Prediction of Convective Boiling up to Critical Heat Flux (CHF) Conditions for Test Facilities with Vertical Heaters

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Abstract

The paper covers the project results of ANSYS Germany in a 3-years R&D consortium "CFD Methods for the Prediction of Critical Heat Flux – NUBEKS", where the main goal was the improvement of predictive capabilities of ANSYS CFD for the coverage of flow regimes from nucleate subcooled boiling up to flow conditions close to critical heat flux (CHF). The paper will provide an insight in the chosen Eulerian multiphase flow modeling concepts and their application to two different test facilities and experiments with comparison to validation data. The CFD simulation methodology involves the combination of conjugate heat transfer (CHT), the extended RPI wall boiling model together with discrete population balance and flow regime transition modeling, commonly known as the inhomogeneous MUSIG model.

The first studied application case is the test facility operated by the TU Munich, Dept. Technical Thermodynamics for convective wall boiling of a NOVEC 649 refrigerant heated by a massive Copper heater under atmospheric pressure conditions. As a second validation experiment the derived ANSYS CFD modeling has been applied to first available experimental data from the COSMOS-L test facility at KIT, Inst. Thermal Process Technology for investigation of flow conditions close to CHF for a water-water vapor system under moderate pressure of up to 2-3 bar. The presentation will provide an insight in the established state-of-the-art of wall boiling prediction by means of CFD, its current predictive capabilities and will provide an outlook for possible future development.

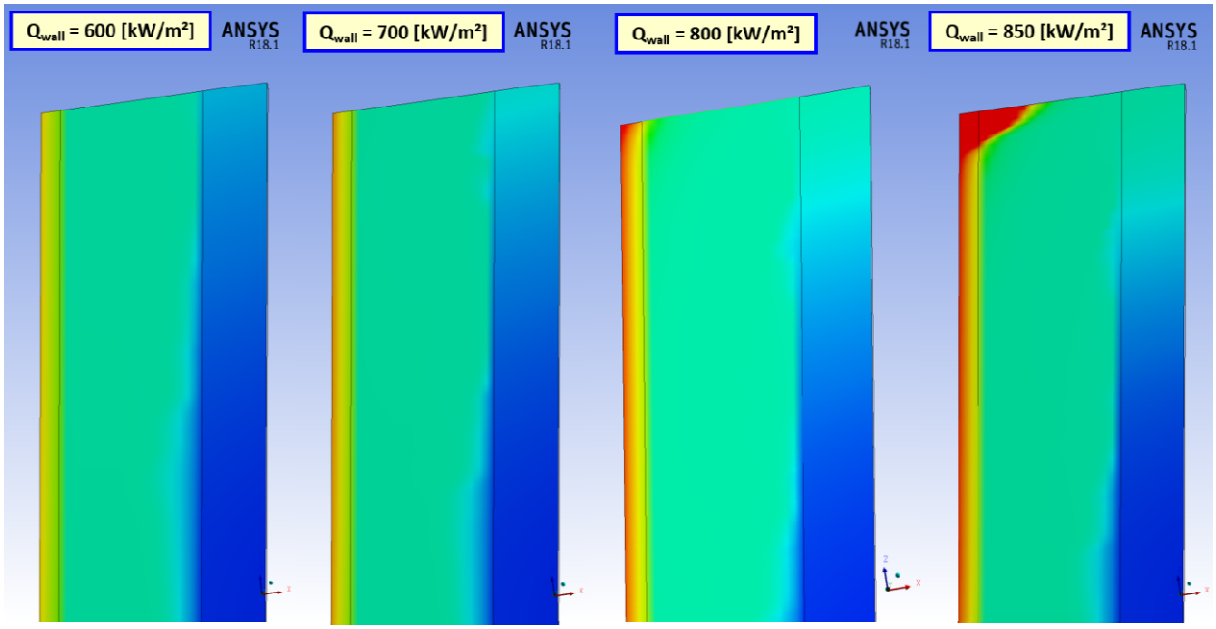

Fig. 1: Temperature distribution in Zirconium alloy heater rod, circular annulus fluid domain and outer Duran glas wall of the COSMOS-L test facility for step-wise increased wall heat flux up to CHF.