

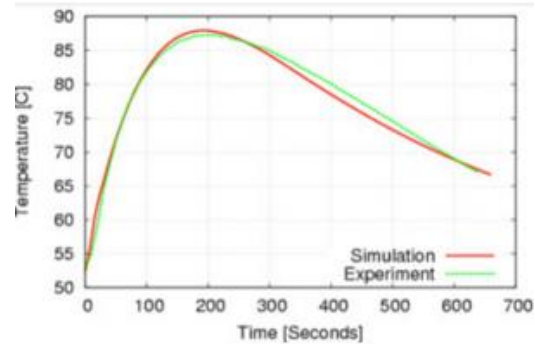
POWERFLOW FOR KEY-OFF AND SOAK



3DEXPERIENCE®

Simulating Key-Off and Soak Thermal Conditions

Many components in a vehicle can become so hot that they can potentially fail or degrade other nearby components, leading to serious safety, durability, and warranty issues. Plastic components are being used increasingly to save on cost and weight, but are more sensitive to temperature. Globalization is leading to vehicles or vehicle platforms that must operate in extremely wide operational temperature ranges. Careful and detailed analysis of component placement and thermal shielding is required to avoid costly late-stage design fixes or, worse, failures when in production. One of the most extreme thermal stress scenarios is “key-off” or “soak,” where a vehicle with a hot engine rapidly comes to a halt and the underhood temperature increases because there is no cooling airflow.



Technical Challenges

Vehicle thermal design traditionally depends heavily on prototype testing in thermal wind tunnels. This testing process is very expensive, time-consuming, and inflexible. Testing involves thermocouple instrumentation that requires test engineers to estimate a priori where thermal problems might occur — but the highly turbulent nature of convective underhood flows makes this very difficult or impossible to predict. Relying on redesign and retesting is an expensive hit-or-miss process that often ultimately fails to identify the highest temperature locations.

Heat soak is an inherently transient problem where the temperature quickly rises then gradually falls through convective cooling. This is almost impossible to visualize in a wind tunnel, yet these complex structures must be understood in order to optimally locate and protect components. In addition, temperature is a function of the complex interaction between conduction, radiation, and convection in the surrounding fluid, especially for very hot components. Accurately predicting this is extremely challenging.

Given that there is increasing pressure from the marketplace to speed up and improve the vehicle development process, it is clear that a more effective method is required to address soak early in the vehicle design process. A high-fidelity simulation is necessary to capture the relevant physics. However, simulation of a transient problem like soak is challenging and time-consuming with traditional Navier-Stokes-based fluid simulation codes because they are not inherently transient.

SIMULIA Solutions

The PowerFLOW suite is ideally suited to address soak issues. PowerFLOW's unique, inherently transient Lattice Boltzmann-based physics enables it to perform simulations that accurately predict real-world transient conditions on the most complex geometry. PowerTHERM is a fully coupled, highly accurate, conduction and radiation solver. The combination of PowerFLOW and PowerTHERM enables you to accurately predict the peak temperatures immediately after key-off and to visualize the flow and temperature fields for the entire vehicle. This enables you to identify

problem areas and provide recommendations to improve the design, and eliminate problems through thermal simulation and analysis. Rapid turnaround time for simulation and model setup enables you to quickly make design changes to the baseline and evaluate the improvements in soak performance.

Using the SIMULIA solution for thermal key-off/soak problems, you can:

- Limit peak component temperatures to avoid fire hazard or part failure.
- Optimize the protection strategy for sensitive parts using heat shields, insulating materials, or better component placement.
- Retain thermal energy in the powertrain to facilitate cold-start behavior.