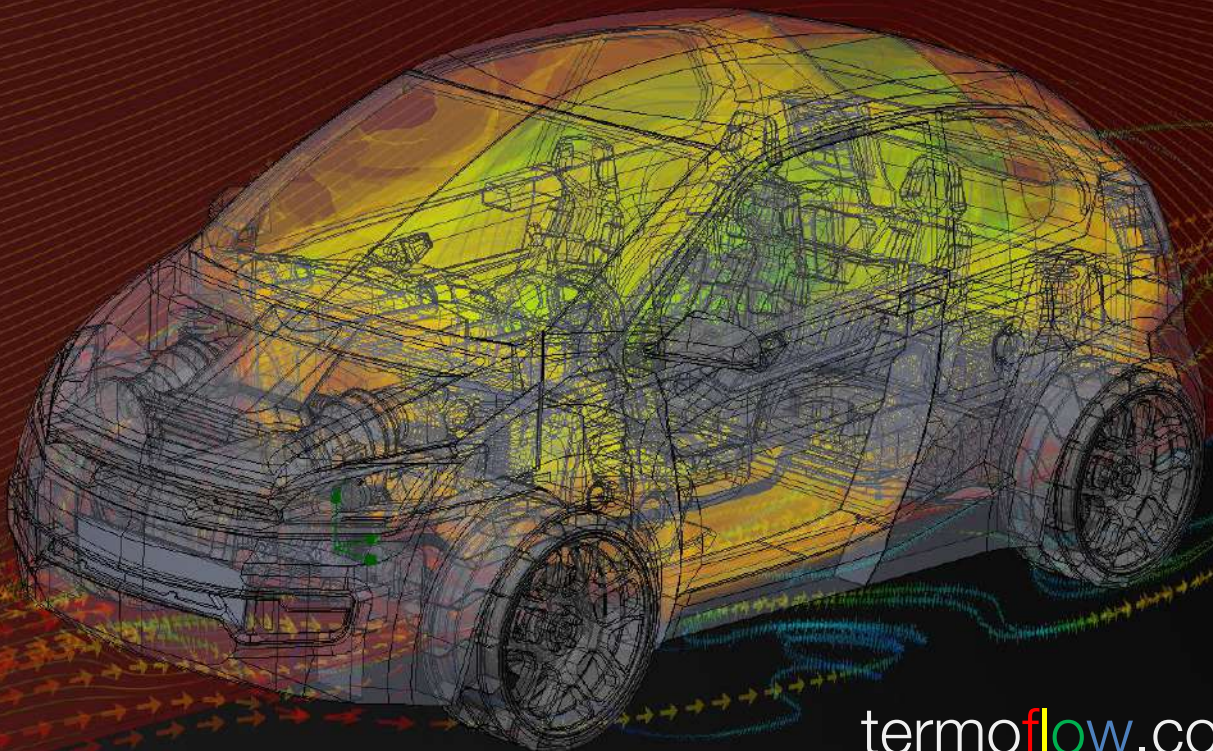


Thermal simulation for electromobility

- Air conditioning & comfort (HVAC)
- Electric machines and drive units
- Battery thermal management
- Electronics and power electronics cooling



Air conditioning & comfort (HVAC)

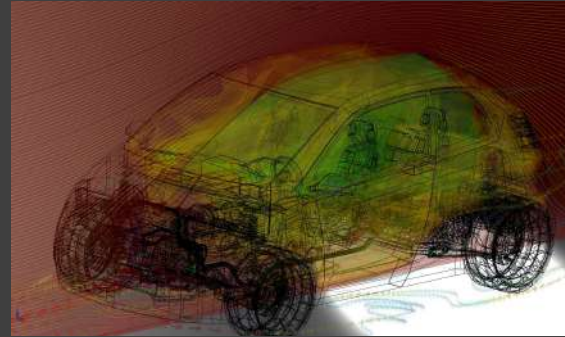
Intelligent thermal management increases the range of electric vehicles. By optimally utilizing waste heat from the powertrain, heat pumps, coolant pumps, intelligent coolant valves and the targeted distribution of heat and cold in the vehicle, the energy required to heat and cool the passenger compartment and accumulators can be reduced, thus increasing the range. We do all the simulation tasks for you in the following areas:

- Promote, manage, distribute and regulate air and other media
- Heat recovery (heat exchangers, heat pumps etc.)
- Window defrosting and fitting
- Flow and temperature fields in passenger compartments and housings
- Particle studies, particle separation in filters, air contamination, exhaust emissions
- Humid air and condensation

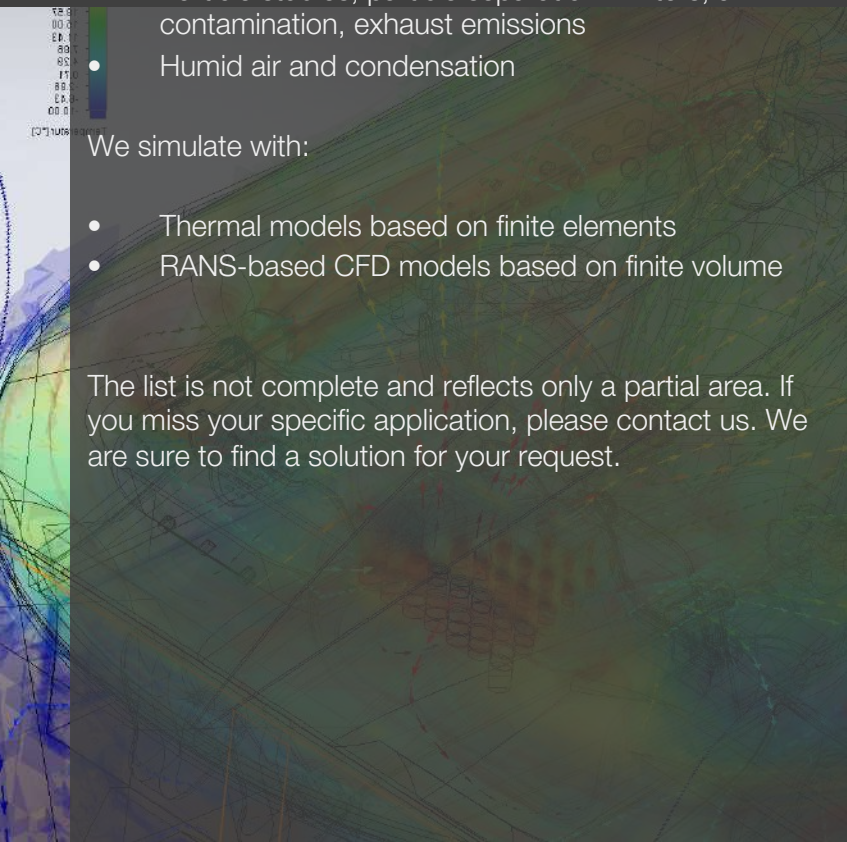
We simulate with:

- Thermal models based on finite elements
- RANS-based CFD models based on finite volume

The list is not complete and reflects only a partial area. If you miss your specific application, please contact us. We are sure to find a solution for your request.



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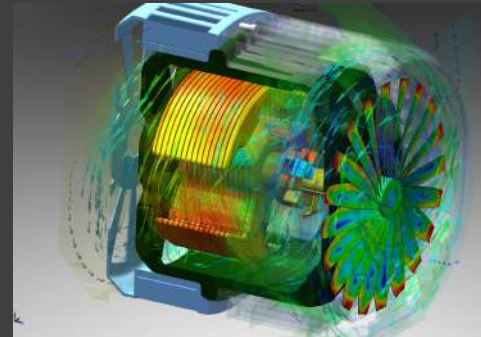
Electrical Machines and Drives

In order to make the electric motor ready for mobile use, great efforts are required in terms of size, service life, temperature insensitiveness, reliability and efficiency. For safe operation, even in case of a temporary overload occurrence, the design and development or integration must take into account both the pure performance data of the machine and the heating processes during operation under real changing loads. The goal is always to protect the machine against inadmissible heating in case of overload. Here we are in demand as a flow technician. In order to analyze and evaluate the thermal behavior of electrical machines under dynamic load requirements, we integrate current numerical methods into the design of your electric drive. We take into account:

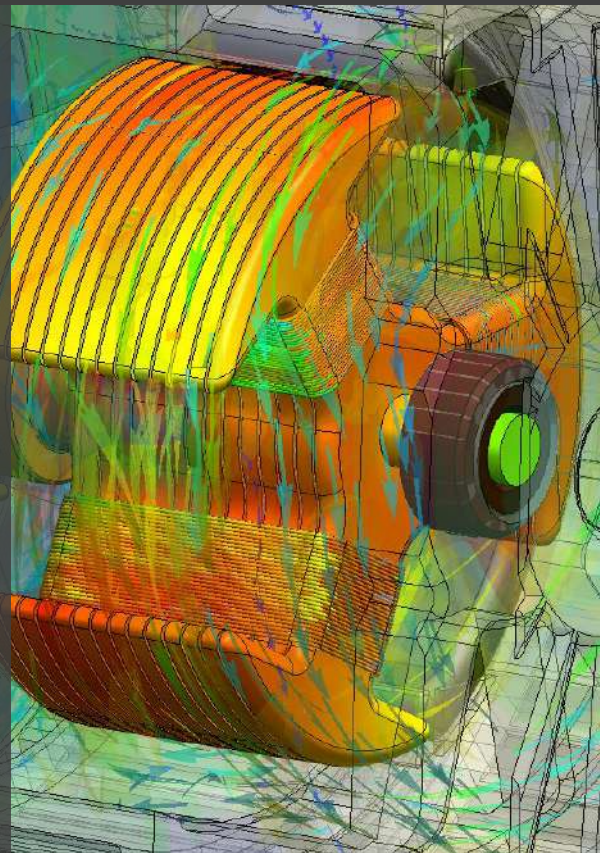
- The detailed geometry of the components and the installation space, no matter how complex
- Heat transfer through conduction, convection and possibly radiation
- Transient events
- Turbulence
- Structure coupling (material heating and thermomechanical stress)
- Rotating assemblies

Possible applications include:

- Assessment and development of cooling concepts
- Flow in wheel sidewalls
- Heating by electrical currents (Joule heat)

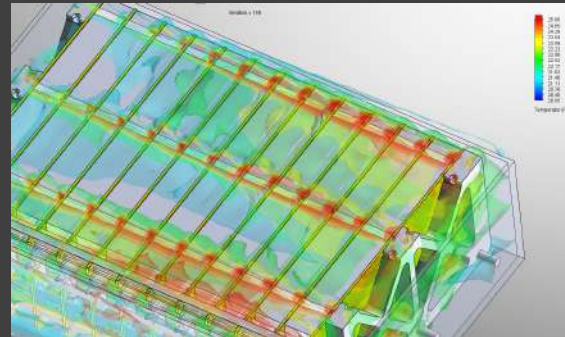


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Battery thermal management

In operation, various factors influence the behavior of batteries. Thus, the battery temperature has a significant impact on performance and capacity. In addition, certain temperature limits must not be exceeded. The frequently occurring in driving high charging and discharging rates act here by releasing heat unfavorable. Inadmissibly high temperatures are the result, if not actively intervened by cooling measures. On the other hand, it is important to protect the batteries from low temperatures by heating. Consequently, thermal management is necessary for the safe and stable long-term operation of batteries. With our in-depth know-how in the field of thermal analysis and CFD, we are happy to assist you in the development of highly efficient cooling concepts and systems.



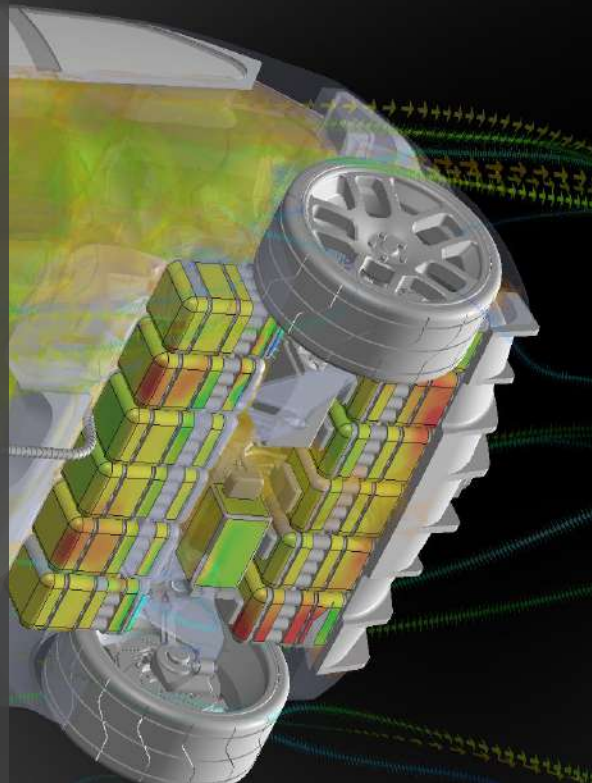
We simulate with:

- Thermal models based on finite elements
- RANS-based CFD models based on finite volume

The following physical phenomena and circumstances are u.a. considered:

- The complete packing geometry as well as the materials used
- Heat transfer through conduction, convection and possibly radiation
- Transient, turbulent processes
- structure coupling

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Electronics and power electronics cooling

The ongoing trend towards miniaturization of electronic components is offset by the compression of electrical energy in ever smaller spaces or areas. At the same time, as the switching frequencies increase, the power loss due to increased current flow also increases. This has an unfavorable effect on the operating temperature and thus on the failure rate of the electronic components and components. We support you in the context of thermal management in all matters relating to the packaging, heat dissipation and thermal dimensioning of your electronic devices and systems. For this we use the thermal simulation to exploit the optimization potential of your design.



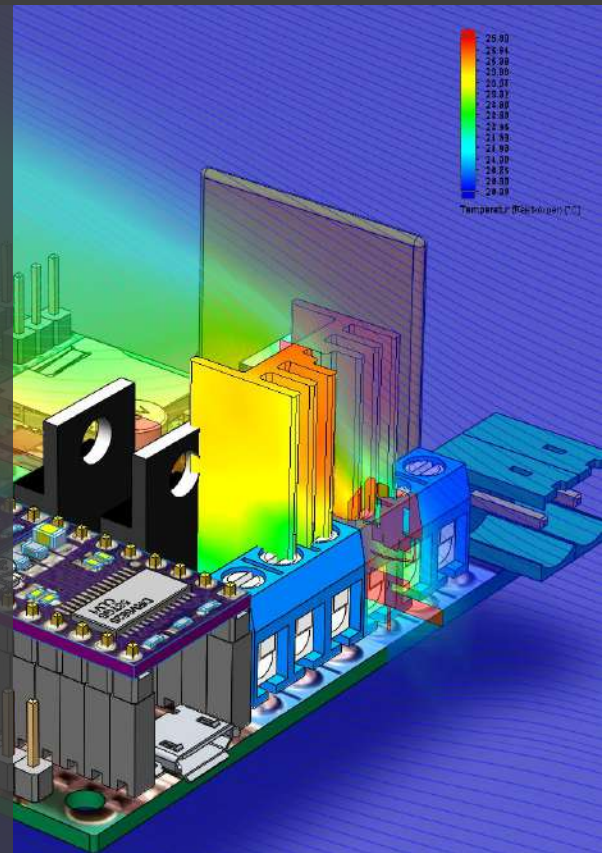
Some application examples:

- Localization of hotspots, shadowing, air shortcuts
- Design and dimensioning of cooling circuits
- Coolers, heat exchangers and air conditioners
- Pressure losses (device characteristic)
- Fan integration and selection

The following physical properties are i.a. considered:

- Heat conduction, convection and radiation
- Transient currents
- Turbulence
- Joule heat

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