Improving Energy Use in Heavy-Duty Vehicles

Technology advances in consumer automobiles may dominate the headlines, but heavy-duty trucks and trains also have challenges that need to be addressed. From excessive idling to engine wear, Argonne researchers are currently tackling a number of energy-related issues for heavy-duty vehicles.

What is Argonne doing?

Reducing Truck and Locomotive Idling

Opportunity: Idling is a common practice for big rigs. However, it leads to the consumption of about 20 million barrels of diesel fuel each year, resulting in emissions of about 10 million tons of carbon dioxide, 50,000 tons of nitrogen oxides, and 2,000 tons of particulates. Trains also idle frequently. Typically, switcher locomotives idle 75 percent of the time, which accounts for 27 percent of their total fuel use.

Solution: In 2000, Argonne researchers set the stage for a revolution in the way heavy-duty vehicles operate, with a landmark study entitled, "Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks." The Laboratory did a similar analysis for locomotives. Argonne continues to do research to compare the energy use, emissions, and economics of different idling reduction technologies.

Outcome: 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. Argonne's continued research makes it easier for those in the trucking and train industries to evaluate competing technologies and decide which option is best for them.

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Using Nanofluids to Control Heat Production

Opportunity: Modern diesel engines for heavy vehicles are designed for the most demanding conditions – driving full loads up steep grades in the hottest temperatures. These conditions call for bigger and heavier radiator systems, which in turn increase the parasitic energy losses from cooling fans.

Solution: To mitigate this problem, Argonne is investigating the use of nanofluids (fluids containing small nanoparticles of metals, oxides, carbides, nitrides, or nanotubes) that enhance the thermal conductivity of the fluid, thereby removing more heat. Research indicates that an ideal nanofluid could result in a reduced radiator size and increased fuel efficiency.

Outcome: Argonne is working with several large companies, including manufacturers of heavy vehicles, tire manufacturers, and manufacturers of nanoparticles, to develop and test nanofluids. This group is also testing various characterization techniques, such as laser scattering and small-angle X-ray scattering to measure nanoparticle size, shape, and distribution.

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Addressing New Engine Wear Concerns

Opportunity: New fuels and new emission regulations are having an impact on the longevity and performance of diesel engines. A new low-sulfur diesel fuel standard resulted in fuels with lower levels of lubricious compounds, which could potentially lead to increased engine wear.

Solution: Argonne researchers are evaluating vegetable-based and boric acid-based lubricity enhancers for low-sulfur diesel fuels, which can lessen the harmful effects of lower-lubricity fuels. They are also looking at reducing the damage caused by increased engine heat and friction by using advanced coatings such as near-frictionless carbon films.

Outcome: These coatings are now being used by several diesel engine manufacturers to offset the effects of low-sulfur diesel fuels and new emissions reduction standards. 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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