B75-10205

NASA TECH BRIEF

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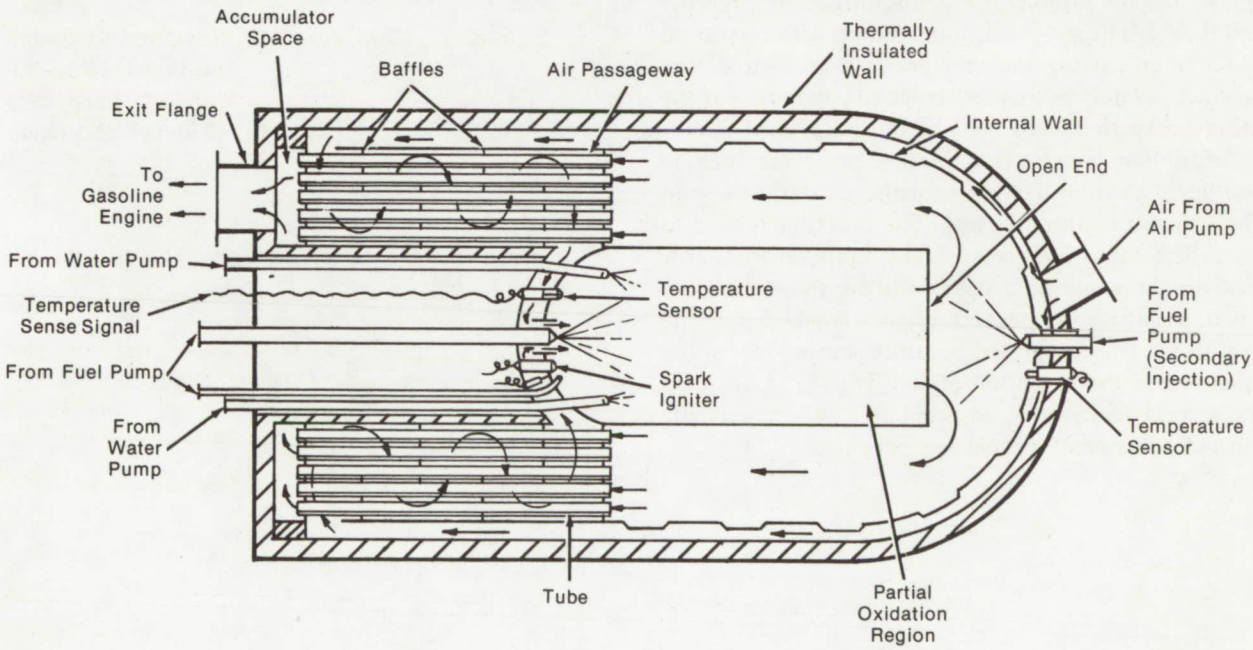
Gas Generators Produce Hydrogen-Rich Fuel

Several new gas generators have been proposed which produce hydrogen-rich fuel from gasoline and water. The resulting fuel can be burned by gasoline engines with significantly reduced pollution and improved fuel economy. The generators are similar to those described in NASA Tech Brief B75-10208 (NPO-13560 and NPO-13561) but they use water in the process.

A typical generator as shown in the illustration is enclosed by a bell-shaped thermally insulated wall. Underneath this wall is an air passageway bordered by another wall. This second wall surrounds a hot region and preheats the air moving through the passageway. The hot air is fed through a heat exchanger consisting of baffles and tubes and into a partial oxidation region. At the entry, the hot air is mixed with the fuel fed by a pump. This fuel-rich mixture is spark ignited. The resulting vortex-type flame produces high turbulence which thoroughly mixes the air with the fuel. A sufficient amount of air is provided to prevent the formation of carbon, yet the quantity is controlled to prevent complete fuel oxidation.

As the combustion is taking place, two tubes feed water spray into the region. The spray is vaporized by the hot gases, and the resulting steam is mixed with the partially burned fuel. The entire mixture leaves the oxidation region through an open end.



Gas Generator

(continued overleaf)

A second spray of liquid fuel is introduced into a space facing the open end of the oxidation region. The spray mixes with the partially burned fuel and vaporizes rapidly. A steam-reforming reacton then takes place in the space between the inner wall and the oxidation region. As an example, the reactions which occur are as follows:

$$C_8H_{18} + 8H_2O \rightarrow 8CO + 17H_2$$

$$C_8H_{18} + 16H_2O \rightarrow 8CO_2 + 25H_2$$

$$CO + H_2O \rightarrow CO_2 + H_2$$

The first reaction is the major one; the last two reactions are of lesser importance. The spray nozzle is carefully selected to correct curve angle and spray penetration. This insures uniform mixing of the hot gas and the vaporized fuel.

Should it be desired to speed up the steam-reforming reaction, a catalyst can be placed in the reaction space. This is particularly effective when the fuel contains no materials like lead or sulfur that would poison the catalyst.

The resulting hot product gas flows through the tubes and is partially cooled since these tubes constitute a heat exchanger interacting with the incoming air. The tubes terminate in the accumulator space, and the product gas is discharged through the exit flange. The gas is still superheated with respect to water upon leaving the reactor. If it is desired, the product gas may be further cooled to condense out the water for recirculation back to the water feed tank.

Additional components in the generator include another fuel tube feeding into the oxidation region and two temperature sensors. The fuel tube is used to start the combustion process. The temperature sensor used in the same area opens up the main fuel line when a sufficient temperature is reached for the oxidation. The second temperature sensor, facing the open end of the oxidation region, is used to open up the second fuel nozzle adjacent to it when partially burned gases reach proper temperatures.

The fuel flow, the water flow, the temperature sensors, and the ignition are all controlled by electronic circuitry. The other generator models are modified versions of the one explained. All are described in a published report. Some simplifications have been made. For example, the secondary fuel injection has been eliminated, and water has been added as steam and premixed with air before the fuel is added. This results in slightly better hydrogen yield with a marked decrease in soot. Other modifications such as internal water injection, emulsions of fuel and water, and a pneumatic atomizer have also been examined.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Pasadena, California 91103
Reference: TSP75-10203

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to the California Institute of Technology, Pasadena, California 91109.

Source: John Houseman, Raymond Kushida, and Jack H. Rupe of
Caltech/JPL
(NPO-13342 and NPO-13464)

Categories: 06 (Mechanics)
04 (Materials)
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02 (Electronics Systems)