Scuffing Reduction in Diesel Engines

Heavy Vehicle Propulsion System Materials

Transportation

FOR THE 21ST CENTURY

U.S. Department of Energy

Energy Efficiency and Renewable Energy Program

Oak Ridge National Laboratory

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Background

Under the direction of the U.S. Department of Energy (DOE) FreedomCAR and Vehicle Technologies Program, Oak Ridge National Laboratory (ORNL) is conducting research on new materials and surface treatments to improve the durability and fuel efficiency of diesel engines. Reducing wear and tear on critical mechanical parts in exhaust gas recirculation (EGR) systems and fuel delivery systems is key for meeting future diesel engine emission goals.

The scuffing of mating parts in diesel engines can lead to catastrophic wear and a loss of function. It results from the failure of a lubricant to effectively separate moving surfaces. The phenomenon is particularly insidious because it can appear with little warning, causing parts to seize or sealing surfaces to leak. Consequently, the development of new materials and surface treatments to resist scuffing enables next-generation designs for new, energy-efficient, low-emission engines.

The Technology

A three-pronged approach is under way to attack diesel engine component scuffing problems: (1) scuffing test method development, (2) collaborative research projects with diesel engine companies, and (3) research to elucidate the effects of microstructure, composition, and heat treatment on the tendencies of different materials to scuff.

Engine testing of candidate materials is very expensive, so ORNL developed laboratory-scale test methods to simulate scuffing conditions in critical areas of diesel engines.

A high-temperature, oscillating scuffing testing rig was built to simulate conditions in EGR control valve actuators. Actuators operate at temperatures as high as 650ºC with little or no lubrication, and this creates scuffing problems. Test results have identified promising ceramics and intermetallic alloys. By taking advantage of the High Temperature Materials Laboratory User Program, a major diesel engine manufacturer used the scuffing test system to evaluate candidate material combinations for a new engine emissions control system.

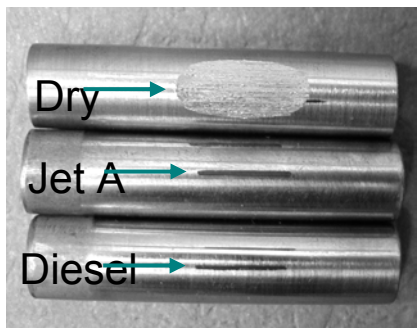
Another type of test, using twin crossed cylinders, was developed to study scuffing in high-precision, diesel engine fuel injection systems. Tests were run in both current and low-sulfur diesel fuels to study the onset of scuffing and its sensitivity to both material type and surface condition.

Future Direction

Future goals include preparing "scuffing control maps" for various material combinations to mark critical thermal and mechanical conditions that lead to scuffing in engine parts. Ultimately, a mathematical model will be developed that will predict the tendency of given materials or surface treatments to scuff based on their metallurgy, surface finish, and the environment to which they are exposed.

Benefits

- Reduces cost and time needed to characterize scuffing characteristics of engineered materials
- Diesel engine companies can utilize the test equipment through existing User Programs
- Leading to a fundamental scientific basis for selecting materials for scuffing-prone diesel engine wear parts



Low-sulfur fuel (Jet A) produces more scuffing damage on bearing steel than standard No. 2 diesel fuel.

For more information on how ORNL is helping America remain competitive in the 21st century, please contact:

D. Ray Johnson, Manager
Heavy Vehicle Propulsion System Materials Program
Metals and Ceramics Division
Oak Ridge National Laboratory
(865) 576-6832
johnsondr@ornl.gov

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