Microchannel devices with micro pin fin heat sinks and sCO2 have been designed and built in three generations. The devices were microfabricated at the Cornell Nanoscale Facility (CNF). First generation is microchannel array heat sinks, followed by circular pin fin heat sinks and airfoil pin fin heat sinks, as second and third generation devices, respectively. Heat transfer characterization including heat transfer coefficient, Nusselt number, and pressure drop was performed on the devices. In microchannel array devices (first generation) the capability of sCO2 and the effect of height to width ratio (H/W) on thermal performance of the microchannel heat sink was investigated. In circular micro pin fin heat sink device (second generation), a parametric study for the effects of fin height over diameter, and inline and staggered arrangement on heat transfer coefficient and pressure drop of the system were conducted. Heat transfer experiments were performed on airfoil pin fin heat sink devices, as well. In general, the heat transfer coefficient characteristics revealed the incredibly high values of heat transfer in such systems. Comparing thermal performance of the three generations, heat transfer coefficient obtained by the circular micro pin fin heat sink is higher than microchannel array heat sinks due to higher active surface area and better flow mixing creating turbulent flow. Micro pin fin configuration also prevents relaminarization followed by flow acceleration to be aggressively dominated in the entire micro channel. However, pressure drop in the microchannel array is less than that of circular micro pin fin heat sinks. It was observed that thermal performance of airfoil micro pin fin heat sinks is better than that of two microchannel array and circular pin fin heat sinks. Among airfoil micro heat sinks, staggered arrangement has higher thermal performance than inline arrangement. It is concluded that as airfoil thickness increases, thermal performance of the heat sink increases, but comprehensive performance of the heat sink decreases. It was also found that existing conventional scale correlations and flow maps did not predict well the corresponding characteristics in micro-scale systems, and thus, new correlations have been developed.

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The public is welcome to attend.