Numerical investigations on the onset of nucleate boiling for submerged liquid impingement flow

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Abstract

Jet impingement flow is a successful solution for thermal management of some high heat flux electronics. By introducing the liquid-vapor phase change in jet impingement, the heat transfer coefficient can be further improved and a relatively uniform temperature distribution of the heating surface can be maintained. This paper numerically studies the initiation of this liquid-vapor phase change phenomenon (i.e. onset of nucleate boiling) in the submerged jet impingement flow. The framework of our computations is the Computational Fluid Dynamics (CFD) code FLUENT. The Eulerian multiphase model and standard k-ε turbulent model are used in the simulation study. The Rensselaer Polytechnic Institute (RPI) boiling model, together with appropriate models simulating bubble dynamics, are applied to describe boiling phenomenon in submerged jet impingement. The effects of jet parameters (e.g. jet velocity, jet outlet temperature and nozzle size) on the boiling initiation are investigated. The results show that the RPI model is able to well predict the onset of nucleate boiling at various conditions of impinging jet. The streamline and temperature distribution at onset of nucleate boiling are discussed.

Keywords: Submerged jet impingement boiling, onset of nucleate boiling, CFD, RPI boiling model