Wall condensation modelling for nuclear power plants

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This paper presents the development and validation of a wall condensation model. Steam condensation at walls is an important phenomenon for the simulation of accidents in nuclear power plants and the assessment of the risk of hydrogen combustion. GRS works together in a network of different German research institutes and universities to apply OpenFOAM for the simulation of these different accident phenomena.

For these simulations OpenFOAM 6.0 was used at GRS. The chtMultiRegionFoam solver is the most appropriate solver for the simulation gas mixing phenomena and wall condensation phenomena. It was necessary to implement additional source terms for condensation mass and energy. This model is based on a single-phase simulation, because multiphase simulations are too time consuming for the complex nuclear power plant geometries. The kOmegaSST model was used to model turbulence. Further on it was necessary to add source terms for species diffusion into the chtMultiRegionFoam solver. In these OpenFOAM simulations the influence of numerical parameters like mesh sensitivity or time step size on simulation results were analyzed.

The new developed wall condensation model was validated with small scale experiments (CONAN-Benchmark) and with big scale experiments (THAI facility). The simulation results show good agreement in comparison to experimental data and to simulations with a commercial CFD tool – ANSYS CFX.