Physics of active flow control around a pillar at the micro scale

by

Junkyu Jung

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Examining Committee:

Dr. Yoav Peles, Thesis Adviser

Dr. Michael Amitay, Co-adviser

Dr. Theodorian Borca-Tasciuc, Member

Dr. Joel Plawsky, Member

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

The use of microchannels for heat transfer enhancement has been studied for the last few decades. To take full advantage of a microchannel, various approaches such as two-phase flow, enhanced heat transfer surface, and flow boiling across pin fins entrenched inside a microchannel have been studied. Among them, micro pin fins heat exchangers, similar to their conventional counterparts have been seriously considered due to their superior heat removal performance throughout the extended surface area. In addition, an early transition to turbulent flow via micro pin fins is believed to improve heat transfer at the micro scale. Therefore, the aim of this study is to extend fundamental knowledge of flow around a micro pin fin with and without active flow.

The flow field around a micro pillar was measured using micro particle image velocimetry (µPIV), and the turbulent kinetic energy (*TKE*) of the flow was measured to quantify flow mixing around the micro pillar. It was found that an early transition to an unsteady flow was not achieved through the micro pillar due to the inherently small height-to-diameter ratio of the pillar, and the corresponding *TKE* around the micro pillar was not significant in a quasi-steady flow regime.

Active flow control via a steady jet was employed through the slit on the micro pillar surface, where the circumferential location of the slit was varied. The velocity field as well as the *TKE* of the controlled flow was measured to determine the effect of active flow control at the micro scale. Parametric studies were performed and comparison of the various momentum coefficient, flow regime, and the azimuthal location of the control jet were conducted. Suction was introduced as alternative control scheme, and compared to a steady jet. It was found that mixing was significantly enhanced through the steady jet whereas suction was not successful with same momentum coefficients.