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Master Thesis Defense

Entitled

EXPERIMENTAL INVESTIGATIONS OF TECHNIQUES TO ENHANCE THE COOLING RATE OF HOT FLUIDS BY UTILIZING GALLIUM AS A HEAT SINK MATERIAL

by

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Abstract

The thesis work proposes novel techniques to cool hot water in batch-wise operation. In these techniques, the water is allowed to lose its heat in a direct-contact manner to a high thermal conductivity sink material (i.e. Gallium). In this case, the gallium melts to a liquid phase, due to its relatively low melting point, that can experience some kind of superheating upon further heat dumping. Consequently, this may cause appreciable diminishing of the temperature difference driving heat transfer from the source. To overcome such possible liquid gallium superheating issues, the present research proposes for the first time in the literature a new technique to integrate chunks of additional un-encapsulated PCM within the solid gallium that has lower melting temperature than that of the gallium. Also, this research proposes new techniques to enhance the rate of heat transfer from the hot water to the gallium either by vibrating the heat sink under a range of amplitudes and frequencies or discretizing the hot water into small bubbles travelling through a liquid gallium bath. In conclusion, this work provides better understanding of heat transfer enhancement applications and proposes unconventional techniques for effective cooling of hot fluids (e.g. hot water) that surpass the heat exchange concepts implemented in existing traditional heat exchangers.

Keywords: Heat Transfer Enhancement, Direct Contact Heat Exchange, Phase Change Materials, Water Bubbling, Vibration.