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Research Paper

HEAT TRANSFER ENHANCEMENT USING DIMPLE SURFACES UNDER NATURAL CONVECTION—AN EXPERIMENTAL STUDY

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Over the past couple of years the use of dimples to enhance the heat transfer has increased tremendously. In this work an experimental investigation of the natural convection heat transfer over circular dimpled surfaces is carried out. The various heat transfer parameters considered for study are Nusselt number, heat transfer coefficient and heat transfer rate. From the obtained results, it can be concluded that large amount of heat transfer enhancement does takes place for the dimpled surfaces.

Keywords: Natural convection, Dimples, Heat transfer enhancement, Compact heat exchanger

INTRODUCTION

Passive techniques are used in solar air heaters, electronic cooling equipment's (heat sinks), biomedical devices, turbine airfoil cooling, etc. In passive techniques heat transfer rate is increased by making surface modifications such as protrusions, dimples and pin fins. Among these, the dimples (surface indentations) are considered important because in dimple manufacture the material is removed whereas in pin-fin or rib tabulators extra material is added which increases weight and cost of the equipment. A variety of Numerical and experimental work has been carried out on augmentation of heat transfer. Kuethe (1970), can be considered as the first person who suggested the use of dimples on flat surfaces to increase the heat transfer rate. Chyu *et al.* (1997), carried out an experimental investigation to study local heat transfer coefficient distribution in a channel using two different shaped dimples (spherical and tear drop type) placed at the bottom.

Chen *et al.* (2001) carried out an experimental investigation to study the effect of dimples(present at the inner tube of a co-axial pipe heat exchanger) on heat transfer rate. Burgess and Ligrani (2005), carried out an experiment to study the effect of dimple depth on friction and heat transfer

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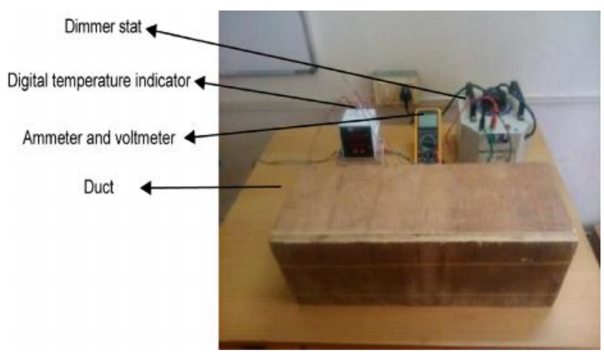
characteristics in a channel. Small *et al.* (2006), carried out investigations numerically and experimentally on heat sinks with and without dimples. Wei *et al.* (2007) carried out a numerical study of laminar flow inside a micro-channel having dimples at the bottom surface.

EXPERIMENTAL SETUP

The Experimentalsetup required for this study is as shown in Figure 1 below.

Figure 1: Experimental Setup



RESULTS AND DISCUSSION

Experiments were conducted on aluminum test plates with circulargeometries. The dimples were arranged in a staggeredfashion&the data obtained was usedto find heat transfer parameters like Nusselt number, heat transfer coefficient and heat transfer rate. And the experimental findings have been plotted in the formof graphs, mainly

- Nuv sheat input
- hvs heat input
- Qv sheat input

Figure 2 shows variation of Nusselt number 'Nu' with heat input for circular dimples considered. It is obvious that the 'Nu' increases asheat input increases for all the conditions.

Figure 2: Variation of Nusselt Number with Heat Input

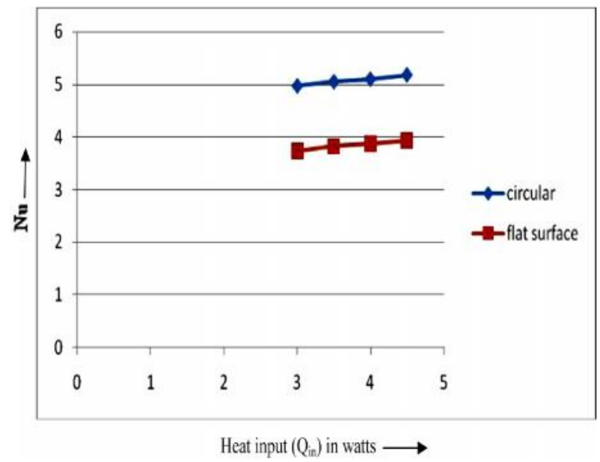


Figure 3 shows variation of heat transfer co-efficient 'h' with heat inputcircular dimples considered. It is obvious that 'h' increases as heat input increases because of the delay or disruption in the development of the thermal boundary layer.

Figure 3: Variation of Heat Transfer Co-efficient with Heat Input

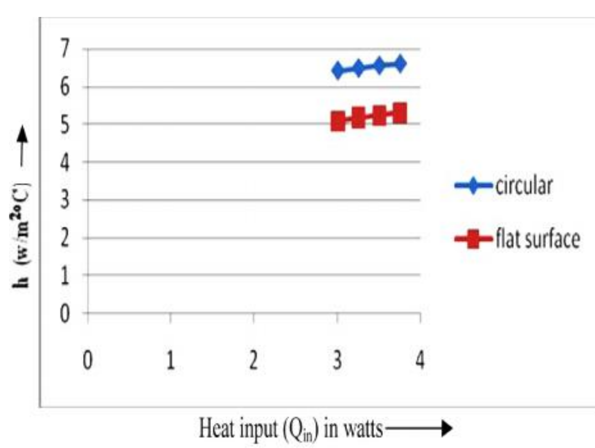
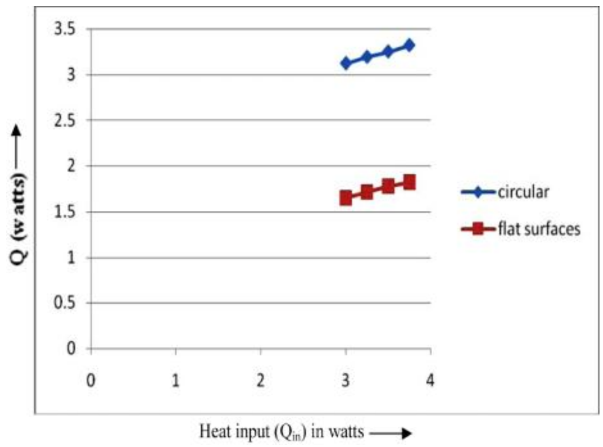


Figure 4 shows variation of heat transfer rate 'Q' with heat input for circular dimples considered. It can be seen that that heat transfer enhancement is very much higher for circular dimples due to the increased flow area.

Figure 4: Variation of Heat Transfer Rate with Reynolds Number



CONCLUSION

In this experimental work an investigation of the effect of air flow over a flat plate with circulardimples is carried out. The main conclusions of the work are as follows:

- Nusselt number 'Nu' increases with heat inputfor all the cases considered.
- Heat transfer co-efficient 'h' increases with heat input for circular dimples considered.

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