HYDROGEN INITIATIVE Research & Development

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Reforming Diesel Fuel to Hydrogen

The INEEL is participating with SOFCo EFS in its 500 kWe Integrated Fuel Processor Program -- part of the Ship Service Fuel Cell Program of the US Navy – to design, fabricate and test a first generation integrated fuel processor for producing hydrogen-rich gas from NATO-76 diesel fuel, as part of a fuel cell electric power generation system. The process utilizes technology developed by SOFCo EFS, and when completed, the processes could provide clean electric power on Navy ships or as a stand-alone power system in remote areas such as Yellowstone National Park.

How the Process Works

The Integrated Fuel Processor takes in diesel fuel, air, and water. It reacts these components to make a gas mixture containing about 30% hydrogen and various inert gases from the air – like carbon dioxide, steam, and nitrogen. This mixture is fed to a catalytic burner (similar to flameless kerosene space heaters used in many home garages or shops) that is used to simulate a fuel cell. The burner reacts about 80% of the hydrogen with added air to make heat and water, simulating a fuel cell that has about an 80% conversion rate. A second catalytic burner reacts the rest of the hydrogen with yet more air to convert all the hydrogen to steam. The system then vents an inert mixture of carbon dioxide, steam, and nitrogen. The entire process is show in the illustration at right.

The hydrogen that is made exists for about 15 seconds before it moves to the end of the process where it is oxidized. There is no intermediate storage of hydrogen or other gases in the process. The amount of pure hydrogen gas that exists at any instant is about 46 cubic feet – one-fourth of the amount in a typical laboratory gas cylinder. The very low inventory of hydrogen does not present an extraordinary hazard.

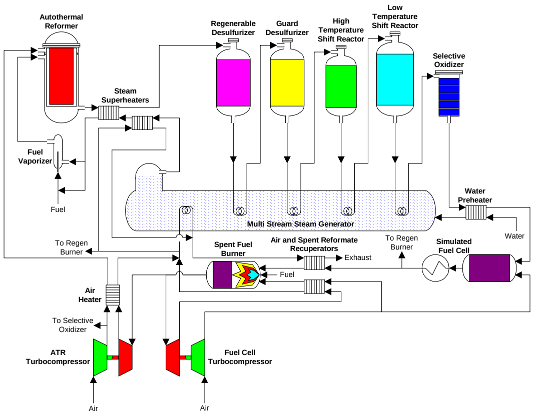
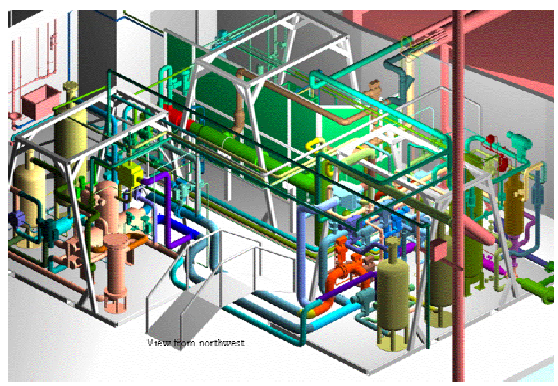


Diagram of the integrated diesel fuel reforming flow process (above), and schematic of the system installation (below).



Safety Features

The system is designed to be inherently safe. A Hazardous and Operability analysis was performed to identify and resolve potential safety concerns with the design of the process. Because the system only uses diesel fuel, air and water as feeds, there is no possibility that hydrogen – or any other hazardous gas – will leak, unless the process is running. A process control computer dedicated to this system

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tracks about 150 measurements – 50 of which can trip an automatic shutdown. Unless all these conditions are as intended, the computer will not allow either diesel fuel or air into the process. The control system must verify that the process is working properly several times per second to allow the process to continue to operate. Without this verification the process will automatically shutdown to a safe condition within two to five seconds.

Testing and Characterization Phase

The system will undergo a six-month start-up, testing and characterization period, followed by a series of formal tests for the Navy. In all, about 500 hours of operation are anticipated over the six-month period. While operating, the system will use about 30 gallons of diesel fuel per hour. Normal emissions from the operation will consist of water vapor, carbon dioxide and nitrogen. Sulfur that was introduced with the fuel, and captured on regenerable sulfur sorbent, will be periodically oxidized and released to the atmosphere. While the amount of Sulfur is small, it is equivalent to about 2.5 lbs – or less – per hour of operation, and is below regulatory limits requiring control or permits.

Subcontractor Atlas Mechanical is currently installing the integrated fuel process system at the INEEL's Engineering Demonstration Facility in Idaho Falls, Idaho.

The INEEL Engineering Demonstration Facility (top photo) and the diesel reformer equipment under construction (bottom photo).