Improving Energy Use in Heavy-Duty Trucks and Diesel Locomotives

Heavy-duty trucks and trains spend a great deal of time running their engines when stopped, a practice known as idling. They also lose energy to wind resistance (aerodynamic losses) and operation of components such as pumps and compressors (parasitic losses). Researchers at Argonne National Laboratory are exploring ways to improve these vehicles so they can become more energy-efficient.

Mitigating Heavy Engine Wear Resulting Emissions Reduction Efforts

As diesel engine manufacturers work to meet stringent new emissions regulations taking effect later this decade, they are confronting several related issues that affect engine longevity and performance. The implementation of a new low-sulfur diesel fuel standard in 2006 will result in fuels that have lower levels of lubricious compounds, potentially leading to increased wear on engine fuel system components. Some manufacturers may also use a technique known as exhaust gas recirculation (EGR) to reduce vehicle emissions, even though EGR may degrade the engine oil. Argonne researchers are looking at ways to address the engine wear concerns raised by new fuels and emissions control techniques. They are evaluating vegetable-based and boric-acid-based lubricity enhancers for low-sulfur fuels, which can lessen the harmful effects of lower-lubricity fuels on engine components. They are also looking at the use of advanced coatings (such as near-frictionless carbon films) on selected engine components, which help to protect component surfaces against the effects of reduced fuel lubricity and increased engine heat and friction. Such coatings are now being used by several diesel engine manufacturers as they prepare for the introduction of low-sulfur fuels and new emissions reduction techniques. It is likely that solving the engine wear problem will require some combination of lubricity-boosting fuel additives, friction-reducing surface coatings, and more durable advanced component materials.

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Reducing Truck and Locomotive Idling

Argonne researchers authored a landmark study in 2000 entitled, "Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks," (available at http://www.transportation.anl.gov/research/technology_analysis/idling.html) that set the stage for a revolution in the way heavy-duty trucks operate. Argonne researchers conducted a similar analysis for locomotives that is discussed in a presentation at http://www.transportation.anl.gov/pdfs/RR/290.pdf. An updated and expanded study covering all heavy vehicle modes is in progress. In the years since the truck study was first published, government agencies and the trucking and railroad industries have worked to reduce idling time and develop equipment options that preserve operator comfort during rest periods without the need for idling. Collaborating with the U.S. Department of Transportation, U.S. Department of Defense, U.S. Environmental Protection Agency, and industry stakeholders, the U.S. Department of Energy and Argonne researchers are working on a draft National Idling Reduction Plan for heavy vehicles.

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Controlling Heat Production in Heavy Vehicles

Controlling heat production (thermal control) in heavy vehicles can affect engine performance, fuel economy, safety and reliability, engine/component life, driver comfort, materials selection, emissions, maintenance, and aerodynamics. Improved equipment capabilities increase demand for more powerful engines, more air conditioning, more stringent emissions requirements, and additional auxiliary equipment, which in turn boost the heat rejection requirements of large trucks. In response, manufacturers must design higher-performing thermal control systems that are smaller, lighter weight, and require less fluid inventory. Argonne researchers are investigating methods of dissipating heat build-up, including the use of phase-change heat transfer, nanofluid coolants, and evaporative cooling to enhance air-side heat rejection; as well as operating with engine coolant at higher temperatures.

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