PROJECT facts

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

Gasification Technologies

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THE ULTRA-CLEAN GAS CLEANUP PROCESS FOR INTEGRATED GASIFICATION COMBINED CYCLE (IGCC)

Novel Gas Cleaning / Conditioning for IGCC

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Description

Coal gasification generates a raw gas that requires considerable cleaning and removal of particulate and several vapor-phase contaminants to very low levels before the gas can be used in applications such as integrated gasification combined cycle (IGCC) power generation or fuel/chemical production. Conventional gas cleaning processes cool the raw gas to a low temperature, resulting in the nearly complete removal of condensable species from the gas. This condensate stream is used to absorb highly water-soluble contaminants from the gas (halides and ammonia), generating a dry gas and a highly contaminated condensate stream that requires extensive processing. Syngas is followed by "dry-gas" treatment in a low-temperature, gas-solvent absorption contactor to remove sulfur species. In IGCC applications, the clean, dry gas must be re-humidified to generate a fuel gas that can be fired in the turbine combustors with acceptable NO_X emissions. This "dry-gas" cleaning technology, while highly effective for gas cleaning, results in a complex process that has high overall power and thermal energy consumption. In addition, none of the conventional gas-sorbent contactors can achieve the very low gas contaminant levels that will be required in future IGCC plants or the extremely low contaminant levels required in many fuel/chemical applications.

The Siemens Westinghouse Power Corporation (SWPC) is conducting a program with GTI to develop a Novel Gas Cleaning process that uses a new type of gas-sorbent contactor, the "filter-reactor." The filter-reactor is both a barrier filter that achieves very efficient removal of particulate from the gas, and a gas-sorbent reactor used for once-through sorbent, gas-contaminant polishing. The filter-reactor behaves, in principle, as a fixed bed reactor but having several potential advantages over conventional gas-sorbent contactors. Injected sorbent particles distribute uniformly on the filter-reactor elements, providing very efficient gas-sorbent contacting conditions, and several polishing functions, using once-through sorbents, can be simultaneously performed in a single vessel. The filter-reactor outlet particle loading is extremely low, and it might operate efficiently using cheap, fine, unsupported sorbent particles. The proposed Ultra-Clean gas cleaning process is operated under "humid-gas" conditions and is configured in a series of stages of gas-sorbent filter-reactors that will chemically react with specific contaminants (halide species, sulfur species, mercury species, etc.). Sorbents identified in laboratory testing under the Base Program will be used to achieve near-zero emissions of all targeted pollutants.

PARTNERS

Siemens Westinghouse Power Corporation

GTI

PROJECT COST

Total Project Value
$4,332,785

DOE/Non-DOE Share
$3,425,343/$907,442

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Primary Project Goals

The process goals are to: (1) provide improved plant performance and economics when meeting future IGCC fuel gas cleaning requirements, and when meeting the stringent gas cleaning requirements for chemical plant synthesis applications (e.g., H_2S <60 ppbv, HCl <10 ppbv, particulate <0.1 ppmw, mercury 95-99 percent removal) and (2) lead to gas clean up capital cost reductions of $60-80/kWe and cycle efficiency improvements of >1 percentage points.

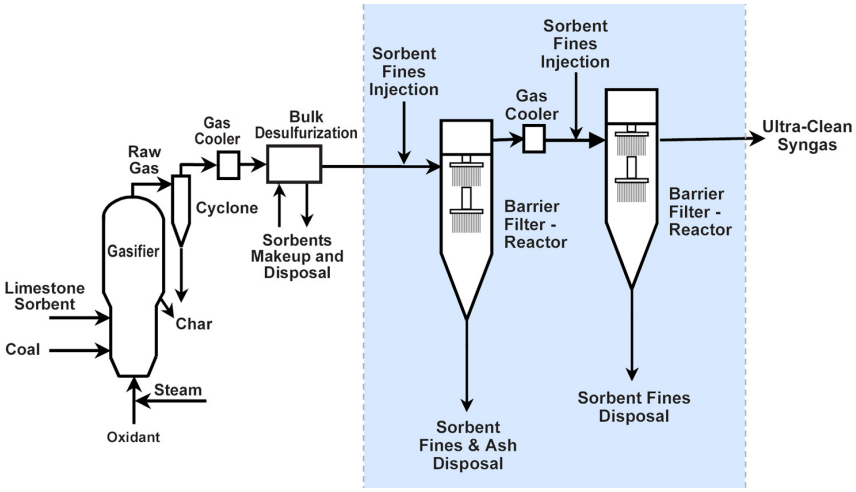
Accomplishments

To date, the program has accomplished the following:

- Completed comprehensive laboratory evaluations to select appropriate sorbents for sulfur, halide, and mercury species
- Identified the filter-reactor contacting stages performance requirements
- Identified the likely ranges of operating conditions for the filter-reactors in the process
- Devised commercial, integrated, humid-gas cleaning process configurations that apply the filter-reactor contacting stages
- Generated process material, energy balances, and conceptual equipment designs for commercial applications
- Quantified the overall, conceptually-based, gas cleaning performance and cost potential for IGCC and chemical synthesis applications
- Designed and constructed a bench-scale, coal gas test facility on a GTI, 10 ton/day coal gasifier facility to test the critical barrier filter-reactor components of the process and to demonstrate its ability to achieve the performance goals
- Initiated testing and completed the first and second test campaigns using coal-derived syngas from the GTI's 10 tons per day coal gasifier facility.

Benefits

The Ultra-Clean Process provides several potential benefits. Conventional gas-sorbent contactors are prone to plugging, transient pressure drop increases, sorbent particle attrition and elutriation, and the need to operate with high-cost, highly durable, specially fabricated sorbent particles. The filter-reactor minimizes such issues. Also, the Novel Gas Cleaning process builds upon prior humid-gas cleaning technologies for bulk halide and sulfur removal developed under DOE sponsorship and is integrated with these bulk removal technologies to improve performance. Finally, the filter-reactor gas-sorbent contactors in this highly efficient, humid-gas cleaning process have the potential to provide improved plant operating conditions and improved thermal efficiency while being able to achieve near-zero emissions. This process is anticipated to increase the cycle efficiency by more than 1 percentage points and reduce gas clean up capital costs by $60-80/kWe.



Ultra-Clean Process

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