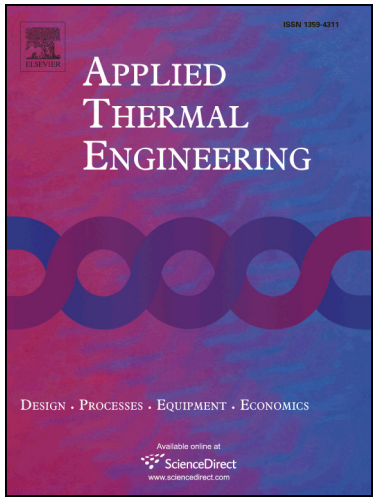

Research Paper

Numerical investigation of heat transfer and pressure drop in a rotating U-shaped hydrophobic microchannel with slip flow and temperature jump boundary conditions

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Numerical investigation of heat transfer and pressure drop in a rotating U-shaped hydrophobic microchannel with slip flow and temperature jump boundary conditions

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Abstract

Numerical simulations are performed to investigate the fluid flow and heat transfer in a three-dimensional rotating U-shaped microchannel with a square cross-section for Reynolds numbers of 200-1000. The water is employed as working fluid. The microchannel surface is considered to be hydrophilic (no-slip flow) and hydrophobic (slip flow). Effects of slip flow, temperature jump and rotational speed in the range of 0-300 rad/s are studied on the heat transfer, pressure drop and thermal performance coefficient. Various slip lengths ranging from zero (hydrophilic surface) to 10μm are employed and their results are compared. It is observed that the effect of slip flow results on the leading and trailing walls is not similar due to the rotational effects. It is found that the slip flow augments the heat transfer rate in comparison with that of no-slip flow while using both slip flow and temperature jump reduces the heat transfer rate in comparison with that of slip flow. A relatively large reduction on the pressure drop and an improvement on the Nusselt number are found when the slip length increases from zero to 10μm. The thermal performance coefficient increases about 90 percent for 10μm slip length in comparison with that of no-slip condition. Moreover, for a rotating microchannel (300 rad/s), the thermal performance coefficient increases about 43 percent for low Reynolds numbers and about 11 percent for large Reynolds numbers in comparison with that of the stationary microchannel.

Keywords: U-shaped microchannel; slip flow; temperature jump; rotational speed; thermal performance coefficient; hydrophilic; hydrophobic