia present in syngas will be removed by adsorption on high-surface-area acidic supports and subsequently desorbed by temperature and/or pressure swings to generate a small NH_3 tail gas stream which will be converted to nitrogen and water with commercially available catalytic oxidation processes. It is projected that these combined technologies could reduce pollutants to near-zero levels while costing about as much, or potentially less than, commercial amine systems.

The following figure shows a schematic of the overall process for removal of sulfur, chlorine, and nitrogen compounds from syngas to ultra-clean part per billion levels. As seen, this approach consists of a number of different modular processes that can be integrated as needed for the different syngas-conditioning requirement for fuel cell, chemical production, or power generation applications. It is contemplated that various individual modules can be used in a "mix and match" fashion depending on the type and level of contaminants and cleanup requirements.

PRIMARY PARTNER

Research Triangle Institute
Research Triangle Park, NC

PARTICIPANTS

Membrane DuPont Air Liquide (MEDAL)
Newport, DE

North Carolina State University
Raleigh, NC

Prototech Company
Needham, MA

SRI International
Menlo Park, CA

CUSTOMER SERVICE

(800) 553-7681

WEBSITE

www.netl.doe.gov

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Novel Technologies for Gaseous Contaminants Control

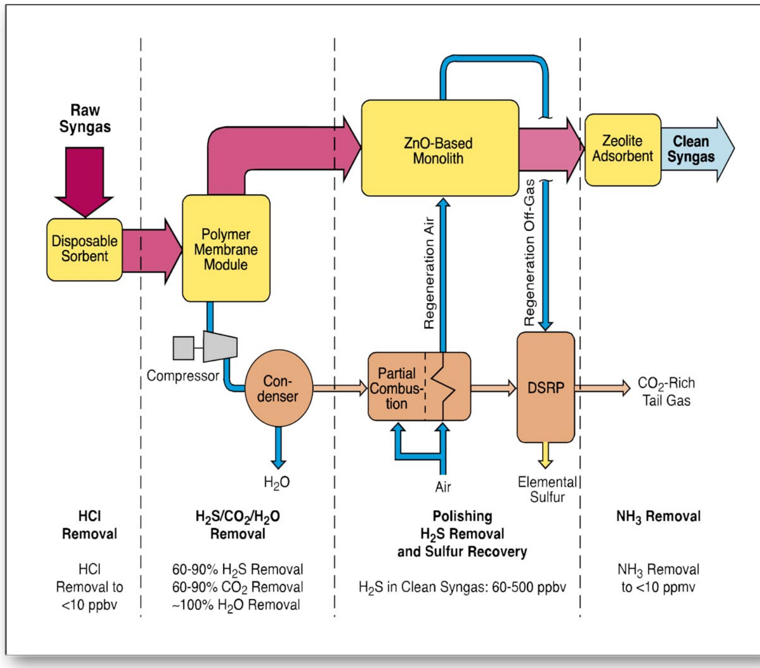
Research Triangle Institute

CONTACTS

Gary J. Stiegel
Product Manager, Gasification Technologies
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
(412) 386-4499
gary.stiegel@netl.doe.gov

Suresh C. Jain
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-5431
jain@netl.doe.gov

Raghubir P. Gupta
Research Triangle Institute
3040 Cornwallis Road
P.O. Box 12194
Research Triangle Park, NC 27709-2194
(919) 541-8023
gupta@rti.org



Goals

The goal of this study is to develop technologies for cleaning/conditioning gasifier-generated syngas to meet contaminant tolerance limits for fuel cell, chemical production, and power generation applications. The specific goals are to develop processes for (1) removal of reduced sulfur species to sub-ppm levels (< 60 ppbv) using a hybrid process consisting of a polymer membrane and a regenerable ZnO-coated monolith, (2) removal of hydrogen chloride vapors to sub-ppm levels (< 10 ppbv)using an inexpensive, high-surface-area material; and (3) removal of NH_3 (< 10 ppmv) with acidic adsorbents followed by conversion of this NH_3 into nitrogen and water.

Benefits

This technology, if successfully developed, could replace conventional systems that are currently used for syngas cleanup and achieve near-zero emissions of all pollutants. The potential cost of this desulfurization technology could be 50% lower than the cost of a conventional Rectisol-based system. As shown in the process configuration, a concentrated CO_2 stream can be obtained, thus allowing effective CO_2 sequestration without any major additional processing costs.

The combination of the bulk desulfurization by membranes with the polishing capability of monoliths provides both a significant cost advantage as well as reduced environmental impact. This process has vast potential to reduce net emissions of sulfur gases without sacrificing any thermal efficiency. Use of the monolith process, if successfully demonstrated, can potentially avoid the pollution implications of Zn recovery as well as offer substantial cost savings in terms of using a regenerable material rather than a disposable sorbent. Successful development of inexpensive chloride removal sorbents may reduce the cost of chloride removal processes that are currently in practice.