Apros® Datasheet
Containment Modelling

The containment model is based on the conservation equations of mass, momentum and energy using so called lumped-parameter approach. The simulated containment is described by arbitrary number of subvolumes (nodes) and flow paths between the subvolumes (branches) enabling flexible modeling of various containment geometries. Also all relevant engineered safety features can be modeled.

Containment modelling principles

Each node may include a gas region, a water droplet phase and a liquid pool. Atmosphere of each node is assumed to consist of homogeneous mixture of water vapour and non-condensable gases. However, the liquid and gas phases may have different temperatures. Both gas and liquid flow between the nodes is calculated using specific branches.

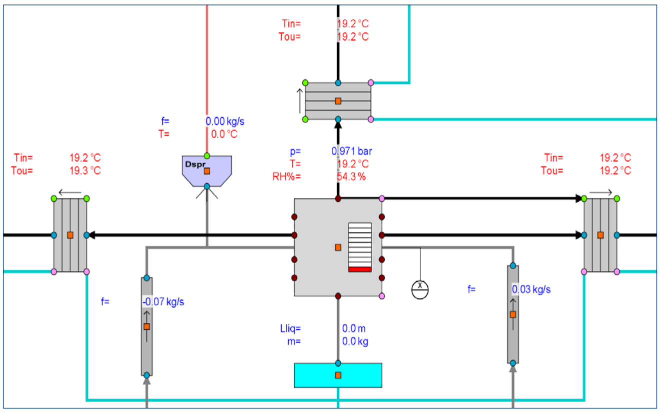
The gas region and water pool of a node can be connected to one or more heat structures. The containment model calculates the heat and mass transfer between the gas/water phase and the heat structure surface. Both convective and radiation heat transfer is treated. The heat conduction inside the structures is calculated by using the general heat conduction model available in Apros.

The sprinkler spray (internal and external spray systems) or a leakage flow from other systems can be introduced into any node. The leakage can be specified either as a time dependent table of the leakage mass flow and enthalpy or by defining a flow path between the thermal hydraulic nodes and the containment nodes.

The internal spray system model is based on the complete mixing droplet model, which assumes a uniform droplet temperature. The droplet surface temperature is however iterated separately due to its strong effect on the combined heat and mass transfer.

The model takes into account the change in the droplet size due to steam condensation or water evaporation and the influence of noncondensable gases and water vapour mass flux on the heat and mass transfer coefficients. The falling droplets can be described in five size groups. The spray cooling can also be specified for the outer surface of the containment.

The ice-condenser model consists of three optional heat transfer correlations. Also the user specified heat transfer coefficients can be used. The operation of ice-condenser lower inlet doors, intermediate deck doors and top deck doors are modeled. Heat conduction inside the ice is not treated.



Containment node with connected heat structures and internal spray module.

The ice-condenser can be divided into various nodes and branches, and thus, the internal flows and unhomogeneous ice melting within the component can be described.

The suppression pool model includes a model for the vent pipes and the interaction of steam and noncondensable gases with the pool water. The expulsion of the water plug inside the vent pipes is calculated by taking into account the water plug acceleration. A user defined fraction of the steam is assumed to condensate in the suppression pool, and no pool scrubbing is modeled.

Hydrogen deflagration and continuous burning (diffusion flame) models calculate the rate at which the hydrogen reacts with oxygen to form steam. Actual reaction kinetics and the flame front structure are not modeled. The energy release during a burn is deposited into the node atmosphere. A simple procedure is also implemented to assess the susceptibility of gas mixture to deflagration-to-detonation transition (DDT). Also the operation of catalytic recombiners can be modeled.

Containment library is included in the following products:

- *Apros® Nuclear + Containment*

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