Apros® Combustion
## High-fidelity dynamic simulation of thermal power plants

Apros® Combustion is a high-fidelity dynamic simulation product for integrated thermal power plant process and automation design and engineering, and for creating highly realistic plant-specific operator training simulators. It includes complete model libraries to build plant-specific dynamic models of thermal power plants for high-fidelity engineering and training simulation needs. Typical Apros® Combustion users are main process or automation equipment vendors, power plant owner operators, engineering companies, system integrators, and training providers.

Apros® Combustion combines the high-fidelity thermal hydraulic solvers, and modern, easy-to-use fully graphical user interface. The entire power plant model covering the boiler, turbine plant, auxiliary systems including the automation and electrical system can be simulated using a single tool. The openness and supported communication, e.g. OPC UA and OPC DA, it is easily connected to most emulated or virtual DCS and automation HMI on the market.

## Increased realism for dynamic simulation and efficient model configuration for plant design and engineering

Apros® Combustion is currently in active use by several boiler, turbine, and automation system vendors, and has proven efficient and highly realistic dynamic simulation to satisfy dynamic simulation needs of the most demanding customers. Apros® Combustion is completely process and automation system vendor independent. The easy-to-use graphical user interface, the openness to integrate customer's own in-house models, and the features to support customers own model library development makes Apros® Combustion an ideal dynamic simulation tool for boiler, turbine, heat exchanger manufacturers, and engineering companies.
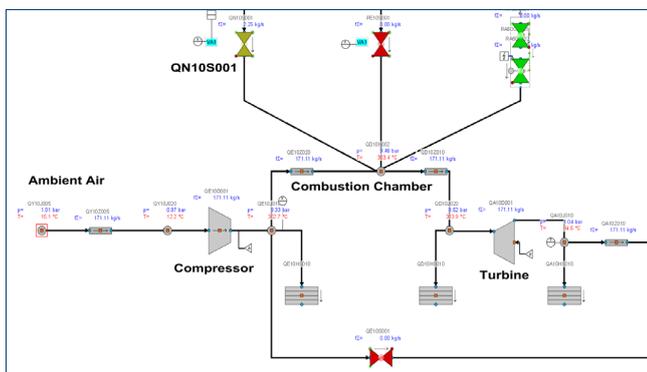
The thermal hydraulic solvers of Apros® Combustion are based on solvers verified and validated based on nuclear industry requirements. Apros® Combustion software brings along the same high level of modelling and simulation quality to thermal power plants.

Operator training simulators with proven realism and connectivity with wide range of automation systems

More than 30 high-fidelity operator training simulators have been successfully delivered internationally based on Apros® Combustion software.
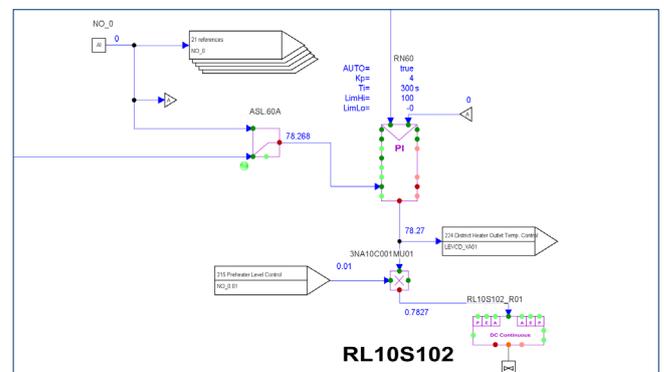
The core of the Apros® Combustion based training simulators is the highly realistic dynamic power plant model customized to the design data provided by boiler/turbine vendors.

The connectivity (e.g. OPC UA / OPC DA) of Apros has helped successful integration to most DCS systems on the market; either hardware-in-the-loop, or emulated/virtual DCS approach based on customer project requirements.

In partnership with

Apros® Combustion

Customized high-fidelity power plant models based on Apros® Combustion component libraries

Apros® Combustion includes complete set of process components for configuring highly-realistic dynamic models for various kinds of plants, also operating in super-critical region.

The capabilities of power plant modelling includes and is not limited to the following:
- super-critical, sub-critical boilers,
- pulverised coal fired,
- fluidised bed boilers,
- circulating fluidised bed combustion,
- gas turbines, compressors,
- heat recovery steam generators, motor and turbine-driven pumps,
- piping systems,
- steam turbines,
- coal pulverisers, fuel handlings systems,
- air and flue gas systems,
- heat exchangers,
- valves, steam reduction stations,
- steam attemperators,
- fuel gas and oil burners,
- ID/FD fans, rotary air heaters,
- condensers, feed water tank, flash tanks, water tanks, vacuum pumps, vacuum system,
- dewatering systems, etc.
- plant utilities, electrical system,
- electrical grid,
- turbine excitation,
- cooling towers,
- district heating/cooling systems,
- heat accumulators,
- carbon capture processes,
- weather, solar systems, wind power systems,
- equipment casing metal heat inventories,
- thermal stress / fatigue calculation,
- flue gas composition, effluents,
- diesel engine systems, etc

A plant-specific boiler, gas or steam turbine plant, or even a vendor-specific heat exchanger component can be configured by combining various existing process components.

Apros® thermal hydraulic solvers guarantee the accuracy of dynamic behavior

The modelling is based on solving the dynamic conservation equations for mass, momentum, energy and mass fractions. These conservation equations are solved simultaneously for the entire model network. These equations are discretized and non-linear terms are linearized before solving the pressures, flow velocities, void fractions and enthalpies. The steam tables are based on IAPWS-IF97. Steam properties are calculated as a function of pressure and enthalpy.

Calculation of combustion and other relevant chemical reactions is performed within the thermal hydraulic model of Apros. The reactions are assumed to take place ideally if enough oxygen is present and if the gas temperature is above the ignition temperature.

Automation system functionality either simulated using Apros® Automation Library or emulated based on your project needs

Apros automation library contains complete set of analogue and binary automation components to configure a DCS vendor independent implementation for automation functionality.

In full-scope training simulator applications, Apros® Combustion typically is responsible for plant (process, electrical system, field measurements, motors and actuators) simulation, and the automation functionality is on emulated or virtual DCS/PLC connected to Apros® Combustion.

For engineering purposes Apros Combustion includes complete model libraries for detailed or simplified simulation of operational automaton, BMS, and safety systems:
- closed-loop controls,
- interlockings,
- change-over automation
- sequence logics
- advanced process control (APC),
- field measurements,
- actuators, device controls

You can create and test your automation design during basic engineering phase, prior to decision of DCS vendor. The automation model on Apros® Combustion is your complete basic automaton design documentation that you can use as complete and tested technical documentation as input data for detailed automation design.

Furthermore, Apros® Combustion software has been readily integrated to several major plant and automation design systems. Openness and connectivity to APC packages, DCS is e.g. via OPC UA, OPC DA. Please ask for more details.

In partnership with

Next generation energy company | Fortum

Apros® Combustion

Data requirements for model development

The following plant information is typically required for model configuration using Apros® Combustion:

- system descriptions
- piping and instrumentation diagrams (P&ID)
- layout drawings
- equipment specifications: boiler, turbine, heat exchangers, major tanks, generator, pumps, fans, valves,
- plant operating manuals,
- balance diagrams: full and partial loads

Software licenses, modelling and training services, or turnkey plant-specific simulators

Would you prefer purchase Apros® Combustion software licenses and initial training, and continue independently with successful engineering or training simulator delivery projects, Apros® Combustion may be your optimal selection.

Would you be interested to case engineering studies for solving your current design or engineering challenges, or e.g. turn-key delivery of full-scope operator training simulator, Apros® Combustion may be your optimal selection. Please ask your for more details.

Apros® Combustion product includes the following libraries:

- Apros® Thermal Hydraulic Library
- Apros® Automation Library
- Apros® Electrical Library

For more information see separate Apros® library specific datasheets.

http://apros.fi

Fortum, Nuclear and Thermal Power Division
Thermal Production and Power Solutions,
P.O.Box 100, 00048 Fortum, Finland, Tel. +358 10 4511
www.fortum.com/powersolutions, www.apros.fi

For further information, please contact:
Sami Tuuri, Product Manager
sami.tuuri@fortum.com, Tel. +358 40 354 5604
Matti Paljakka, Key Account Manager
matti.paljakka@vtt.fi, Tel. +358 20 722 6423

In partnership with

VTT

Next generation energy company | Fortum