Behaviour of Flow Models of Nonequilibrium Condensation of Water Steam in High Pressures Conditions

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Abstract

In this work we deal with the numerical modelling of spontaneous condensation of rapidly expanding water steam primarily in nozzles under high pressures conditions (higher than 1 MPa) and nonequilibrium state. High pressure implies using of nonideal thermodynamic models and revision of two parts of spontaneous condensation - nucleation of liquid cores and its subsequent growth/shrink. Therefore, numerical solution is much more complicated and time consuming. For this purpose we developed in-house CFD code with the following limitation: 2D geometry, time dependent laminar Navier-Stokes or turbulent RANS system of equations, method of moments for description of time evolution of liquid phase closed by constant, linear or nonlinear droplet growth model, classical nucleation theory, equation of state for vapor phase based on IAPWS releases, simple equations describing thermodynamic properties of condensate (liquid water in the region close to liquid saturation curve). We tested our approach on convergent-divergent nozzle profiles with supersonic outlet. Only a few experiments of high pressure condensation exist and are documented in literature. We chose experiments of Gyarmathy and Bakhtar. Our preliminary results give quite good correspondence with the experimental data, providing that we incorporate appropriate corrections to existing state-of-the-art condensation models.

References

1. F. Bakhtar and K. Zidi. Nucleation Phenomena in Flowing High-pressure Steam - Experimental Results. Proc Instn Mech Engrs 203 (1989) 195-200.