SimHydraulics™ 1.2

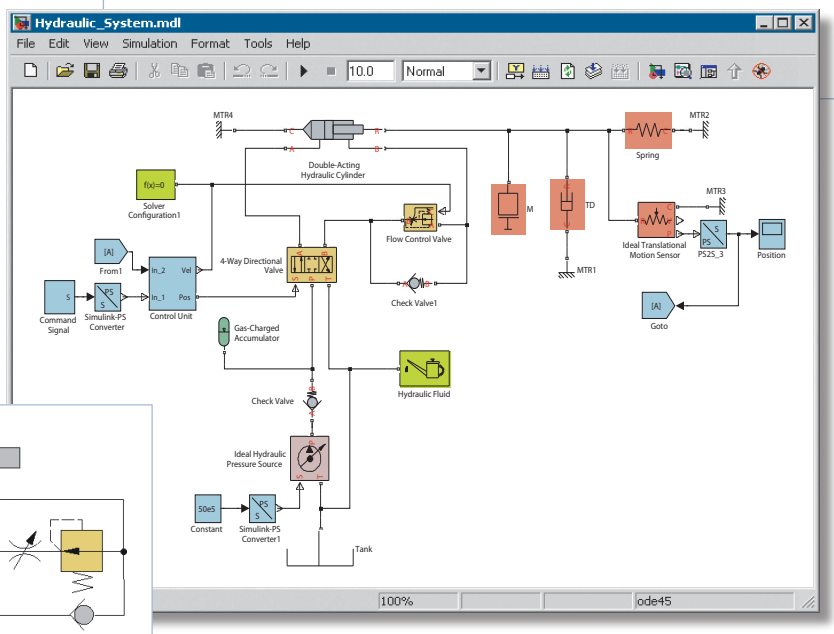
Model and simulate hydraulic systems

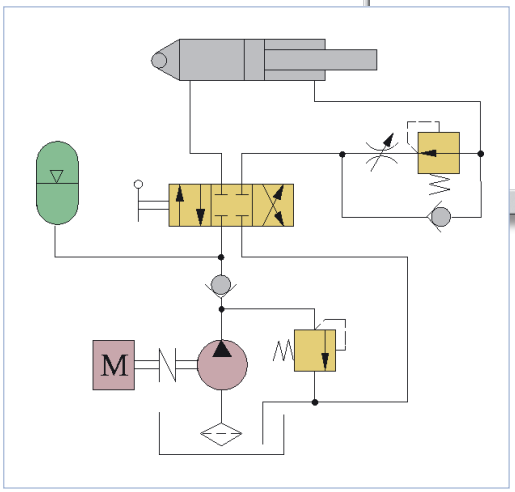
SimHydraulics™ extends Simscape with tools for modeling and simulating hydraulic power and control systems. It enables you to describe multidomain systems containing connected hydraulic and mechanical components as physical networks. It provides a representative library of hydraulic components and building blocks that lets you implement other components.

SimHydraulics can be used for a variety of automotive, aerospace, defense, and industrial equipment applications, such as modeling automatic transmissions, and actuating flight control surfaces and heavy equipment. With Simscape, SimMechanics, SimDriveline, and SimPowerSystems (all available separately), SimHydraulics lets you model complex interactions in hydromechanical and hydroelectrical systems.

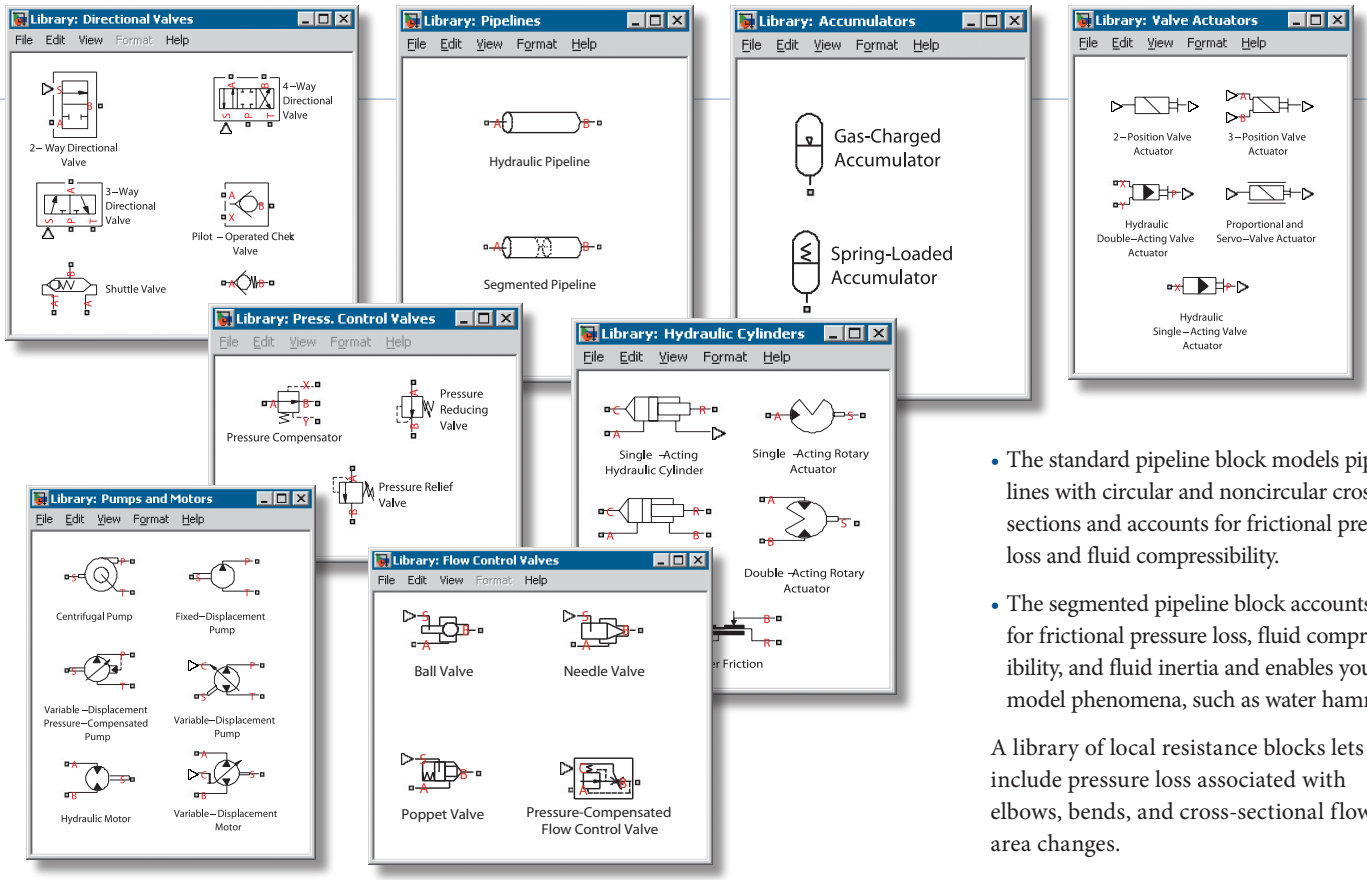
KEY FEATURES

- Modeling environment for building hydraulic and hydromechanical systems as physical networks
- More than 45 hydraulic and mechanical components, including pumps, valves, accumulators, and pipelines
- Customizable library of common hydraulic fluids
- Access to linearization and steady-state capabilities in Simscape





Hydraulic circuit schematic of a system that contains a gas-charged accumulator and a double-acting cylinder (left). The colored blocks in the associated SimHydraulics model (above) correspond to the colored elements in the circuit schematic.



SimHydraulics model libraries of valves, accumulators, pipelines, pumps, motors, cylinders, and most standard components in hydraulic systems.

Modeling Hydraulic and Hydromechanical Networks

With SimHydraulics you build a model of a system just as you would assemble a physical system. The symbols used in your model are based on the ISO 1219 fluid power standard. SimHydraulics employs a physical network approach to model building: components (blocks) corresponding to physical elements such as pumps, motors, and valves, are joined by lines corresponding to the physical connections that transmit power. This approach lets you describe the physical structure of a system rather than the underlying mathematics.

From your model, which closely resembles a hydraulic schematic, SimHydraulics automatically constructs equations that characterize the behavior of the system. These equations are integrated with the rest of the Simulink® model.

SimHydraulics libraries provide more than 45 models of hydraulic and mechanical components, including models for pumps, cylinders, accumulators, and hydraulic flow lines. You can easily represent most commercially available hydraulic components.

You can use the sensor blocks in Simscape to measure values for any hydromechanical variable, such as pressure, flow, position, velocity and force, and then pass these signals into standard Simulink blocks. Source blocks enable Simulink signals to assign values to any hydromechanical variable. Sensor and source blocks let you develop an entire control algorithm in Simulink and connect it with a SimHydraulics network.

Modeling Hydraulic Components

SimHydraulics includes spring-loaded and gas-charged accumulator models, as well as two pipeline models:

- The standard pipeline block models pipelines with circular and noncircular cross sections and accounts for frictional pressure loss and fluid compressibility.
- The segmented pipeline block accounts for frictional pressure loss, fluid compressibility, and fluid inertia and enables you to model phenomena, such as water hammer.

A library of local resistance blocks lets you include pressure loss associated with elbows, bends, and cross-sectional flow area changes.

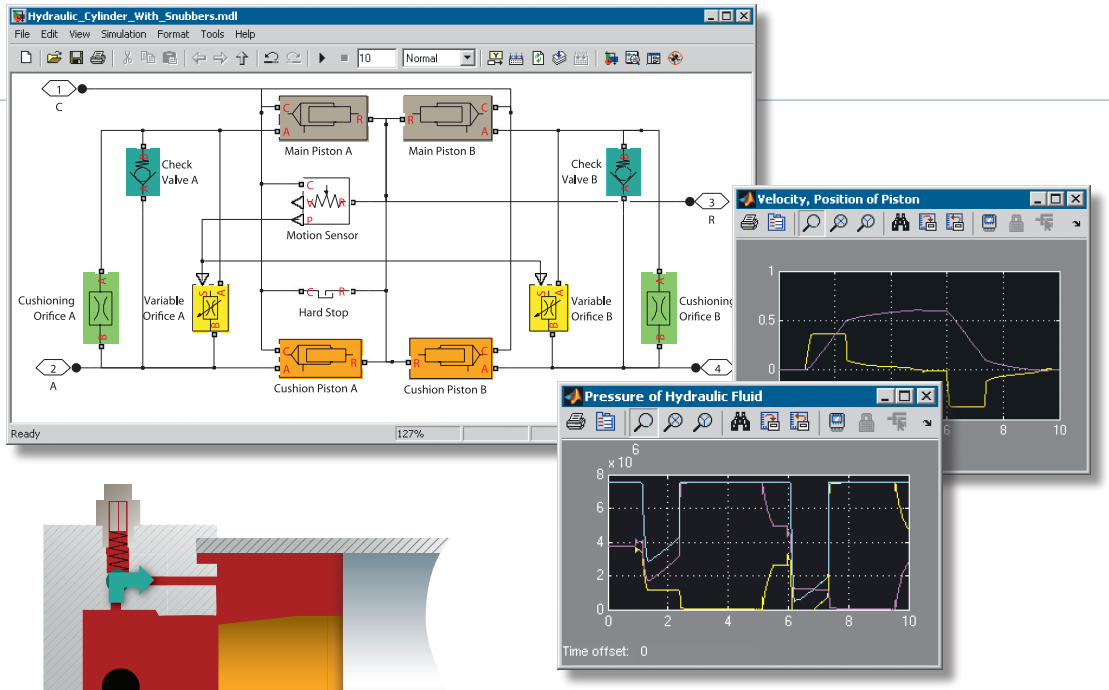
SimHydraulics provides actuators and pumps that let you:

- Model hydraulic cylinders and rotary actuators, including effects such as cylinder friction
- Model hydraulic motors, fixed-displacement pumps, and variable-displacement, pressure-compensated pumps for power exchange with rotational mechanical components

The valves library lets you model:

- Directional valves, including 2-way, 3-way, 4-way, shuttle, check, and pilot-operated check valves
- Flow control valves, including ball, needle, poppet, and pressure-compensated flow control valves
- Pressure control valves, including pressure-reducing and pressure-relief types

The valves library also includes actuator models to simulate electromagnetic, discrete and proportional actuators, and servo-valves.



Cross-section illustration of a hydraulic cylinder with snubber (left). The colored blocks in the SimHydraulics model (top, left) correspond to colored arrows in the cross-section illustration, which represent typical hydraulic flow paths. The graphs (above) track the velocity and position of the piston, and the pressure of the hydraulic fluid during the simulation.

Customizing Models

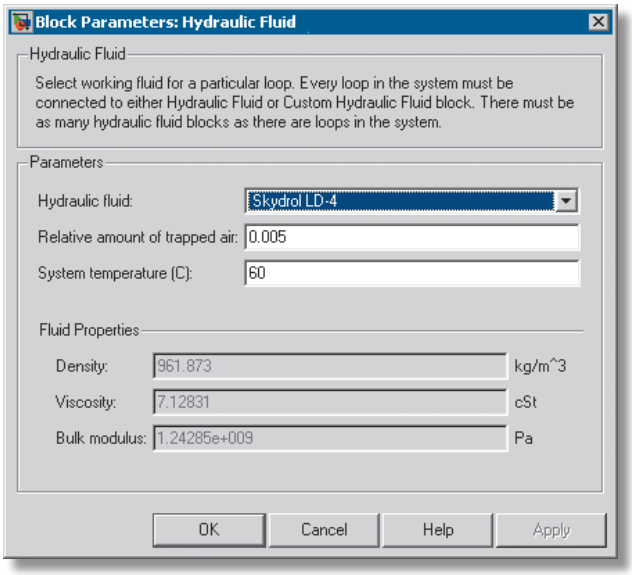
You can combine the blocks in the SimHydraulics libraries to create custom hydraulic models. In addition, Simscape (required by SimHydraulics) contains a foundation library that includes a set of basic building blocks for different physical domains; these blocks define the pressure/flow relationship for basic physical effects, such as fluid compressibility, fluid inertia, mechanical friction, energy transduction, and flow through fixed and variable orifices. You can combine these building blocks with SimHydraulics blocks to model a component that spans different physical domains.

As with Simulink, you can then group this assembly of blocks into a subsystem and parameterize it to reuse and share the custom component.

SimHydraulics models can include physical signals that have units associated with them. You specify the units and parameter values in block dialogs, and Simscape performs the necessary unit-conversion operations when solving a physical network. A Physical Signals block library in Simscape lets you perform math operations on physical signals and graphically input equations inside the physical network. Physical signal ports are used in Simscape block diagrams to better integrate physical signals into your physical system, which increases computational speed.

Defining Fluid Properties

SimHydraulics employs efficient methods for defining density, viscosity, and bulk modulus—the fluid properties that affect system behavior. SimHydraulics provides 18 commonly used hydraulic fluids, such as Skydrol LD-4, HyJet 4A, and Fluid MIL-F-83828. Properties for these fluids are automatically calculated when you input the temperature and amount of trapped air. You can define a fluid by entering its fluid properties.



Dialog box for selecting a hydraulic fluid for a hydraulic loop. You can select commonly used hydraulic fluids, such as Skydrol LD-4, HyJet 4A, and Fluid MIL-F-83828. SimHydraulics automatically calculates key fluid properties from your specified values for trapped air and fluid temperature.

Extending Model Capabilities

You can generate a linear model (continuous or discrete time) from your nonlinear SimHydraulics model. You can analyze the linear model's behavior about a certain operating point, or you can create a controller by applying linear control theory to the system. You can also automatically calculate the steady-state solution of your SimHydraulics model to remove unwanted transients at the start of simulation, thus reducing the amount of time needed to simulate your system.

Modeling the Plant and Controller in Simulink

As a physical modeling product built on Simscape, SimHydraulics provides expanded capabilities for modeling hydraulic systems. You can create your physical plant model using physical connections, and, through Simscape interface blocks, connect it directly to your control model built with signal flows in Simulink. As a result, you can test your entire system within the Simulink environment.

Required Products

MATLAB®

Simulink

Simscape

Related Products

SimDriveline. Model and simulate mechanical driveline systems

SimMechanics. Model and simulate mechanical systems

SimPowerSystems. Model and simulate electrical power systems

Simulink® Parameter Estimation. Estimate model parameters using test data

Platform and System Requirements

For platform and system requirements, visit *www.mathworks.com/products/simhydraulics* ■

Resources

VISIT
www.mathworks.com

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