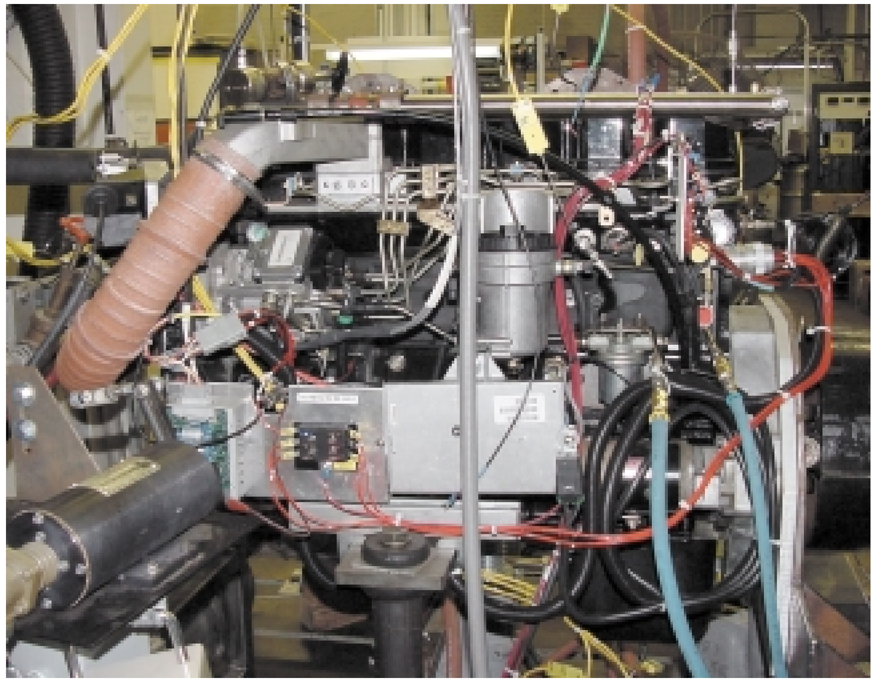
Cleaner Reciprocating Engines for Transportation and Power

Large reciprocating engines ("recips") make up about 48% of today's combined heat and power installations, dominating the small-scale distributed power market. These recips are internal combustion, piston-driven engines much like the ones that pull big rigs down the highway. While recips for transportation are generally fueled by diesel, those being used in distributed generation applications run on propane or natural gas. However, some of the goals and technology needs for both types of engines are similar: reduce emissions, improve efficiency, and hold or reduce costs.

One barrier to the wider use of recips, in DG systems as well as in transportation, is emissions. Oxides of nitrogen (NOx) are of particular concern in natural-gas recips. Driven by increasingly stringent standards for heavy-duty diesel engines in large trucks, industrial partners are working with ORNL to decrease and control NOx and other emissions. That R&D is expected to improve the emissions characteristics of gas-fueled recips for DG applications, also.



A reciprocating engine undergoing emissions testing in ORNL's Advanced Propulsion Technology Center.

The goals of improved engine efficiencies, fuel flexibility, and maintenance intervals equal to or better than those for existing models will require materials that can withstand higher operating temperatures in a variety of combustion environments. Higher-temperature operation can mean higher efficiencies and lower emissions.

To help meet that need, ORNL is developing advanced materials to overcome specific technology barriers. These materials include advanced metal alloys, intermetallic alloys, high-temperature ceramics, metal-matrix composites, ceramic-matrix composites, cermets, and bulk amorphous metals. The High Temperature Materials Laboratory gives the ORNL R&D staff unmatched capabilities in atomic-scale microscopy, materials processing, and component grinding and finishing. Some of the materials work is focused on the fuel system, including the development of carbon storage materials for gaseous fuels, and wear- and scuff-resistant materials for fuel injection systems.

The Advanced Propulsion Technology Center is the site of R&D on just about every aspect of reciprocating engines other than materials. It can apply unique diagnostic and analytic tools for system simulation and optimization, emissions measurement, and emissions control R&D. ORNL collaborates with engine and auto industry partners in areas including improved catalyst development, studies of engine cyclic dispersion, NOx sensors, ignition modeling and diagnostics, and development of high-speed, mass spectrometer–based emissions instrumentation.

Contact: David P. Stinton, 865-574-4556, stintondp@ornl.gov
Sponsor: Office of Heavy Vehicle Technologies and Office of Distributed Energy Resources

Continued from page 5

turbine engine recuperator (a heat exchanger that increases engine efficiency by using heat recovered from the exhaust to preheat inlet air). A team consisting of ORNL, Allegheny-Ludlum, and Solar Turbines developed a process for strengthening the material for improved durability at normal or higher temperatures and pressures. The new processing technique and improved recuperators are still being tested by Solar Turbines and Allegheny Ludlum and will eventually be incorporated into industrial-sized gas turbine engines.

What's next for turbines? Like most systems, they're getting smaller. Commercial businesses are interested in microturbines for distributed energy systems. Whereas large gas turbines generate from 3 to 30 MW of electricity, microturbines generate 500 kW or less. Many of the technical challenges are similar and involve materials R&D. ORNL's one-of-a-kind combination of research expertise, facilities, and equipment is making a major contribution toward ensuring that tomorrow's dominant source of electrical power is highly efficient and low in emissions.

Contact: Michael A. Karnitz, 865-574-5150, karnitzma@ornl.gov
Sponsor: Office of Power Technologies, Office of Industrial Technologies Implementation A