THERMOELECTRIC TECHNOLOGY FOR AUTOMOTIVE APPLICATIONS

Aleksandr S. Kushch, John C. Bass, and Mark Hauerbach
Hi-Z Technology, Inc.

and

Richard A. Bergstrand, Lew Plummer, David Furrow, and Mike Melvin
PACCAR Technical Center

A thermoelectric generator (TEG) waste heat recovery system for Class 8 diesel trucks is under development by Hi-Z Technology and PACCAR. The TEG was assembled and tested at Hi-Z and integrated by PACCAR into the exhaust system of a Kenworth truck, which is equipped with a Caterpillar 550-hp diesel engine. The TEG is mounted on the truck frame under the cab. The shock absorption system developed by PACCAR reduces the mechanical impact of the harsh road environment. The inlet of the TEG is connected with the engine exhaust via an 80-inch insulated pipe. TEG cooling plenums are integrated into engine cooling system by means of flexible hoses. An additional heat exchanger is installed into the coolant line in order to reduce the coolant temperature. The test truck is equipped with the data acquisition system that allows recording of all the engine parameters (speed, load, rpm, temperatures, etc.)

A test truck with a TEG has already completed a test run that is equivalent of about 100,000 miles and is continuing. No TEG mechanical damage or internal resistance change has been recorded yet.

A self-powered cab/space heater needed to minimize cold weather truck idling has also been demonstrated by Hi-Z. The D1LC heater manufactured by Espar has been modified by integration of two HZ14 thermoelectric modules (TEM) and pin-type heat sinks. The heater uses diesel/gasoline as the fuel and uses about 22 W of electric power when operated at a high thermal output mode; it releases 2 kW of thermal energy. The TEM's were sandwiched between two flat sides of the heat exchanger and the heat sinks. The circulation blower conveys the ambient air through the heat sinks ensuring TEM cooling and drives the heated air into the cab.

The TEM's generated about 26 W of electricity, which is more than sufficient to make the unit self powered. The self-powered heater was assembled and tested with a DC/DC converter and a battery. During startup, a battery supplied power for the igniter, blowers, and pump. After 2 minutes, the TEM generated sufficient electric power and also recharged the battery.

A similar unit can be converted into a larger auxiliary power (APU) unit by adding more thermoelectric modules. Diesel-driven APU's can be used as an anti-idling device, saving considerable fuel and reducing pollutant emissions.