HEAT TRANSFER AUGMENTATION USING DIMPLES IN FORCED CONVECTION-AN EXPERIMENTAL APPROACH

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Over the past couple of years the use of concavities or dimples to enhance the heat transfer has been reported by several researchers. This work deals with experimental investigation of the forced convection heat transfer over circular dimpled surfaces. The various heat transfer parameters considered for study are Nusselt number, heat transfer coefficient, heat transferrate andReynolds Number. From the obtained results, novel conclusion for the design of compact heat exchanger can be drawn (Katkhaw, 2014).

Keywords: Forced convection, Dimples, Heat transfer augmentation, Compact heat exchanger

INTRODUCTION

In compact heat exchanger design, passive techniques are one of the most important techniques used by researchers to enhance the heat transfer (Liu et al., 2013). Passive techniques are also 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.

Afanasyev et al. (1993) carried out an experimental investigation of heat transfer characteristics of flow over spherical dimple surfaces.

Chyu et al. (1997) carried out an experiment to study local heat transfer coefficient distribution in a channel having two different shaped dimples (spherical and tear drop type) at the bottom. Burgess et al. (2005) carried out an experiment to study the effect

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of dimple depth on friction and heat transfer characteristics in a channel. They reported an increase in local and average Nusselt number with increase in dimple depth. Wei et al. (2007) carried out an numerical study of laminar flow inside a micro-channel having dimples at the bottom surface. Small et al. (2005) carried numerical and experimental studies on heat sinks with and without dimples and concluded that the presence of dimples increase heat transfer rate considerably.

From the above literature, it is very much clear that dimples have a high potential to increase heat transfer. However, most of the researchers carried out experimental or numerical study on spherical shaped dimples in channels and a very few studies were reported on non-spherical dimples (Chyu, 1997; and Katkhaw, 2014). Deriving motivation from this, the present study aims at investigating experimentally the effect of air flow over a flat plate with circular dimples. The obtained results, helps in drawing novel conclusion for the design of compact heat exchanger (Katkhaw, 2014).

EXPERIMENTAL SETUP
The forced convection setup required for this study is shown in Figure 1 below.

![Figure 1: Experimental Setup](image)

**Data Reduction**
The study was carried out under Steady-laminar external forced convection regime. Steady state value of the plate and air temperature for a given heat flux were used to determine the values of the different performance parameters.

**RESULTS AND DISCUSSION**
Heat transfer experiment on test plate with squared dimples for staggered arrangement were done and the data was used for finding parameters like Nusselt number, heat transfer coefficient and heat transfer rate. Experimental findings have been plotted in the form of graphs, mainly
- Re vs Nu
- Re vs h
- Re vs Qto facilitate a better discussion on experimental data.

Figure 2 shows the variation of Nusselt number ‘Nu’ with Reynolds number ‘Re’ for the dimple surfaces. It can be seen that the ‘Nu’ increases obviously with ‘Re’ for both the cases.

![Figure 2: Variation of Nusselt Number ‘Nu’ with Reynolds Number ‘Re’](image)

Figure 3 shows the variation of Heat transfer coefficient ‘h’ with Reynolds number ‘Re’. It is obvious that ‘h’ increases with ‘Re’ in both the cases.

![Figure 3: Variation of Heat Transfer Coefficient ‘h’ with Reynolds Number ‘Re’](image)
CONCLUSION

In this study an experimental investigation of the effect of air flow over a flat plate with circular dimples is carried out. The main conclusions can be summarized as follows:

1. Nusselt number ‘Nu’ increases with Reynolds number ‘Re’.
2. Heat transfer co-efficient ‘h’ increases with Reynolds number ‘Re’ in all the cases.
3. The Heat transfer rate ‘Q’ increases as Reynolds number ‘Re’ increases for both the cases.

REFERENCES