SIMULIA

3DEXPERIENCE®

PowerTHERM

Simulation of thermal airflow through cabin demonstrates temperatures in HVAC vents and on human model using PowerFLOW coupled with PowerTHERM.

A COMPLETE THERMAL MANAGEMENT SOLUTION

Thermal management is a critical aspect of vehicle design. When designing with ever-tight packaging and thermally sensitive electronics and plastics for weight reduction, components can exceed safe operating temperature limits and there is potential for systems to fail. Additionally, conditions can degrade nearby components leading to catastrophic durability, safety and warranty issues. Vehicle systems (such as the engine, transmission, HVAC, or power steering) have significant energy requirements and the related thermal efficiency has a direct impact on fuel economy, performance and passenger comfort. Careful analysis of cooling airflow, component placement and thermal shielding is required to avoid costly late-stage design fixes - or worse, failures in operation.

Thermal design traditionally depends heavily on prototype testing, both in thermal wind tunnels and on roads with natural windflow. The testing process is prohibitively expensive, time consuming and inflexible. The highly turbulent nature of engine compartment and underbody flows makes physical testing with thermocouple instrumentation very difficult or impossible to predict. The inherently transient nature of turbulent flow is almost impossible to visualize in a wind tunnel, yet these complex structures must be understood to optimally place and protect components.

Temperature is a function of the complex interaction between conduction, radiation, and convection in the surrounding fluid. Accurately predicting this thermal exchange poses significant challenges to simulation methodologies.

DASSAULT SYSTEMES

SIMULIA'S SOLUTION

PowerTHERM® coupled with PowerFLOW® offers a complete, extensively validated, digital thermal management solution. PowerFLOW's unique, inherently transient, Lattice Boltzmann-based physics accurately simulates real-world transient airflow conditions on the most complex geometry. PowerTHERM is a fully coupled, highly accurate, conduction and radiation solver. The combination of PowerFLOW and PowerTHERM enables engineers to accurately predict temperatures and visualize the flow and temperature fields throughout the vehicle. Engineers can identify cause for problems and provide recommendations to improve the design to eliminate issues. Rapid turnaround time for simulation and model setup allows engineers to quickly make design changes to the baseline and evaluate multiple design variants to improve thermal performance.

PowerTHERM has been validated to help solve many thermal management problems, including:

- Underbody and engine compartment thermal protection
- Brake cooling
- Key-off /soak
- Electronics and battery cooling
- HVAC system performance
- Cabin comfort
- Defrost and demist
- Heat exchanger cooling in underhood with PowerCOOL

CAPABILITIES

PowerTHERM predicts surface temperatures and heat fluxes generated by heat radiation, conduction and convection. Convection is calculated by PowerFLOW and coupled to PowerTHERM via an integrated interface enabling two-way data exchange. The coupled simulation is easily set up as part of a regular PowerFLOW simulation. The result is a complete flow and heat transfer simulation allowing the user to efficiently and accurately predict thermal results.

Add on capabilities are available with PowerCOOL to model heat exchangers such as automotive radiators and charge air coolers and used in instances such as cooling the underhood. When coupled with PowerFLOW simulation, engineers can predict the calculated heat exchange between the air flow and the heat exchanger. The result is provided as the temperature of the coolant at the inlet of the heat exchanger (top tank temperature) or the heat rejection. Other results include distribution of air parameters like velocity, temperature, and density on the surface of the heat exchanger as well as coolant temperature distribution within the heat exchanger. These results provide essential information needed for positioning heat exchangers, understanding operation and optimizing overall underhood design of a vehicle.

BENEFITS:

Faster product development
Improve designs through early stage thermal evaluation

Reduce development costs
Decrease or eliminate the need for prototype testing throughout the design process

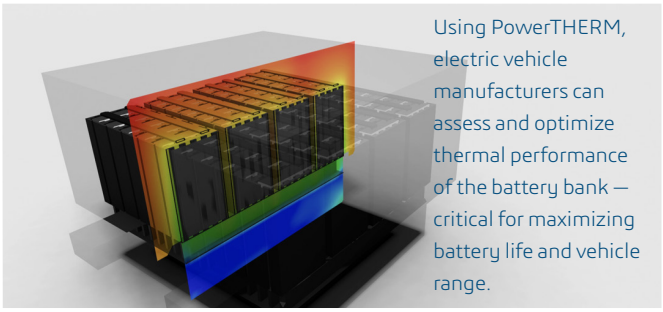
Improve products
Comprehensive, early-stage thermal testing results in better products with increased reliability and longevity

Warranty savings
Improved thermal evaluations catch potential warranty risks early in the process

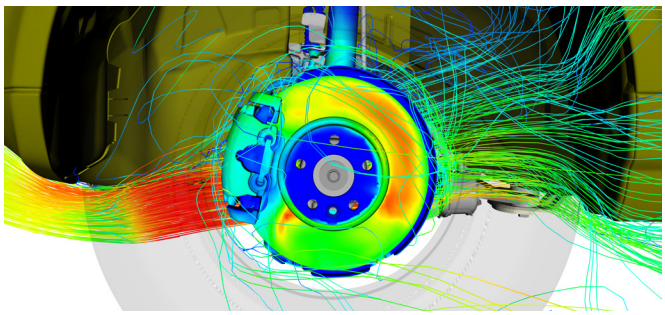
Improve efficiency
By maintaining optimal thermal operating conditions, vehicle efficiency improves

Increase customer satisfaction
Increase customer satisfaction through analysis of cabin airflow and occupant comfort

Improve thermal safety with PowerCOOL
Ensure that heat generating exchangers are at safe temperatures with optimized coolant flow and pressure.



Using PowerTHERM, electric vehicle manufacturers can assess and optimize thermal performance of the battery bank — critical for maximizing battery life and vehicle range.



Evaluate and optimize cooling airflow to the brakes using SIMULIA PowerFLOW and PowerTHERM.

Advanced solver for radiation, conduction and convection

- Multi-bounce radiation
- Shell and solid conduction models
- Convection via coupling with PowerFLOW
- 1-D advection and fluid stream models for modeling coupled internal flows, e.g., within an exhaust system
- Temperature dependent properties including, conduction, specific heat, and emissivity
- Handles multi layer parts: solid, air, vacuum or mixed
- Efficient and robust numerical scheme with adaptive solution algorithms

Accurate and efficient over many time scales

- Steady-state or transient
- From a few seconds to hours

High performance and easy-to-use

- Rapid, easy-to-use, thermal model creation and case setup
- Seamless, integrated coupling with PowerFLOW fluid simulation
- Results analyzed in PowerVIZ, SIMULIA's powerful simulation results visualization & analysis environment—a single environment for analyzing the flow results.
- Optional parallel processing for reduced simulation time

Battery cell model

- Optional module for coupled thermal-electrical analysis of a battery cell or pack
- Supports both charging and discharging states
- Captures realistic time-varying loads and charges

Natural environment models for accurate climate control analysis

- Solar loading–direct, diffuse, and reflected
- Wind loading

Human comfort model

- Optional module for advanced human thermal comfort within complex environments
- Place virtual test dummies with layers of clothes into virtual operating environment and compute comfort indexes
- Full radiant, convective and conductive heat transfer is accounted for
- Computes localized thermo-regulatory response such as perspiration, respiration, and blood flow changes
- Steady state or transient localized thermal sensation and comfort analysis

Additional Aircooling Application Abilities with PowerCOOL

- Geometry optimization is available for underhood radiators (I- and U-type) and chargeair-coolers
- Heat transfer between the internal and external flow is measured based on temperature difference in inlet coolant temperature or heat rejection
- Air flow is calculated by PowerFLOW, Coolant Flow is calculated by PowerCOOL and all capabilities are integrated in PowerCASE

Using PowerFLOW simulations coupled with PowerTHERM, thermal managment of the engine compartment can be evaluated and optimized early in the development cycle — critical for cevaluating component longevity

Our **3D**EXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3D**EXPERIENCE® Company, provides business and people with virtual universes to imagine sustainable innovations. Its world-leading solutions transform the way products are designed, produced, and supported. Dassault Systèmes' collaborative solutions foster social innovation, expanding possibilities for the virtual world to improve the real world. The group brings value to over 210,000 customers of all sizes in all industries in more than 140 countries. For more information, visit **www.3ds.com**.

3DEXPERIENCE®

DASSAULT SYSTEMES | The **3D**EXPERIENCE® Company

Americas
Dassault Systèmes
175 Wyman Street
Waltham, Massachusetts
02451-1223
USA

Europe/Middle East/Africa
Dassault Systèmes
10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex
France

Asia-Pacific
Dassault Systèmes K.K.
ThinkPark Tower
2-1-1 Osaki, Shinagawa-ku,
Tokyo 141-6020
Japan