Innovative climate control technologies boost vehicle economy, decrease emissions

OAAT ACCOMPLISHMENTS

Vehicle Auxiliary Loads Reduction

Challenge

The vehicles of today and tomorrow are in need of systems that reduce vehicle auxiliary loads. Such loads, like the climate control system on an automobile, can dramatically reduce fuel economy and increase emissions. Moreover, future vehicles, such as hybrid electric vehicles, will use smaller engines that will not be able to handle peak air-conditioning loads (sometimes as high as 6 kW) or cabin heating requirements without serious fuel economy penalties. The goal of this project is to reduce the amount of fuel used for air conditioning by 50-75%.

Technology Description

This project has focused on defining the impacts of, and developing cost-effective solutions for, vehicle auxiliary loads, especially those associated with an automobile's climate control system. Activities have included defining "worst case" solar incidence and heat scenarios, modeling air-conditioning processes and human thermal comfort, and testing material barriers to solar heat penetration. To achieve the project's goals, innovative techniques and technologies will be utilized to reduce the energy expended for vehicle auxiliary loads, manage peak loads, and optimize climate control systems and strategies.

Accomplishments

- Developed a human thermal comfort model.
- Tested in-vehicle solar reflective glass and determined resulting fuel economy and emissions impacts.
- Initiated development of a thermal manikin that simulates the human thermoregulatory system and can be used to predict the human response to an advanced climate control system.
- Defined a "worst case" solar incidence environment based on data collected in Phoenix, Arizona.
- Integrated a suite of analytic tools designed to analyze a vehicle's passenger compartment to assess human thermal comfort.
- Initiated development of a two-phase, transient air-conditioning model using Sinda/Fluint and Flowmaster.

Outdoor testing to evaluate impacts of advanced climate control technologies.

Benefits

Vehicle air-conditioning systems can increase nitrogen oxides (NO_x) emissions by as much as 80% and CO emissions by as much as 70%, as well as reduce fuel economy by as much as 22%. Conserving fuel used for the climate control system can help mitigate these associated penalties.

Reduction in weight and size of air-conditioning units, through technologies such as heat-generated cooling and component miniaturization, can reduce fuel consumption. Each 20-lb reduction in weight yields a 0.1 mpg increase in fuel economy.

Achievement of the program's goals will result in vehicle fuel economy benefits of 5-10% depending on the operating environment.

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Future Activities

Apply the results of modeling and testing to the design of systems with integrated climate control components, such as more heat-resistant window glazing, advanced heating, ventilation and air-conditioning systems, and better distribution systems that incorporate cutting-edge technologies like heat-generated cooling and component miniaturization.

Extend the work performed on air conditioning to heating applications.

Achieve commercial applications of research technologies.

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