Success Story

Plasmatron Fuel Converter Reduces NO_x Emissions from Diesel Engines

Background

Research funded for several years by the U.S. Department of Energy's FreedomCAR and Vehicle Technologies Program and later by ArvinMeritor, Inc., has led to deployment of a new technology that can substantially reduce harmful exhaust emissions from diesel vehicles and potentially increase gasoline engine efficiency.

Originally envisioned as a device for producing hydrogen-rich gas from gasoline, diesel, or biocrude fuels onboard a vehicle for use in the engine, the plasma fuel reformer, or "plasmatron," as it is also known, has evolved into a powerful tool for exhaust aftertreatment to reduce nitrogen oxide (NO_x) emissions from heavy-duty diesel engines.

Heavy-duty diesel engine manufacturers are particularly concerned about NO_x emissions, due to strict new U.S. NO_x and particulate matter emissions regulations that will phase into effect starting in 2007. Because aftertreatment technologies can be implemented on new or existing equipment, they can be more cost-effective ways to address NO_x emissions across a heavy-duty fleet, as opposed to some NO_x-reduction methods, which can only be implemented in new engines at the time of manufacture. Since heavy-duty diesel vehicles can stay in operation for as long as 20–30 years, retrofit solutions are very important to preserving heavy-duty vehicle owners' investments.

The Technology

In development since the late 1990s, the plasmatron is an onboard "fuel reformer" that converts a variety of fuels into high-quality, hydrogen-rich gas. Adding a relatively modest amount of such gas (hydrogen) to a car's gasoline engine or to a diesel vehicle's exhaust is known to reduce emissions of certain pollutants.

Researchers from ArvinMeritor and from the Massachusetts Institute of Technology (MIT), who did the original laboratory research, have reported that the device, when used with an exhaust treatment catalyst on a diesel engine bus, removed up to 90 percent of NO_x from the vehicle's emissions. Nitrogen oxides are the primary components of smog. ArvinMeritor has an exclusive license for this use of plasma fuel reformer technology from MIT.

The plasmatron reformer also decreased the amount of diesel fuel that had to be expended for the NO_x removal process (by using an adsorption catalyst). "The adsorption catalyst approach under consideration for diesel exhaust NO_x removal requires additional fuel to work," explained Daniel R. Cohn, one of the leaders of the research team and head of the Plasma Technology Division at MIT's Plasma Science and Fusion Center (PSFC). "The plasmatron reformer can reduce the amount of fuel required by a factor of two, compared to a system without the plasmatron."

In testing, plasma fuel reformer technology coupled with an exhaust treatment catalyst (NO_x trap) removed 90 percent of the smog-producing nitrogen oxides (NO_x) emitted from this bus at the ArvinMeritor test track in Columbus, Indiana.

Commercialization

With support from the State of Indiana 21st Century Research and Development Fund, ArvinMeritor has been developing the plasma fuel reformer for use with a NO_x trap system on heavy-duty vehicles. NO_x traps work by adsorbing NO_x from the exhaust stream so it cannot pass into the atmosphere. These traps require

periodic regeneration with hydrocarbons or hydrogen to reactivate the trap's reagents. Although diesel fuel can be used for this purpose, it reduces the vehicle's fuel efficiency and risks passing unburned diesel fuel into the atmosphere.

ArvinMeritor has demonstrated the system on a bus at an Indiana test track with very promising results. The combined plasma fuel reformer-NO_x trap system not only reduced NO_x emissions and fuel required for catalyst regeneration, it also achieved successful regeneration at a lower temperature than is typical for such systems. Regenerating at lower temperatures allows use over a significantly wider range of vehicle operating conditions, extending the life of catalysts used in NO_x traps and reducing their energy consumption.

Benefits

- Reduces diesel NO_x emissions by up to 90% when used with a NO_x adsorber catalyst
- Operates effectively at lower temperatures than other NO_x-removal systems
- Does not require engine modification
- Can be installed as a new or retrofit solution
- Cuts fuel required for adsorber catalyst regeneration by half
- Pays for itself in fuel savings

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