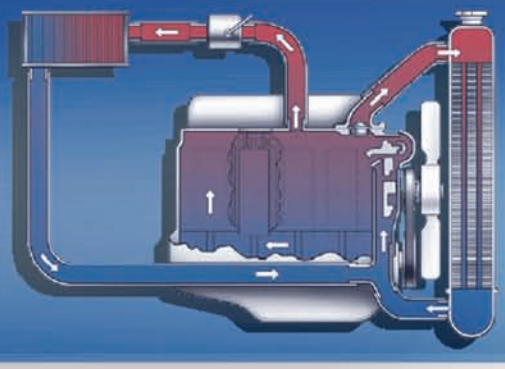


Highlights:

Easy-to-use parametric finite element cylinder structure

Cylinder structure obtains gas side boundary conditions from accurate GT-POWER simulations

Flexible cooling circuit representation

Flow solution is based on Navier-Stokes equations (robust and stable)

Always solves energy equation (thermo-hydraulics)

Stable even with zero flow and thus "standing water" presents no difficulty

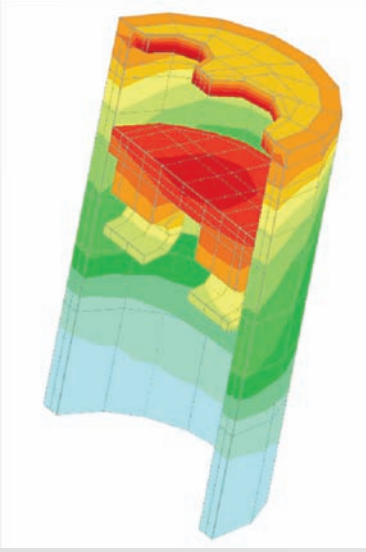
Models of fluid circuits are built semi-automatically from CAD data

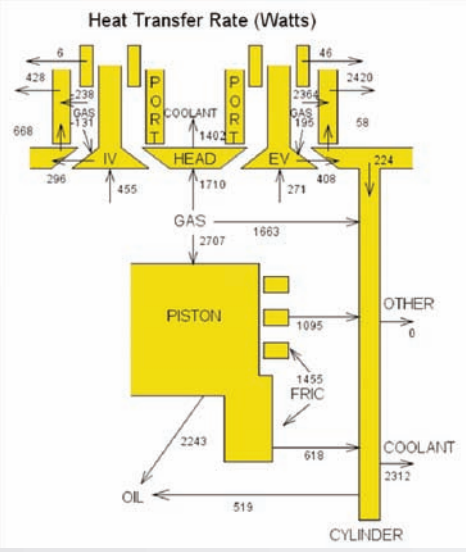
Engine Cooling

Detailed Engine Thermal Balance and Heat Distribution

GT-SUITE offers the leading solution for the simulation of engine cooling. It has the unique capability to **predict engine thermal balance and heat rejection to water and oil**. To predict this heat distribution within the engine requires accurate handling of the "inner" cylinder structure, the sources of heat (combustion and friction), the coolant and oil passages, and the "outer" block structure. GT-SUITE offers unparalleled functionality within each of these areas.

To model the inner structure, GT-SUITE offers an easy to use **parametric FE cylinder model, unique within the industry**. The GT-SUITE solver automatically builds the FE model in seconds based on a relatively small number of numerical geometric inputs (no meshing!). The resulting model includes the cylinder liner, piston and rings, head fire deck face, ports, and valves. The boundary conditions from the combustion gases, coolant, and oil are automatically applied to the FE model, along with the friction-generated heat that is deposited on the piston, liner and rings. A rapid FE solver produces a solution in a **small fraction of a second**, enabling the FE model even for long drive cycle transients.





The true strength of the FE cylinder model is the ability to obtain the gas side boundary conditions from accurate GT-POWER engine models within GT-SUITE. GT-SUITE is the industry standard for engine simulations, and correctly simulates the in-cylinder heat transfer processes in a detailed fashion. Therefore, accurate temperature and heat transfer coefficients can be applied to the FE cylinder surfaces. The integration of the FE structure with the gas side engine model provides **a predictive and transient capability** that cannot be achieved with measured heat rejection data nor with simple 5-mass lumped models.

Advanced Features and Applications:

Can utilize the accurate GT-POWER engine modeling under steady-state and transient operation

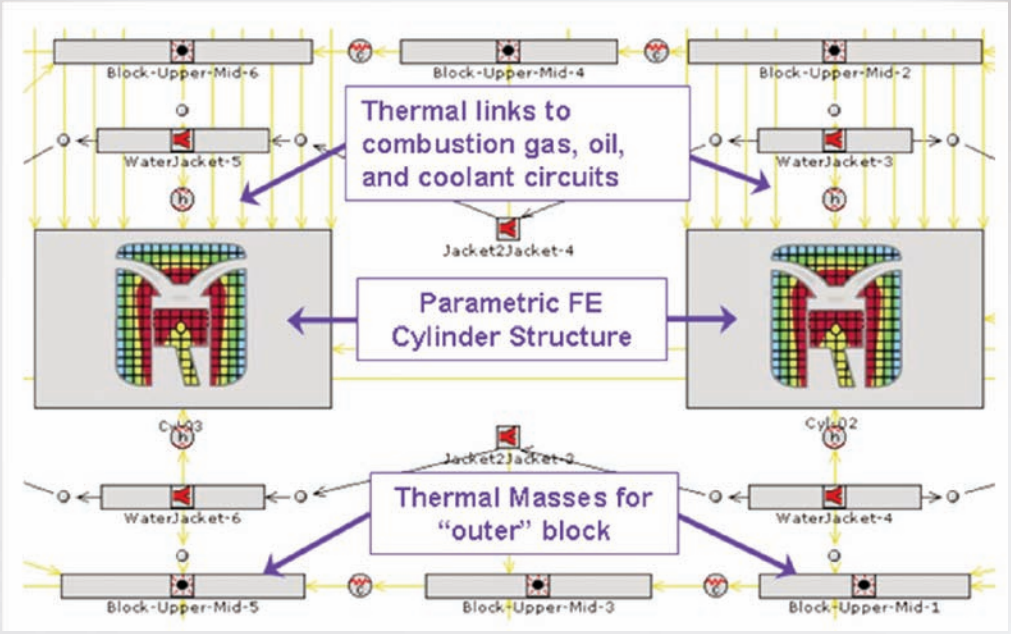
Built-in FE solver predicts engine structure temperatures, steady state and transient

Predicts engine thermal balance by detailed modeling of all heat sources

Predicts heat rejection both to coolant and to the oil

Represents the two-way interactions between cooling of CAC and EGR and engine performance, as they are affected by ambient conditions and by transient driving schedules (drive cycles, (accelerations, soak)

The engine heat is transferred from the FE model to the coolant and oil circuits within the block and head. These flow circuit models can be **easily generated from CAD data using the GEM3D pre-processing tool.** Within the circuit volumes, GT-SUITE uses an advanced solution methodology for compressible 1-D flow, based on the true **Navier-Stokes** solution. This solution is more accurate than all other hydraulic simulation tools, especially under transient or unsteady flow situations. The solution is inherently stable and therefore has no problem predicting low or zero flow ("standing water").



This predictive approach to modeling the heat balance within the engine inherently accounts for the interactions between the various sub-systems, and enables the study of advanced concepts within engine cooling. The engine cooling sub-system may be integrated with other sub-systems in GT-SUITE to create a **virtual vehicle model**.

An important capability of GT-SUITE is representation of the **two-way interactions between cooling and engine performance**. As shown above, it can be used to study the effect of cooling on CAC and EGR temperatures, which have an important effect on engine performance under transient conditions.