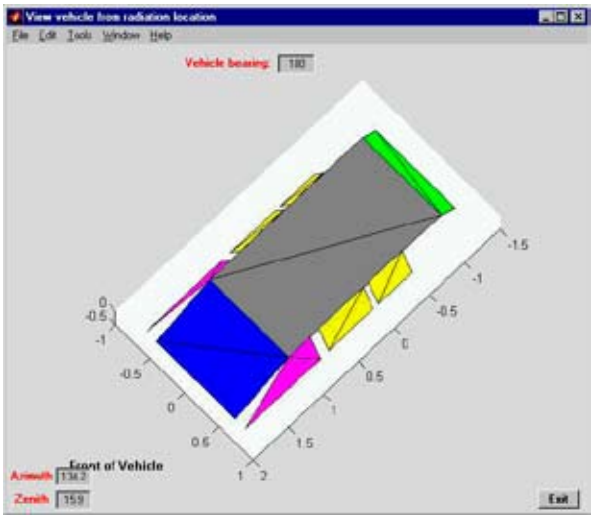
Computer Model Helps Reduce Automobile Heat Soak Temperatures

Background

When its air conditioner is in use, a vehicle's fuel economy decreases significantly, and its tailpipe emissions worsen. With high gas prices translating into concerns over fuel efficiency, there is now a strong impetus to reduce the air conditioning system compressor loads of both conventional and hybrid electric vehicles. The National Renewable Energy Laboratory (NREL) is advocating several tools in the interest of increased air conditioner efficiency. One of these tools is a vehicle solar load estimator (VSOLE), a software program intended to predict the transmitted, absorbed, and reflective power of vehicle glazings. Ultimately, the tool can enable manufacturers to reduce peak soak temperatures and, as a result, develop smaller, more efficient air conditioning systems.

The Technology

VSOLE1.0 is written in Matlab and features an easy-to-use graphical user interface. The program takes into account the angle of incidence and calculates the transmitted, reflected, and absorbed power based on the radiation source, vehicle geometry, vehicle orientation, and glazing type. All glazing surfaces are assumed to be flat, and to have constant thickness, uniform properties, and regular shape. The calculation of the optical properties as a function of wavelength and angle uses a single-pane approximation for glass. The transmitted, reflected, and absorbed power can be calculated at a specific time, a range of times, or a range of orientations. These data can be used to compare different glazings or can be applied as a boundary condition for a computational fluid dynamics (CFD) analysis. Additionally, NREL's solar radiation model provides radiation source data for VSOLE1.0 and is accessed from within the VSOLE user interface through the "pick a city" option in the radiation source pull-down menu. The solar radiation model calculates the solar spectral irradiance incident on the vehicle as a function of location, weather, and vehicle orientation. Model data are available for 239 locations in the United States and its territories in the form of weather and sun-position data extracted or derived from typical meteorological years. VSOLE also works closely with the cabin thermal/fluid model, which is used to predict the flow field inside the passenger compartment, as well as the surface temperatures and temperature and humidity of the air. Before the simulation, the boundary conditions are defined. The transmitted and absorbed solar radiation for each glazing are then generated by the VSOLE model.



Benefits

- Provides a shared simulation tool for government and industry.
- Assists the transportation industry in developing fuel-efficient vehicles and components.
- Enables quick assignment and comparison of solar reflective technologies.
- Allows calculation of radiant boundary conditions for a passenger compartment thermal model.

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