MARS Mechanistic FILM-SPLITTING AND DRYOUT MODEL IN ANNULUS GEOMETRY

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Abstract

Annular flow in annulus geometry is characterized as two liquid films flowing along the inner heated rod and outer unheated walls. Critical heat flux (CHF) occurs when the liquid film on the inner heated wall dries out, while there still exists the liquid film on the outer cold wall. In the MARS code, film dryout is calculated by a mechanistic model or CHF table look-up method. The mechanistic film dryout is modeled using a complex function of film flow rate, applied heat flux and entrainment/deposition rate, etc. and is determined by the hydrodynamic solution. The table look-up method interpolates the AECL-UO CHF table. However, both models were not able to distinguish the liquid films on the cold and hot surfaces in a calculation cell, that is, the cold wall effect. This resulted in over-estimation of the calculated CHF in the single-channel modeling of annulus geometry, which necessitated a new model that could consider the cold wall effect mechanistically in the single-channel modeling. In order to consider the cold wall effect, a mechanistic film splitting model has been developed for MARS implementation, in which the inner and outer liquid film fractions are solved analytically by introducing a maximum velocity plane concept in the vapor core. In addition, the droplet entrainment and deposition models and the transition criterion for the annular flow regime are improved in order to enhance code accuracy. The new MARS version has been assessed using the KAERI annulus CHF tests and the results shows enhanced agreement with the experimental data.