International Journal of Advance Research in Science and Engineering
Vol. No.5, Special Issue No. (01), February 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

EXPERIMENTAL INVESTIGATION OF NATURAL CONVECTION HEAT TRANSFER BY USING TRIANGULAR AND RECTANGULAR VORTEX GENERATORS

Prof.S.A.Wani[1], Miss.S.G.Hakke[2] , Miss.S.N.Kamble[3], Miss.A.S.Shaikh[4], Miss.P.D.Teli[5]

[1]Assistant Professor, [2,3,4,5]UG Students, Department of Mechanical Engineering, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon, Maharashtra, (India)

ABSTRACT

Heat transfer describes the exchange of thermal energy, between physical systems depending on the temperature and pressure,by dissipating heat.The fundamental modes of heat transfer are conduction or diffusion, convection and radiation. The exchange of kinetic energy of particles through the boundary between two systems which are at different temperatures from each other or from their surroundings. Heat transfer always occurs from a region of high temperature to another region of lower temperature. Heat transfer changes the internal energy of both systems involved according to the First Law of Thermodynamics. Natural convection is a mechanism, or type of heat transport, in which the fluid motion is not generated by any external source (like a pump, fan, suction device, etc.) but only by density differences in the fluid occurring due to temperature gradients. In natural convection, fluid surrounding a heat source receives heat, becomes less dense and rises. The surrounding, cooler fluid then moves to replace it.

Keywords: Heat Transfer, Natural Convection, Dimpled Plates.

I. INTRODUCTION

The performance of heat transfer equipment can be improved by mounting protrusions on the surfaces. The surface geometries, which are popular in different industrial applications, are wavy fins, off-strip fins, perforated and louvered fins. Somewhat different concept for the reduction of thermal resistance and enhancement in heat transfer is the use of extended shapes in the form of winglet.

The present work can be further extended for different geometries of the winglets pair being used on the different cross sections for natural convection mode.

II. LITERATURE REVIEW

S.M. Pesteei et al.[4] in the paper presented that local heat transfer coefficients were measured on fin- tube heat exchanger with winglets using a single heater of 2 inch diameter and five different positions of winglet type vortex generators. The measurements were made at Reynolds number about 2250. Flow losses weredetermined by measuring the static pressure drop inthe system. Results showed a substantial increase inthe heat transfer with winglet type vortex generators.

It has been observed that average Nusselt number increases by about 46% while the local heat transfer coefficient improves by several times as compared to plain fin-tube heat exchanger.

Ya-Ling He et al. [5], investigated the heat transfer enhancement and pressure loss penalty for fin and tube heat exchangers with rectangular winglet pairs (RWPs) were numerically investigated in a relatively low Reynolds number flow. The purpose of this study was to explore the fundamental mechanism between the local flow structure and the heat transfer augmentation. The RWPs were placed with a special orientation for the purpose of enhancement of heat transfer. The numerical study involved three dimensional flow and conjugate heat transfer in the computational domain, which was set up to model the entire flow channel in the air flow direction. Theeffects of attack angle of RWPs, row-number of RWPs and placement of RWPs on the heat transfer characteristics and flow structure were examined in detail. It was observed that the longitudinal vortices caused by RWPs and the impingement of RWPsdirectedflow on the downstream tube were important reasons of heat transfer enhancement for fin-and-tube heat exchangers with RWPs.

Guobing Zhou et al. [6] , performance of a pair of newvortex generators e curved trapezoidal winglet (CTW)has been experimentally investigated and compared with traditional vortex generators e rectangular winglet, trapezoidal winglet and delta winglet. The results showed that delta winglet pair is the best in laminar and transitional flow region, while curved trapezoidal winglet pair (CTWP) has the best thermo hydraulic performance in fully turbulent regiondue to the streamlined configuration and then the lowpressure drop, which indicates the advantages of usingthis kind of vortex generators for heat transferenhancement. An appropriate spacing between theleading edges of a pair of CTW VG should beconsidered for different flow regions. In addition,double rows of CTWP do not show better thermo hydraulic performance due to the larger pressure drop and the spacing between the two rows of CTWP should also be optimized.

J.M. Wua et al. [7] achieved heat transferenhancement and lower pressure loss penalty, even reduction in pressure loss; two novel fin-tube surfaceswith two rows of tubes in different diameters arepresented in this paper. Numerical simulation resultsshow that the fin-tube surface with first row tube insmaller size and second row tube in larger size can lead to an increase of heat transfer and decrease ofpressure drop in comparison with the traditional fin tube surface with two rows of tubes in the same size.

K. Torii et al. [8] proposed a novel technique that canaugment heat transfer but nevertheless can reduce pressure-loss in a fin-tube heat exchanger with circulartubes in a relatively low Reynolds number flow, bydeploying delta winglet-type vortex generators.

Feibig et al. [9] experimentally investigated the THE and drag effect by delta and rectangular wings and winglets in laminar channel flow and found that the HTE per unit vortex generator area was highest for delta wings closely followed by delta winglets; rectangular wings and winglets were less effective; theaverage heat transfer was increased by more than 50%and the corresponding increase of drag coefficient wasup to 45%.

III. SUMMARY OF REVIEW

By referring to the above literature, it is observed that–

1. Heat transfer rate has been enhanced by using five different positions of winglet pairs of a particular surface. Augmentation of Heat transfer is done by varying Reynolds number for flow.

2. Heat Transfer rate with single and double rows of vortex generators have been observed and enhancement is found in double row. However, only little attention is given for study of combined effect of the above. Hence a good potential is there for carrying out an experimentation for finding the behavior of various types of winglet pairs under various operating conditions. The behavior will include the characteristics and heat transfer rates from various combinations. The winglet and winglet pairs will be used for increasing the area of heat transfer.

IV. OBJECTIVES

The objectives of the present dissertation work are-

1) Collection of research and review papers for the enhancing the heat transfer in convection mode by various methods.
2) To determine the convective heat transfer coefficient of air passing over a plate by attaching the various shapes of winglets.
3) To investigate the effect of orientation of plate on the heat transfer coefficient at particular winglet shape.
4) To determine the variation in values of heat transfer coefficient of air with respect to winglet shapes at different heater inputs.
5) To calculate the characteristic parameters in different cases.
6) To compare the result for various winglet shapes and their performance with each other.
7) Documentation of dissertation.

V. PROPOSED WORK

Following work will be carried out during the experimentation:-

I) Theoretical Work:

1) Review of previous work on determination of natural convective heat transfer coefficient of air flowing over plate at various winglets shapes.
2) Theoretical development of the setup for experimentation purpose.

II) Experimental Work:

1) To develop the experimental setup as per proposed design.
2) To conduct the experiment for various specified shapes of winglet & note down the set of readings for each specified operating condition.
3) Calculation of Grashoff number, Rayleigh number Nusselt number, heat transfer coefficient of air for various winglet shapes.

Proposed experimental set-up:

Proposed experimental set-up designed for determination of convective heat transfer coefficient of air flowing over a plate at different winglet shapes is as shown in fig. 1. It consists of control system that includes the temperature indicator, heater input, temperature selector switch, fuse, dimmerstat. From the control panel thermocouples are attached to the plate. The plate is hanged by string and it is enclosed by enclosure. The different shapes of winglets are mounted on plate to enhance the heat transfer. The heater is use to give a temperature variation in the plate in order to get the various operating conditions.

In this set-up we will use six-eight thermocouples placed at equal distance on the surface of plate. Heat input can be set with the help of variac provided on control panel and same can be show out digitally with the help of ammeter and voltmeter.

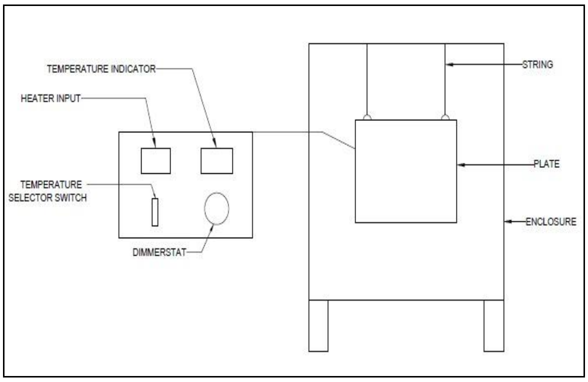
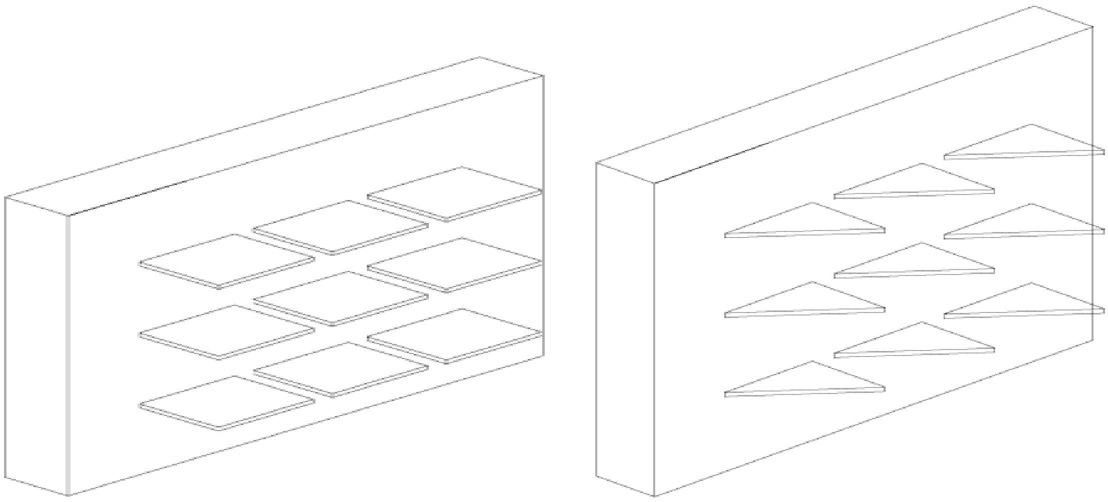


Fig.1-Experimental set-up

Fig. 2 shows a neat arrangement of winglet shapes i.e. rectangular, triangular and trapezoidal, in which winglets is stick on the rectangular plate at equal distance.



a. Rectangular winglet **b. Triangular winglet**

Fig.2- Different configurations of winglets

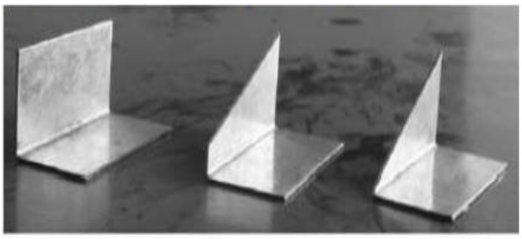


Fig.3- Different winglets

VI. CONCLUSION

It is concluded that the performance of heat exchangers will be enhanced by using various types of combinations of winglet and winglet pairs and also byvarying the suitable parameter which will increase theheat transfer rate.

REFERENCES

[1] M.G. Savage, G.L. Larose. "An experimental study of the aerodynamic influence of a pair of winglets on a flat plate model". Journal of Wind Engineering and Industrial aerodynamics 91(2003) 113-126.

[2] Michael J. Lawson, Karen A. Thole. "Heat transfer augmentation along the tube wall of a louvered fin heat exchanger using practical delta winglets". International Journal of Heat and Mass Transfer 51(2008) 2346-2360.

[3] Munish Gupta. "Numerical study of heat transfer enhancement in a plate fin heat exchanger using rectangular winglet type vortex generator". 2K06-NITK-1098-M (2010).

[4] Guobing Zhou, Qiuling Ye. "Experimental investigation of thermal and flow characteristics of curved trapezoidal winglet type vortex generators". Applied Thermal Engineering 37(2012) 241-248.

[5] Hung- Yi Li, Ci-Lei Chen, Shung-Ming Chao, Gu-Fan Liang. "Enhancing heat transfer in a plate fin heat sink using delta winglet vortex generator". International Journal of Heat and Mass Transfer 67(2013) 666-677.

[6] Guobing Zhou, Zhizheng Feng. "Experimental investigation of heat heat transfer enhancement by plane and curved winglet type vortex generators with punched holes". International Journal of Thermal Science 78(2014) 26-35.

[7] AzitaAbdollahi, Mehrzad Shams. "Optimization of shape and angle of attack of winglet vortex generator in a rectangular channel for heat transfer enhancement. Applied Thermal Engineering 81(2015) 376-387.