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Simcenter Amesim Thermal-hydraulic library

Designing hydraulic systems and components taking into account thermal effects

LMS/IL-DSS.22.3/16-001

Benefits

- Virtually model, analyze and design any type of liquid flow network including thermal effects
- Evaluate dynamic performance of components (pumps, etc.) and systems with variations of fluid aeration
- Design a network with minimum effort and maximum flexibility
- Use a comprehensive collection of validated components
- Use recognizable icons to facilitate direct model identification
- Compare system performance with and without heat exchanges using a single model

Features

- Multiple standard components included (pumps, valves, actuators and heat exchangers)
- Advanced fluid properties with cavitation and aeration effects, isothermal, isentropic and full energy conservation assumptions

Summary

Heat exchanges occur in most industrial processes either because they are expected (heat exchangers, etc.) or unavoidable (thermal losses, friction, etc.). These exchanges are likely to occur as soon as temperature differences are encountered through moving fluids or between moving fluids and the environment.

Fully dedicated to the design of hydraulic systems in which temperature variations are likely to be encountered, the Simcenter Amesim™ Thermal-hydraulic library is composed of a wide range of functional models with various complexity levels based on the information available in manufacturers' data sheets.

The library allows you to select among three different thermodynamic assumptions: isothermal, isentropic (fast dynamics) and full energy conservation.

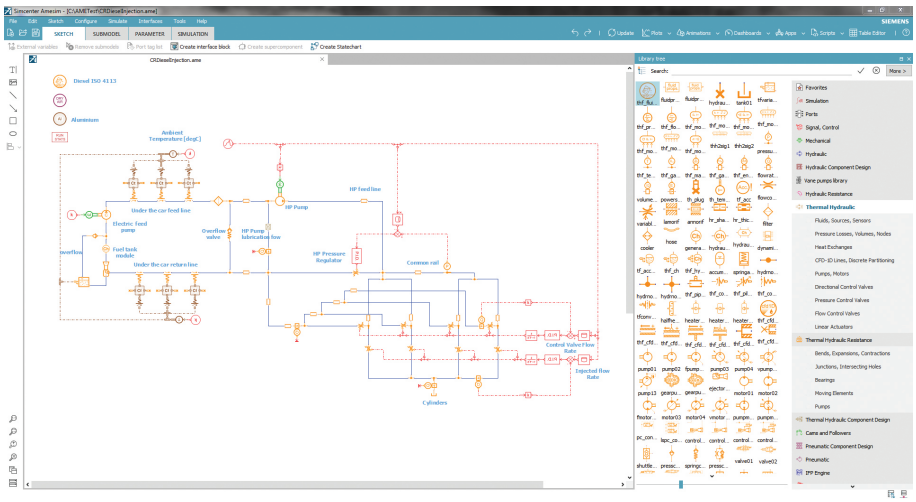
Additionally, cavitation and aeration are taken into account with three different options for aeration: constant total gas content, transport of gas content only and transport of gas content with aeration and dissolution dynamics.

You can compare system performance with and without heat exchanges as well as with constant or variable gas content using a single simulation model to identify the best compromise between physical phenomena and calculation efficiency.

The full energy balance mode is based on a transient heat transfer approach used to represent thermal phenomena in liquids (energy transport, convection) and study the temperature effect on the system behavior.

The Thermal-hydraulic library also includes discrete partitioning components using a technique that can reduce simulation times for certain types of hydraulic systems, such as fuel injection, automatic gearbox command, anti-lock braking system (ABS), etc.

Simcenter Amesim Thermal-hydraulic library



Features *continued*

- Variable gas content with or without aeration and dissolution dynamics
- Dedicated tools for fluid properties, heat exchangers parameterization or gas content initialization
- Lines with lumped parameter approach or CFD 1D Navier-Stokes equations allowing modeling of water hammer transients
- Discrete partitioning for dividing large high-frequency thermal-hydraulic systems into smaller subsystems to speed up simulation
- Computation of power, energy and activity variables in all the components

Components

Sources and sensors

- Sources: Constant and variable pressure, temperature and flow rate and temperature with constant or variable gas content
- Pressurized tank with variable height of liquid
- Conversions between signal and thermal-hydraulic variable
- Sensors: Pressure, temperature, volumetric and mass flow rate, enthalpy flow rate, volume and mass, power and energy

Fluids, nodes and volumes

- Thermal-hydraulic properties: using polynomials or Bode formulation, advanced with cavitation and variable saturation pressure function of temperature
- Fluid database:
  - Pure water, glycol, ethylene glycol, coolant EG20W80, coolant EG40W60, coolant EG50W50, coolant EG80W20 and coolant EG60W40
  - 15W40 oil, 15W30 oil, International Organization for Standardization Viscosity Grade (ISOVG) 32 oil, ISOVG 46 oil and ISOVG 68 oil
  - Simple diesel, high-density diesel, ISO 4113, Deutsche Erdoel AG (DEA) summer diesel, Princeton diesel, dimethyl-ether (DME), rapsmethylester (RME), 50 percent diesel, 50 percent RME; 80 percent diesel, 20 percent RME; SHELL CPU diesel, SHELL HCU diesel, Swedish diesel, 80 percent diesel, 20 percent SME; Japanese Industrial Standard (JIS) number 2 diesel and JIS Special number 3 diesel
  - Hexane, heptane, ethanol, methanol, unleaded gasoline premium, unleaded gasoline super plus, ethanol blend E24 and D40 hydrocarbon
  - Skydrol 500B 4, Skydrol LD 4, military specification (MIL) H 5606, MIL H 8446, MIL H 27601, MIL H 83282 and MIL H 87257
  - JetA, JetA1 and JetB
  - JP-4, JP-5, JP-7, JP-8 and JP-TS
  - Av-gas jet fuel
  - TS-1 and RT kerosenes
  - User defined fluids
- Fluid properties calculations
- Two-, three- and four-port nodes
- Two-, four-, and six-port thermal-hydraulic volumes
- Thermal-hydraulic volume containing liquid and gas
- Gas-filled accumulator
- Spring accumulator

Friction and hoses
- Restrictor
- Variable restrictor
- Filter
- Cooler
- Hoses: simple compressibility, compressibility and friction and simple wave equation

CFD 1D lines, junctions and components
- CFD 1D thermal-hydraulic lines (resolution of Navier-Stokes equation) using Lax-Wendroff method with or without heat exchanges. Frequency-dependent friction and cavitation handling are included
- Connection between CFD 1D line and lumped components
- CFD 1D plug
- Discrete partitioning:
  - Masters: One to four ports with signal ports to exchange extra variables with slaves
  - Slaves: One to four ports with signal ports to exchange extra variables with master
  - Signal sending and receiving components between master and slaves
  - Signal sending and receiving components between slaves and master

Directional control valves
- Shuttle valve
- Dual valves
- Flush valve
- Electrically operated servo valves with up to six ports and three positions
- Valve builder: tool allowing the creation of new directional valves components

Pressure control valves
- Pressure relief valves
- Pressure reducer
- Overcenter valve
- Counterbalance valve

Flow control valves
- Flow regulator
- Local pressure compensator

Pump displacement control valves
- Pressure control with load sensing and/or pressure compensator
- Piston actuator (single or dual) for pump control
- Pressure control shuttle valve

Pumps, motors
- Fixed and variable displacement unidirectional and bi-directional pump, with 2D, 3D or 4D tables or expressions for efficiencies
- Pressure regulated pump
- External gear pumps with one or two mechanical ports
- Jet or ejector pump based on maps or geometry
- Fixed displacement for unidirectional and bi-directional motor
- Variable displacement for unidirectional and bi-directional motor
- Rotary actuator
- Volumetric pumps using tables
- Centrifugal pumps using affinity laws

Linear actuator
- Actuator with single/double hydraulic chambers and single/double roads
- Actuator with or without spring assistance

Lines and hoses
- Lines: compressibility, steady-state friction, frequency dependent friction, distributive pipe and distributive wave equation with heat exchange

Heat exchanges
- Internal/external free or forced convection
- Half heat exchangers for thermal-hydraulic fluid
- Generic heat transfer calculation between two half heat exchangers based on performance maps, regression from experimental data or configuration and geometry
- Generic heat transfer calculation between two half heat exchangers with piloted efficiency
- Generic heat transfer source for one half heat exchanger with piloted heat flux or outlet conditions

Bends, expansions and contractions
- Restriction with friction factor depending on the flow direction and value
- Sharp edge or short tube orifice component with variable friction factor
- Sudden expansion/contraction with friction factor depending on the flow direction and value
- Progressive expansion/contraction with friction factor depending on the flow direction and value
- 30-, 45-, 60- and 90-degree bends
- General bend with friction factor depending on the flow direction and value
- Pipe with and without friction and predefined or user-defined heat transfer definition
- Modular piping component representing successions of straight segments and singularities (changes in direction or diameter) with scalable modeling approach (detailed piping or equivalent pressure drop approach), with or without heat exchange

Junctions and intersecting holes

- 45- and 90-degree T-junction
- T-junction with friction factors depending on the flow direction and value in each branch
- Intersecting holes: 90, 180 degrees and three ports
- Intersecting holes: 90 degrees, two ports and intersecting and nonintersecting axes
- Volume connected to pipe: sharp entry, rounded entry, extended entry, conical entry 90 degrees and conical entry 60 degrees

Bearings

- Bearings for different oil feeding: journal feeding, bearing feeding (single hole, partial groove, full groove)
- Bearings with modulated load and regime (with or without frictional heat release), with modulated load and 1D mechanical ports or with 3D mechanical ports.
- Bearings with eccentricity as input (signal or 3D mechanical) and eccentricity calculation based on the mobility method
- Tabulated bearings

Moving elements

- Rotating pipe with centrifugal effects: constant and modulated velocity
- Centrifugal and volumetric pump
- Centrifugal pump with affinity laws
- Annular pipe
- Grooved bushing: constant and modulated velocity

Prerequisites

The Thermal-hydraulic library requires the following:

- Simcenter Amesim Base [IL-AME.01.1]
- Simcenter Amesim Thermal library [IL-DSS.21.2]

Extensions

- Simcenter Amesim Blackbox Export option [IL-BBO.03.2]
- Simcenter Amesim Real-time option [IL-RTO.03.2]

Supported hardware platforms

For details on supported hardware, minimum/recommended physical configurations and operating systems, please refer to the Simcenter Amesim fact sheet.

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