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Effects of outlet port positions on the jet impingement heat transfer characteristics in the mini-fin heat sink ☆

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ABSTRACT

Effects of outlet port positions on the jet liquid impingement heat transfer characteristics in the mini-rectangular fin heat sink are numerically investigated. The three-dimensional governing equations for fluid flow and heat transfer characteristics are solved using finite volume scheme. The standard k-ε turbulent model is employed to solve the model for describing the heat transfer behaviors. The predicted results obtained from the model are verified by the measured data. The predicted results are reasonable agreement with the measured data. The outlet port positions have significant effect on the uniformities in velocity and temperature. Based on the results from this study, it is expected to lead to guidelines that will allow the design of the cooling system to ensure the electronic devices at the safe operating temperature.

1. Introduction

For the advancements of electronic devices in the few decades, electronic devices have become faster, smaller and higher generated heat. However, to ensure that these are at the safe operating temperature which are increasing a reliable operation, the effective removal of the generated heat is an important role of the cooling system. The developments of the miniaturized technology, mini and micro-components have been introduced as one of heat transfer enhancement techniques for these devices. Zhao and Lu [1] analytically and numerically studied the effect of porosity on the thermal performance of a micro channel heat sink. Wei and Honda [2] reviewed the researches concerning the boiling heat transfer enhancement for the micro-channel heat sink immersed in dielectric liquids. Feng and Xu [3] developed a three-dimensional analytical solution using the method of Fourier expansion for determination of the spreading thermal resistance of a cubic heat spreader for electronic cooling applications. Kobus and Oshio [4] theoretically and experimentally studied on the thermal performance of a pin-fin heat sink with various configurations. Li et al. [5] determined the thermal performance of heat sinks with confined impingement cooling. The effects of the impinging Reynolds number, the width and the height of the fins, the distance between the nozzle and the tip of the fins on the thermal resistance were investigated. Zhang et al. [6] reported the study of a single-phase heat transfer of micro channel heat sink for electronic packages. Dogruoz et al. [7] experimentally and numerically studied on the hydraulic resistance and heat transfer of in-line square pin-fin heat sinks. Yu [8] studied on the thermal performance of a plate-pin fin heat sink and a plate fin heat sink. Peles et al. [9] investigated on the heat transfer and pressure drop over a bank of micro pin fins. Yakut et al. [10] considered the effects of the heights, widths of the hexagonal fins on thermal resistance and pressure drop characteristics. Mohamed [11] investigated the air-cooling characteristics of an electronic device heat sink with various square module array. Didarul [12] investigated on the heat transfer and fluid flow characteristics of finned surfaces. Yang [13] experimentally studied on the heat transfer coefficient of pin fin heat sinks with different cross sections and with different fin arrangements. Jeng and Tzeng [14] experimentally studied the pressure drop and heat transfer of a square pin-fin array in a rectangular channel. Geedipalli et al. [15] simulated the combination heating of food using microwave and jet impingement by coupling Maxwell's equation. Sung and Mudawar [16] studied on the jet impingement single-phase and two-phase heat transfer characteristics. Koseoglu and Baskaya [17,18] used a Laser Doppler Anemometry to observe the jet flow field and turbulence on heat transfer characteristics. Tye-Gingras and Gosselin [19] presented a conceptual design of a heat sink combining a porous medium. Wee et al. [20] investigated the steady flow characteristics of heat sinks with smooth, ribbed, and dimpled surfaces. Yang and Peng [21] studied the thermal and hydraulic performance of compound heat sink. Miao et al. [22] investigated the fluid flow and heat transfer characteristics of round jet arrays impinging orthogonally on a flat plate with confined wall. Wong and Saeid [23] numerically investigated the mixed convection–conduction problem of impingement cooling of a finite thickness solid wall conjugated with a porous medium. Rahman et al. [24,25] presented

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