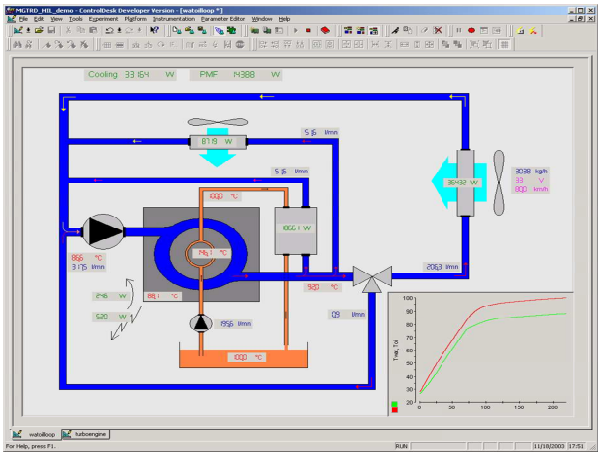
Cooling System Activities

Sherpa Engineering has an extensive experience in engine, motor and circuit cooling activities for automotive and trucks industries. We count with more than ten years in realizing cooling system innovative projects.

We have acquired deep know-how in several research and industrial projects for the French car manufacturers and their suppliers, which has allowed us to develop specialized tools in modeling and control domains.

COOLING SYSTEM SOLUTION

Thanks to our core competencies (modeling, control, system engineering) and our knowledge of powertrain systems, we have developed models and tools for cooling circuit systems (control, actuators, sensors and the physical system). Applications range from system specifications to system validation.



Cooling system perimeter

Our product and service offer include studies, technical support to customers and technological skills transfer.

The level of modeling used in our studies is functional, which is between a behavioral representation (based on maps) and a detailed one (based on meshing). This type of modeling has the advantage of meeting the following requirements:

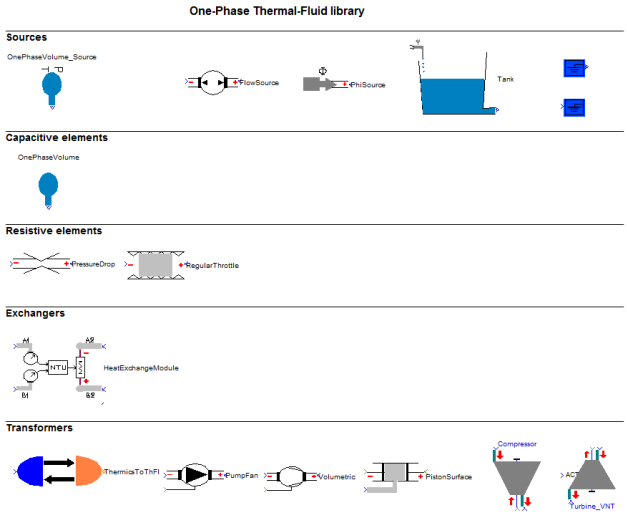
- Represents the physical architecture of the system
- Allows for multivariable model based control
- Covers the whole product life cycle (MIL, SIL, HIL)
- Allows for several approaches such as modular and polymorphic
- Creates automatic parameters as well as model validation and qualification
- Takes into account normal, degraded and failure situations

PhiSim is our tool for system modeling and simulation, including the cooling system. We have built Cooling System libraries and models as part of the PhiSim tool.

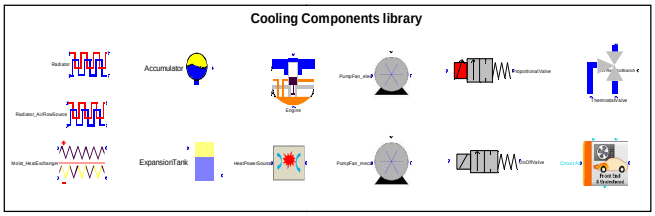
COOLING SYSTEM LIBRARIES

Thermal fluid basic library

This library includes several one-phase fluids (brine, water, etc), and cooling system components: capacity, pressure losses, pumps, heat exchangers, etc.

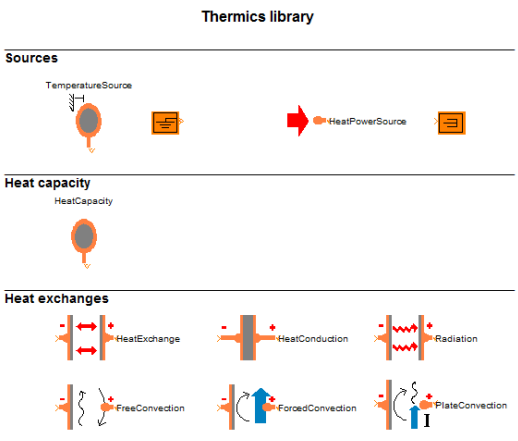


Thermal fluid multiport elements



Cooling Components library

Thermal transfer basic library



Thermal elements

This library includes elements such as forced and free convection, conduction resistance, thermal capacity, heat flux and temperature sources.

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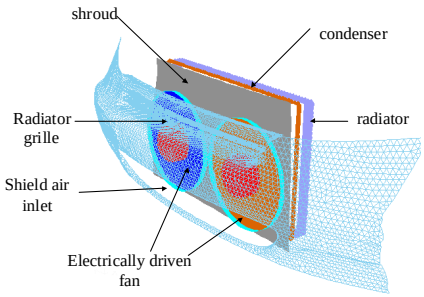
Under-hood model



This model permits to represent thermal interactions among the under-hood components (radiators, condensers, pipes).

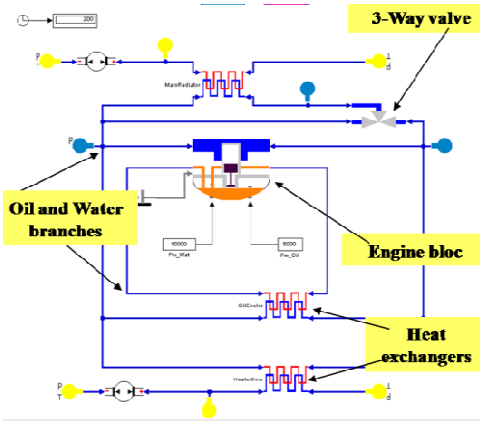
LIBRARY KEY FEATURES

- Fast and easy modeling and simulation of cooling systems using standard components
- Comprehensive block libraries to build complex cooling loop (including air, oil, glycol water and cooling lines)
- Example of a generic control system easily adaptable to any system architecture
- Customized studies such as global system design, dimensioning and control system development
- Real time HIL (Hardware In the Loop) validation

POWERTRAIN APPLICATIONS

Basic engine cooling model

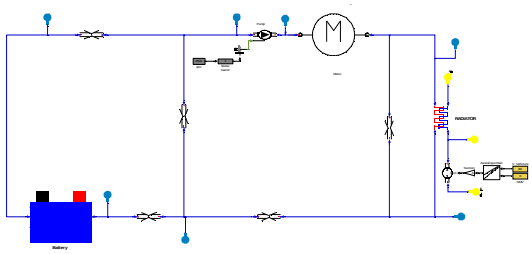
Our basic engine cooling model allows representing all types of cooling architectures (conventional or innovative) for vehicles with different engines such as conventional, hybrid or fuel cell. It takes into account thermal aspects (water, oil, air) and their interactions/coupling with engine, air conditioning system.



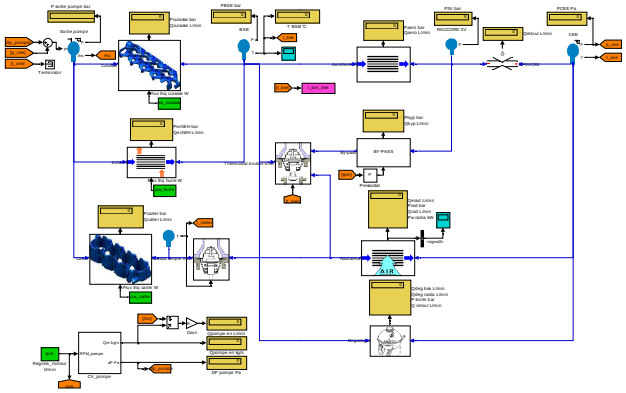
Basic Engine Model

Cooling model for hybrid, electric vehicle or fuel cell

This module takes into account elements such as a thermal engine, an electric motor or a heater core



Cooling for thermo-management

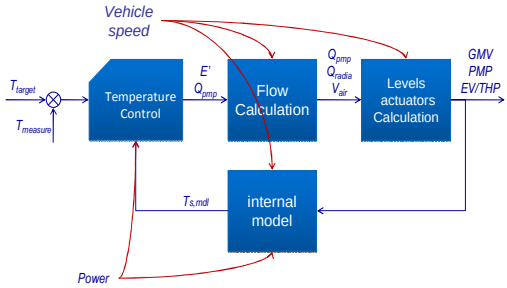


Thermo-management Cooling module

This module represents a thermo-management architecture circuit of a cooling system. Il shows the combination of thermal, thermo-fluid and mechanical elements.

CONTROL FOR COOLING SYSTEM

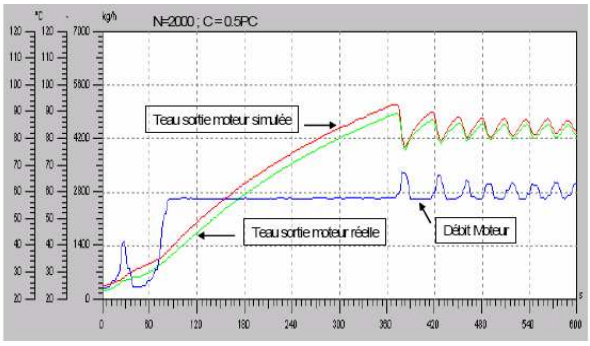
Sherpa Engineering has developed a model based predictive control (MBPC) cooling system. The MBPC approach is based on both, the hierarchical and functional decomposition of the system, and the model-based predictive control method. .



Model-Based Design for control system

Examples of a model calculation

This example is about the temperature water in the cooling system obtained when using our engine models (red curve) comparing to the test bench temperature (green curve):



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