PROJECT facts

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

Gasification Technologies

05/2005

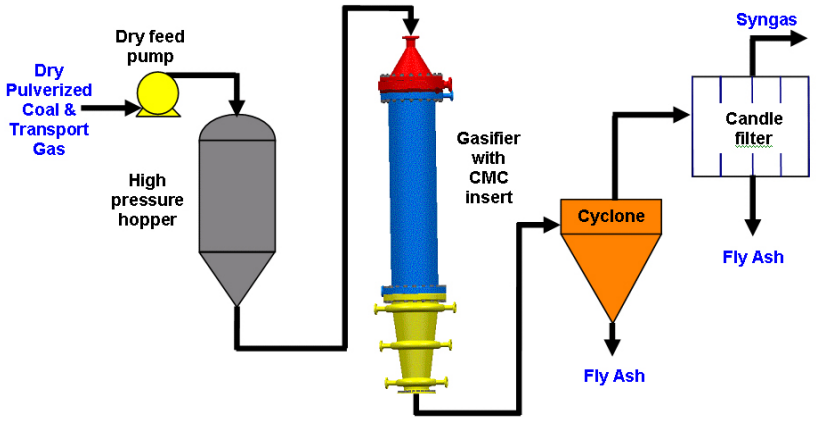
ADVANCED GASIFICATION SYSTEMS DEVELOPMENT

Description

Rocketdyne will apply rocket engine technology to gasifier design, allowing for a paradigm shift in gasifier function, resulting in significant improvements in capital and maintenance costs. Its new gasifier will be an oxygen-blown, dry-feed, plug-flow entrained reactor able to achieve carbon conversions of nearly 100 percent by rapidly heating low coal particles at rates up to 2,000,000 ºF/second. The gasifier's high heating rates make possible very short gasification residence times, increased thermal efficiency, and carbon conversions approaching 100 percent. Another result of the high heating rates is that the reactor is one tenth the size of an equivalent conventional gasifier, which will reduce capital costs.

This project is the first step in realizing Rocketdyne's gasifier vision, and in removing the economic barriers that have prevented the widespread commercial deployment of coal-based gasification systems. The project objectives are to:

- Demonstrate the feasibility of the long-life rapid-mix injectors at a commercial scale. These advanced injectors are critical to achieving the rapid heating rates that will result in increased efficiency, reduced capital costs and reduced Cost of Electricity (COE).
- Test mechanically cooled refractory liner coupons. This liner concept is expected to double the life of a gasifier's refractory liner. This will significantly reduce maintenance costs.
- Perform a conceptual design and hardware definition of an 18 tons per day pilot plant gasifier embodying the Rocketdyne vision. This is the first step towards combining all of Rocketdyne's advanced, and economically beneficial, concepts into one integrated test unit. In addition to the advanced injectors and cooled liner, the Rocketdyne pilot plant will also include a plug flow gasifier and a dry feed system, all of which will contribute to decreased COE.



Conceptual drawing of Rocketdyne's gasification system

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COST

Total Project Value
$6,249,604

DOE/Non-DOE Share
$4,999,683 / $1,249,921

Both the long-life rapid-mix injectors and the actively cooled liners are based on Rocketdyne's rocket technologies. The injector design uses multi-element injection to rapidly mix the coal with hot steam and oxygen while rapidly dispersing the coal across the reactor's cross-section. Water cooling circuits are embedded inside the rocket engine style face plates to ensure long life of the injector unit – over one year. The liner also is actively cooled, using slots in the refractory to carry coolant through and heat away, resulting in a frozen layer of slag inside the gasifier. This frozen layer of slag has been shown in lab tests to protect the refractory underneath.

Primary Project Goals

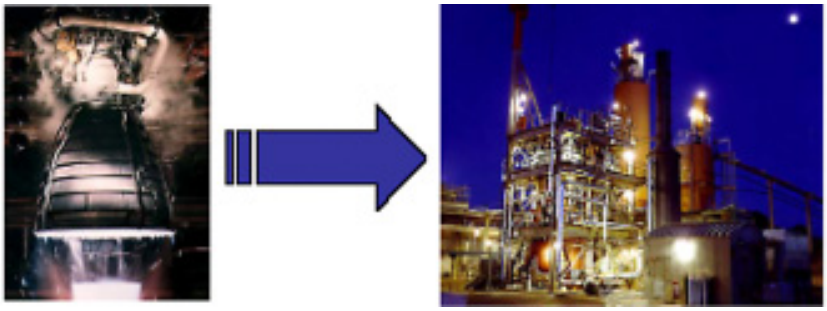
- Test cooled refractory liner coupons in a slagging gasifier.
- Test injector durability and mixing potential in full flow cold tests.
- Complete the conceptual design of a novel 18 tons per day, highly efficient, long-life entrained flow gasifier, including long-life, rapid-mix injectors and the cooled refractory liner.

Accomplishments

- Established and formalized site location agreement for the cooled liner coupon development testing with CANMET Energy Technology Centre (CETC) in Ottawa, Canada.
- Gas Technology Institute (GTI) in Des Plaines, Illinois was selected as the pilot plant site location. GTI will support Rocketdyne in definition of the pilot plant and development of cost estimates for the pilot plant during the current contract.
- Rocketdyne completed preliminary IGCC plant studies to identify a preferred gasifier configuration to use as the basis for the pilot plant design. The results of the study indicate that an advanced commercial gasifier using a CO_2 pump or an extrusion pump dry feed system, ceramic matrix composite (CMC) gasifier liner insert, and partial quench results in substantial reductions to the cost of electricity through lower plant capital costs, higher plant efficiency, and higher plant availability.
- Completed the dry feed system study (part of the pilot plant conceptual design), resulting to the selection of a system based on Stamet pump technology for the pilot plant program. This feed system may be tested during the injector cold flow tests.

Benefits

Preliminary economic analysis has shown reduction in the cost of electricity relative to current technology, range from 15 percent to 18 percent for near term technologies, with >10 percent reduction in plant capital cost per kilowatt. Similar benefits for hydrogen production from this project are anticipated — a 15 percent reduction in capital cost and 19 percent reduction in hydrogen production costs.



Advanced Gasification Systems through Rocket Engine Technology