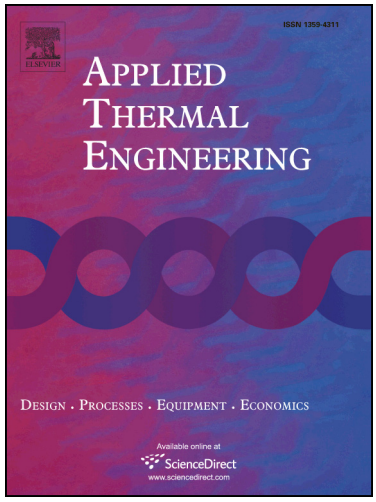

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PII: S1359-4311(16)32972-6
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.012
Reference: ATE 9417

To appear in: *Applied Thermal Engineering*

Received Date: 29 July 2016
Revised Date: 24 October 2016
Accepted Date: 1 November 2016

Please cite this article as: P. Liu, X.B. Peng, Y.T. Song, X. Mao, Subcooled water flow boiling heat transfer in screw cooling tubes under one-sided heating conditions, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.012

Subcooled water flow boiling heat transfer in screw cooling tubes under one-sided heating conditions

P. Liu[1,2,3], X.B. Peng[1], Y.T. Song[1,2], X. Mao[1]

[1]Institute of Plasma Physics Chinese Academy of Sciences, Hefei 230031, China

[2]University of Science and Technology of China, Hefei 230026, China

[3]College of Mechanical Engineering, Anhui University of Science and Technology, Huainan 232001, China

Abstract

Subcooled flow boiling heat transfer in vertically upward screw cooling tubes was numerically simulated in the paper under one-sided high heat fluxes up to 20 MW/m^2 by using the Fluent software. The Eulerian multiphase model coupled with Non-equilibrium Boiling model was dedicated to explaining the thermal and hydrodynamic characteristics of subcooled flow boiling. A solution algorithm of finite volume discretization was presented to solve the Euler equations. The numerical models were effective for predicting the subcooled water flow boiling heat transfer in the screw tube. Finally, the wall temperature of the interface between the CuCrZr component and the fluid, the pathlines of the fluid, the three components' temperatures, the pressure drops and vapor void fraction were simulated and analyzed. The heat transfer performance of screw tubes was compared with smooth tubes and tubes with twisted tape inserts. The simulated results were as follows: Compared with smooth tubes, the swirl flow and secondary vortex in the screw cooling tube could enhance the turbulence intensity of the fluid and postpone the rise of wall temperatures. The heat transfer performance of the tube with twisted tape inserts was a bit higher than that of the screw tube. In order to avoid the meltdown or destruction under the high heat flux, the screw tube and the tube with twisted tape inserts can sustain 10 MW/m^2 heat flux while the smooth cooling tube can sustain 6 MW/m^2 heat flux.

Keywords: Screw tube; Divertor; High heat flux removal; Subcooled flow boiling; Enhancement of heat transfer; One-sided heating.

1. Introduction

Divertor is an important component in the fusion reactor [1]. It serves the purpose of an exhaust pipe where the fusion ions, unburnt fuel, and impurities from the interaction of plasma