

# SIMSTEAM

Site-Wide Steam-System Simulation for Simulink®



A block library for Simulink, for the dynamic simulation of industrial steam systems. SIMSTEAM supports the modelling of site-wide steam-system header and distribution pipe work, boilers, heat-recovery steam generators (HRSGs), steam turbines, letdown stations, steam valves and accumulators, generators and users of steam.

Developed for use in KHACE's steam-system modelling and simulation studies for its clients in the UK and abroad; SIMSTEAM is now available under license for customers and clients to build, test or maintain their own steam-system simulations.

## OVERVIEW

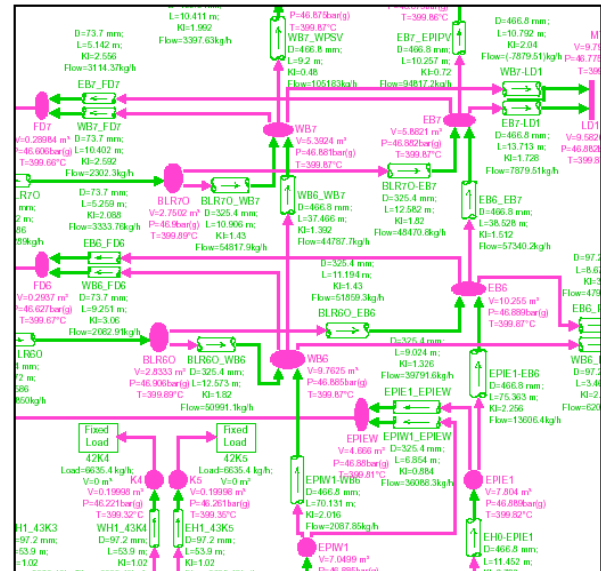
SIMSTEAM is for use by Control Engineers, Chemical Engineers, Process Engineers, Mechanical Engineers, Electrical and Power Engineers or others carrying out engineering design dynamic simulations for steam generating and distribution systems; and who want to take advantage of what is probably the world's most popular engineering dynamic simulation environment: MATLAB® & Simulink®.

Drag, drop and connect block models for pipe sections and pipe nodes to build your steam header dynamic model. Header volumes are calculated automatically from connected pipe dimensions and other hold-ups. Steady-state and intermediate and run-end pressures, temperatures, flows and their directions can be shown as annotations directly on the block diagrams (see figure).

Typical applications include modelling and dynamic simulation of steam-generating and steam distribution plant in support of steam-generator (boiler, HRSG) and steam-user trip and shutdown simulation studies; steam-load shedding and steam-flow distribution design and other studies of the dynamic behaviour of steam generation, distribution and use.

## KEY FEATURES

SIMSTEAM adds to Simulink the capability to build complex models of steam-distribution pipe work, by dragging and dropping model blocks for pipe sections (based on pipe dimensions) and pipe work nodes (for pipe section branches and connections). As the simulation progresses, pressures and



Extract from a complex steam-header system, with optional display of pipe dimensions, temperatures, pressures and flows.

temperatures are calculated at nodes in response to changing inflows and outflows, while the flow between nodes is calculated as a function of differential pressure and steam transport properties. At any time the simulation may be paused and pressures, temperatures and flows optionally displayed on-screen.

SIMSTEAM includes generic models for process controls, including instruments, controllers, valves and actuators. Simulink is especially suited to the modelling and simulation of process controls.

Modelling of boilers and HRSGs is supported by the provision of many process model components; e.g. for liquid and vapour-phase heat and mass balance, and for combustion and heat-transfer modelling. SIMSTEAM includes examples of boiler models that may be analysed or adapted by users to model their own plant.

SIMSTEAM models are solved using Simulink's own built-in differential equation solvers.

Relevant simulation results are optionally stored during the simulation for post-run analysis and plotting. Simulink's own plotting and visualisation features may be used to monitor progress of the simulation.

## STEAM PROPERTIES

SIMSTEAM includes a complete copy of KHACE's WATSTEAM product: *Water and Steam, Thermophysical properties for MATLAB*.<sup>ii</sup>

WATSTEAM is a suite of MATLAB toolbox style functions for calculating Thermodynamic Properties according to the IAPWS<sup>iii</sup> Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam; with Transport Properties calculated using the recent IAPWS equations.

SIMSTEAM uses WATSTEAM to calculate all necessary thermodynamic and transport properties of water and steam within SIMSTEAM models. All of WATSTEAM's functions are also fully available to support the MATLAB user's own calculations and model development.

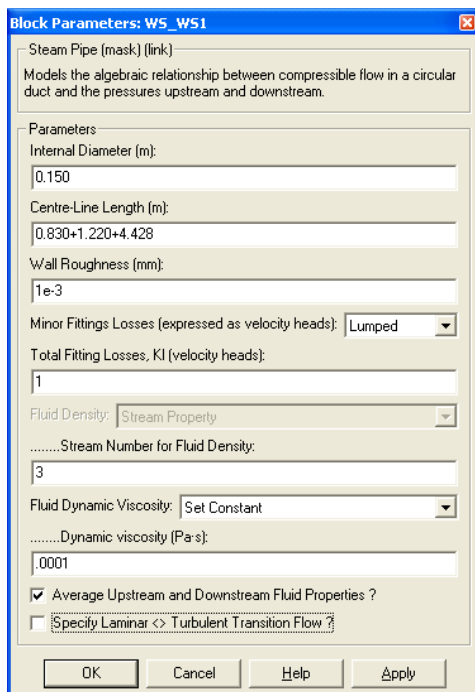
## DOCUMENTATION

The *SIMSTEAM User's Guide* includes a tutorial section. The *SIMSTEAM Model Reference* is a complete reference for all the SIMSTEAM library blocks, with an explanation of the equations underlying each block's function and examples of how to use each block.

## EXTENSIBILITY AND OPENNESS

Most of the top-level functions and physical models in SIMSTEAM are implemented in programmable M-files – routines written in the MATLAB language – that give you access to the source code.

Only SIMSTEAM's own system and management



A typical pipe section configuration dialog box.

functions are implemented in MATLAB P-files, i.e. pre-compiled M-files.

This dual M-file/P-file approach allows users access to SIMSTEAM physical models while providing a reasonable compromise between traditional MATLAB openness and extensibility, and the need to protect the intellectual property rights of the authors.

Simulink is a general-purpose engineering dynamic simulation environment. SIMSTEAM users can therefore add readily their own simulation models to the Simulink environment and build simulations that integrate a user's own models with models from SIMSTEAM and from other commercially available Simulink block libraries; e.g. for electrical, mechanical and control engineering.

## SYSTEM REQUIREMENTS

SIMSTEAM is available as standard for MATLAB under Microsoft Windows. Supported versions of Windows include Windows 2000 and XP. MATLAB for Windows, version 7.0.1 (R14SP1) or later is required. Single user or network licenses are available.

Please enquire for availability on other MATLAB supported platforms.

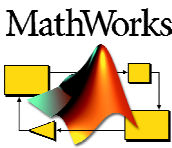
## TRAINING AND SUPPORT

We understand that process modelling and dynamic simulation are skills that require a special combination of knowledge and experience. MATLAB and Simulink are easy to use, and The Math Works Inc. provide training courses for all levels of MATLAB & Simulink skill. As well as offering e-mail and telephone support, KHACE can offer on-site training for new SIMSTEAM users. We can also work with clients to build and deliver custom steam-system models, and then train end-users for handover.

<sup>i</sup> MATLAB and Simulink are Registered Trade Marks of The Math Works Inc. <http://www.mathworks.com>.

<sup>ii</sup> WATSTEAM is also available for license as a stand-alone package for MATLAB.

<sup>iii</sup> IAPWS: International Association for the Properties of Water and Steam. <http://www.iapws.org>

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