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Titled

HEAT TRANSFER IN MINI-CHANNEL HEAT EXCHANGER WITH SMOOTH AND PIN-FINS SURFACES

by

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Abstract

This research aims to investigate heat transfer of single-phase and two-phase fluids in minichannel heat exchanger with smooth and pin-fins surfaces. The main goal of the study is to develop a high-performance heat exchanger for thermal management in various processing applications. This research study is carried out using computational fluid dynamics (CFD) and experimental testing. The proposed method is to use enhanced structured pin-fins surfaces in a mini-channel heat exchanger to improve heat transfer. The pin-fin microchannel heat exchanger is investigated using a CFD method with single-phase fluid (water, air). The experimental investigations are conducted using single-phase and two-phase fluid involving condensation. The obtained experimental results show improvement of heat transfer coefficients in the mini-channel heat exchanger with micro pin-fin surfaces at the expense of increased pressure drop. The theoretical modeling study and experimental investigation provides heat transfer results that are useful in understanding enhanced heat transfer and are valuable to the heat transfer research field.

The CFD analysis is carried out for Reynold numbers between 50 – 250. The inlet temperatures for hot and cold fluids are set to 335 K and 285 K, respectively. It was found that the maximum effectiveness occurs at lowest Reynolds number, and it is 47.4%, 64.8%, and 65.8% for surface without fins, surface with circular fins, and surface with square fins respectively.

The experimental testing is carried out on aluminum surface with a channel that has a length of 270, width of 30 mm, and height of 1.3 mm. Both smooth and surface with pin-fins are tested experimentally, with pin-fins are on the bottom in inline arrangement, and they have a height and diameter of 1 mm. The inlet temperature at hot fluid and cold fluid are fixed to 293 K and 353 K, respectively. It was found that pressure drop increased as the Reynolds number increased, and turbulent flow showed an even greater increase in pressure drop. The flow rates of air varied from 35 LPM to 77 LPM, and the cold fluid has different flow rates, which are chosen based on the heat capacity ratios of 0.25, 0.5, 0.75, and 1. The experiment showed that an increase in the ratio of heat capacity causes an increase in the convective and overall heat transfer coefficients. Increasing the ratio increased the cooling rate, which also increased the difference in temperatures between the two loops and increased the heat transfer rate. It was found the heat transfer rate is greater in enhanced surfaces with pin-fins in all single phase and two-phase fluids with condensation.