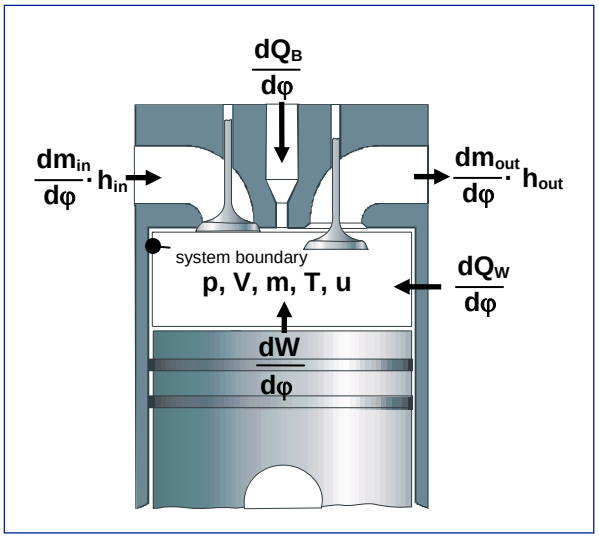
en-DYNA® THEMOS®
New Generation of Real-Time Engine Models

Applications

enDYNA Themos is the professional software for real-time simulation of combustion engines. Due to the thermodynamic approach, these high fidelity engine models are able to consider detailed dynamically coupled physical effects. enDYNA Themos thus constitutes a crucial extension for the test and the development of electronic controllers for modern diesel and gasoline engines in software- and hardware-in-the-loop environments. The high accuracy of enDYNA Themos engine models allows ECU developers to make precise and reliable statements on controller behaviour and to quantify a good level of ECU calibration already at the simulator:

- Development of engine control functions with cylinder pressure feed back
- Conceptual design and control of innovative supercharging concepts
- Hardware-in-the-loop tests for modern engine controllers with fully variable valve actuation
- Test and development of controllers for exhaust gas aftertreatment, e.g. particle filter regeneration or exhaust gas recirculation
- ECU pre-calibration at the simulator

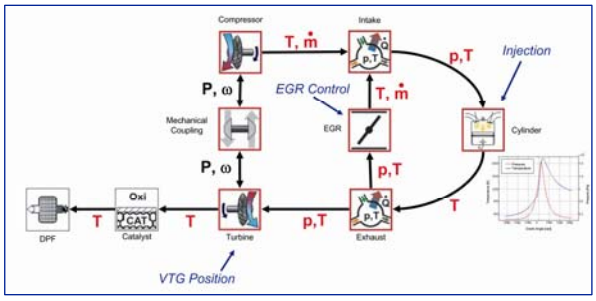


Real-Time Simulation of the Combustion Process, Based on the Conservation of Energy

Simulation Framework

enDYNA Themos supplements the enDYNA simulation framework by high precision models with a previously unmatched level of detail in the field of real-time engine dynamics simulation.

- **Engine Models**
  Real-time capable thermodynamic models of diesel and gasoline engines comprising detailed gas dynamics calculation and a zero dimensional model of the combustion process.
- **Simulink Libraries**
  Additional Simulink libraries provide generic thermodynamic modules of fundamental components of the gas path and cylinders to build up various engine configurations.
- **Powerful Model Parameterisation Tool**
  Full enDYNA Preprocessing support to calculate high precision model parameters from available standard data.
- **Ready-to-Use Examples**
  Ready-to-use example models, measurement data and parameters.
- **Documentation and Online-Help**
  Comprehensive documentation, context-sensitive and printable.
- **Based on Matlab/Simulink**
  Open Matlab/Simulink implementation for model based design and rapid controller prototyping.
- **All major Real-Time Platforms Supported**
  RTW code generation for PC executables and all major real-time targets.



Dynamic Interaction of Model Components for Diesel Engine Simulation

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Features at a Glance

Engine Models

- Modular and highly flexible thermodynamic model of the gas path.
- Zero-dimensional combustion process calculation. Cylinder pressure progression and exhaust gas parameters calculated from the heat release rate of the chemical reaction, the heat transfer over the cylinder walls and the piston kinematics.
- Injection/ignition timing and multiple injections fully considered. Highly accurate engine dynamics which does not rely on tabled data from extensive measurements.
- Accurate exhaust gas recirculation (EGR). Gas path thermodynamics and consideration of the gas composition inside the cylinder during combustion shows the effects of exhaust gas recirculation on NOx and torque.
- Variable valve train for gasoline engines. Calculation of the gas mass flow over the cylinder valves respecting number of valves, variable valve lift and timing.
- Exhaust system for the development and test of exhaust gas aftertreatment control.

Simulink Libraries

- Enthalpy flow based blocks for containers, throttles and heat exchangers. Combination of gas path components allow to model almost any engine's air intake and exhaust system.
- Separate modules for turbine, compressor and mechanical coupling. Complex supercharging concepts, e.g. two-stage turbo charging and mechanically or electrically supported turbo charging, easily configured.
- Exhaust system components including particulate filter and oxidising catalytic converter (diesel engines) and 3-way catalyst, NOx trap, secondary air path (SI-Engines) and lambda probes.

Powerful Model Parameterisation Tool

- Easy and straightforward parameterisation despite the model complexity.
- Using data that is readily available saves time and money – no delay or extra costs due to special measurements.
- Dedicated functions ensure parameter consistency and eliminate measurement errors. No expert knowledge necessary. No need for manual parameter adjustments.
- Data filter and fit tool operated via graphical user interface. Easy, highly flexible and transparent elimination of measurement errors for optimum parameter calculation results.
- Management of various preprocessings for reproducible results and comparison.

Ready-to-Use Examples

- Example models of diesel and gasoline engines. Fast and easy modelling by using example models as templates.
- Example preprocessings and measurement data for a quick start and easy learning. Examples can be used as templates for own preprocessings.

Documentation and Online-Help

- Data requirements, block and function reference, model overview
- Printable documents
- Context-sensitive online-help

Based on Matlab/Simulink

- Matlab interface for external data assignment and script-based simulation control. Many options for automated test runs as well as programmed pre- and postprocessing.
- Standard Simulink interface for user-defined model extension and integration of control functions.

All major Real-Time Platforms Supported

- ADI, dSpace, ETAS, Mathworks xPC, National Instruments, Opal-RT. Other targets available on request.

IAV Engineering Experience included.

enDYNA Themos is the reliable solution for advanced engine simulation. Our specialists are available to support you in the commissioning and application of your engine model. For further information, please visit www.tesis.de/themos.

TESIS DYNAware GmbH • Baierbrunner Straße 15 • 81379 München • Germany • Phone +49 89 74 73 77-0 • Fax +49 89 74 73 77-99
tesis.dynaware@tesis.de • http://www.tesis.de/dynaware