R & D facts
U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Separations and Fuels Processing

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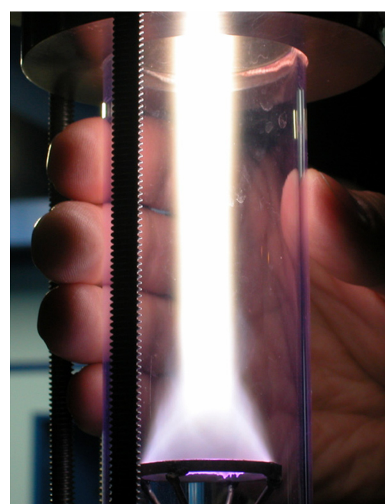
Plasma Reforming Technology Project

Background

The U.S. Department of Energy (DOE) sponsors development of mass-manufactured high temperature fuel cell power systems based on solid oxide technology through its Solid State Energy Conversion Alliance (SECA) program. One of the applications of this program is a diesel-fueled auxiliary power unit (APU) for long-haul truck transportation. The fuel processor is a critical component of this system and must be able to provide a clean, tailored synthesis gas to the fuel cell stack for long-term operation. Most known catalytic-only systems are not capable of sustained reforming operation in low steam concentration (dry) reforming conditions. Oxide-based catalysts show some promise but are unproven at this point.

Novel approaches are necessary for the development of robust fuel processors for fuel cell systems. Non-catalytic processes, such as plasma reforming, need to be evaluated and considered. Because of the absence of any catalyst that can be deactivated in the presence of highly complex, diesel-like fuels, low-temperature non-thermal plasma may be a viable alternative to the catalytic process. Plasma techniques to reform a simple hydrocarbon such as methane are well known. However, the technical and economic viability of reforming higher hydrocarbons (i.e. diesel) using plasma has yet to be established. A series of plasma techniques using different plasma discharge mechanisms used for reforming are as follows: Corona, Gliding Arc, Dielectric Barrier, Radio Frequency, Microwaves. The reverse vortex plasma reformer, which uses a Gliding Arc discharge, will be explored for hydrocarbon fuel reform. This novel type of reactor design has a plasma discharge that is created and contained within a vortical counter-current flow-field. The technology will be supplied by Drexel Plasma Institute (DPI) of Drexel University, Philadelphia, PA, and evaluated by NETL.



Gliding arc plasma reformer

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Objective

The main objective of this project is to evaluate the use of plasma energy to reform heavy hydrocarbons (diesel) into hydrogen-rich synthesis gas for use by high-temperature fuel cells being developed in the SECA program. The project's specific target is to develop a "waterless" plasma diesel fuel reformer with 100 percent fuel conversion to less than C3 hydrocarbons with minimal carbon formation or performance decline and parasitic power consumption of less than 3 percent.

Accomplishments

DPI is designing and constructing a special plasma system, the Gliding Arc in Tornado (GAT) reactor, for technology evaluations at NETL. Currently, this system is undergoing initial testing at DPI and should be shipped to NETL in January 2007. To prepare for the Drexel plasma reactor, the Catalyst Screening Unit at NETL has been successfully modified and shaken-down.

Benefits

Non-equilibrium plasma generated in the Gliding Arc demonstrated the potential of combining advantages of both thermal and non-thermal plasmas in optimized regimes. GAT is a source of non-equilibrium plasma for plasma-catalytic processing of partial oxidation. This means that energy for chemical conversion is taken mostly from the process itself, and only a small portion (about 2 percent) is supplied by plasma. The GAT system is especially promising for liquid fuel conversion because the reverse vortex flow that stabilizes plasma has a natural place for a second flow injection, such as disperse fuel. Absence of such a place in conventional vortex reactors and resulting fuel coking are major reasons for significant delays in commercialization of the technology developed to date.

Photo of plasma from the top down into the reactor