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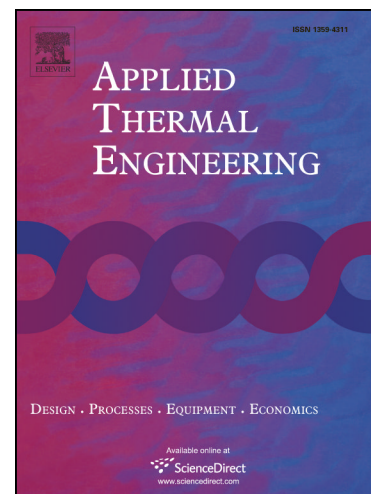
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CFD simulation on the heat transfer and flow characteristics of a microchannel separate heat pipe under different filling ratios

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Key words: Microchannel separate heat pipe; Computational fluid dynamics (CFD); Refrigerant filling ratio; Thermal characteristics; Flow pattern.

Abstract

This paper established a CFD model of the evaporator of a microchannel separate heat pipe(MCSHP) used for special indoor environment cooling (e.g., telecommunication station) to study its heat transfer characteristics and flow mechanisms under different filling ratios. The louvered fin model outside the pipe was simplified to shorten the computation time without ignoring the thermal enhancement. The CFD simulation results were validated by experimental data. The optimal refrigerant filling ratio was from 68% to 100%. The bubble flow existed inside the whole pipe during the early stage of evaporation, and converted to slug flow under continuously heating. It was found that the cooling capacity increased with the filling ratio, and was high to 4087W at the filling ratio 78%. Due to the formation and movement of refrigerant bubbles, the liquid fraction distribution inside the evaporator varied with the filling ratio and dimensionless time. The distribution of wall temperature and the liquid fraction both indicated that the effective heat transfer area of two-phase region was a key parameter affecting the cooling capacity. This study can be used to simplify experiment procedure and to optimize the system design and operation of MCSHP.

1. Introduction

Recently, with the rapid development of telecommunication industry in China, the communication network with over 600,000 telecommunication stations(TSs) has become one of the largest in the world [1], and its operation costs 20 billion kWh annually, one third of which is accounted by TSs [2]. Because of the necessity to maintain proper temperature, relative humidity, and cleanliness of the

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