HYDROGEN GENERATION FROM PLASMATRON REFORMERS AND USE FOR DIESEL EXHAUST AFTERTREATMENT

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ABSTRACT

The status of plasmatron reformers under development at the Massachusetts Institute of Technology (MIT) and ArvinMeritor will be presented. In these reformers, a special low- power electrical discharge is used to promote partial oxidation conversion of hydrocarbon fuels into hydrogen and CO. This very fuel-rich mixture reaction is hard to initiate, and the plasmatron provides continuous enhanced volume initiation. To minimize electrode erosion and electrical power requirements, a low-current, high- voltage discharge is used, with wide area electrodes. The reformers operate at or slightly above atmospheric pressure.

Plasmatron reformers provide the advantages of rapid startup and transient response; efficient conversion of the fuel to hydrogen-rich gas; compact size; relaxation or elimination of reformer catalyst requirements; and capability to process difficult-to-reform fuels, such as diesel and bio-oils. These advantages facilitate use of hydrogen-manufacturing reformation technology for diesel exhaust aftertreatment. Plasma-enhan-ced reformer technology can provide substantial conversion even without the use of a catalyst.

Recent progress includes substantial decrease in electrical power consumption (to about 200 W), increased flow rate (above 1 g/s of diesel fuel corresponding to approximately 40 kW of chemical energy), soot suppression, and improvements in other operational features.

This technology has been evaluated for use as a regeneration mechanism for NO_x-adsorber aftertreatment systems. At ArvinMeritor, tests were performed on a dual-leg NO_x adsorber system using a Cummins ISC 8.3L diesel engine in a vehicle. A NO_x adsorber system was tested with the plasmatron reformer as a regenerator, and without the reformer (i.e., with straight diesel fuel based regeneration as a baseline case).

The plasmatron reformer was shown to improve NO_x regeneration significantly, compared to the baseline diesel case. The net result was a significant decrease in fuel penalty, roughly 50 percent at moderate catalyst temperatures. This improvement is accompanied by a dramatic drop in slipped hydrocarbon emissions, which decreased by 90 percent or more. Significant advantages are demonstrated across a wide range of engine conditions and temperatures. The study also indicated the potential to regenerate catalytic adsorbers at low temperatures where diesel fuel based regeneration is not effective, such as are typically seen at idle conditions. A vehicle has been equipped for plasmatron reformer exhaust aftertreatment tests.