HEAT TRANSFER ENHANCEMENT OF SOLAR COLLECTOR WITH V – CUT TWISTED TAPE INSERT

S. R. RAMESH[1], S. CHARLEY[2], S. MAHENDRAPRABHU[3], R. POOVARASAN[4]
[1]Head&Assistant Prof. Dept. of Mechanical Engg
[2,3,4]Student BE Final year Mechanical Engg.
[1234]ARJUN COLLEGE OF TECHNOLOGY, Coimbatore, India.

***Abstract*-- This work presents an experimental and numerical study to investigate the enhancement techniques can be applied to flat-plate liquid solar collectors towards more compact and efficient designs. Tube-side passive techniques can be consisting of adding additional devices which are incorporated into a smooth round tube (V-cut twisted tapes), modifying the surface of a smooth tube (corrugated and dimpled tubes) or making special tube geometries (internally finned tubes). Based on previous studies from the authors, V-cut twisted tapes were selected for enhancing heat transfer. This type of inserted device provides better results in laminar, transitional and low turbulence fluid flow regimes.**

***Keywords*-- Heat transfer enhancement, V-Cut AlTwisted Tapes, Solar Collector, Heat Transfer Enhancement Efficiency.**

I. INTRODUCTION

Several experimental studies on heat transfer augmentation techniques using twisted tape as passive technique have been reported in the literature. So, the passive technique is selected and it does not need an external power source. In the present work enhancement of heat transfer in a circular tube was investigated by inserting v-cut twisted tape. Twisted tape used has 20mm pitch and the Aluminium material is used. The experiment was conducted keeping constant working medium flow rate and by varying heat flow rate. The heat transfer rate, friction factor, Nusselt number, were determined and compared with the plain tube and the plain twisted tape. The twisted tape having Vcut of width and depth (W_e=10mm, D_e=10mm) were used. .

II. METHODOLOGY

The heat is absorbed by the flat plate solar collector and it passed by the radiation to the Al(Aluminium) pipes. The Al v-cut twisted tapes are already inserted into the Al pipe. Then the heat is conducted by insert to flow medium as water. Then the temperature of the water is increased by the solar collector with v-cut twisted tape insert setup. The v-cut twisted tape is increasing the turbulence upto 5000. Also increase the heat transfer rate and decrease the 30% of the heat loss.

III. EXPERIMENTAL SETUP

A. Construction

Fig 1 Arrangement diagram for the experimental setup

The solar collector was placed in wooden frame. The Aluminium pipe are attached below the solar collector glass. The Aluminium v-cut twisted tape are inserted into the Aluminium pipes. The thermocouples are fixed at the two ends of Aluminium pipe inlet and outlet. Then thermocouples are connected to the temperature indicator. The two water tanks are placed and connected to inlet and outlet of the Aluminium pipe.

TOTAL HEAT TRANSFER RATE PLAIN TUBE

Water Inlet Temperature= 39ºC

Water Outlet Temperature=46ºC

Total heat transfer rate $Q = mc_p \Delta T$

Mass flow rate of water (m) = 0.18 kg/s

Specific heat of water (m) = 4180 J/kgk

Total Heat transfer rate (Q) = 0.18X4180(46-39)°C

= 5266.8W

$Q_{max} = mC_p\ (T_{water\ inlet} - T_{air\ inlet})$

= 11413.9W

$\in_{fin} = \frac{Q_{fin}}{Q_{max}}$

= 5266.8/11413.9

$\in_{fin} = 0.47$

TOTAL HEAT TRANSFER RATE WITH V-CUT TWISTED TAPE

Water Inlet Temperature = 44ºC

Water Outlet Temperature =76ºC

Total heat transfer rate $Q = mc_p \Delta T$

Mass flow rate of water (m) = 0.18 kg/s

Specific heat of water (m) = 4180 J/kgk

Total Heat transfer rate (Q) = 0.18X4180(76-44)°C

= 24076.8W

$Q_{max} = mC_p\ (T_{water\ outlet} - T_{water\ inlet})$

= 11413.9W

$\in_{fin} = \frac{Q_{fin}}{Q_{max}}$

= 24076.8/11413.9

$\in_{fin} = 2.10$

V. FIGUIRES

Fig 2 Temperature indicator

Fig 3 Thermocouple

VI. RESULTS AND DISCUSSION

The tangential flow modifies the intensity of swirl generation in radial direction for every pitch distance and increases the hydraulic length of fluid flow. The friction factor for tapes inserted collector is higher than that of a plain collector because of the flow mixing effects caused by tangential direction of fluids which increases the wetted surface area. Hence enhanced heat transfer effect increases the fluid velocity which affects the pressure loss near the tube wall.

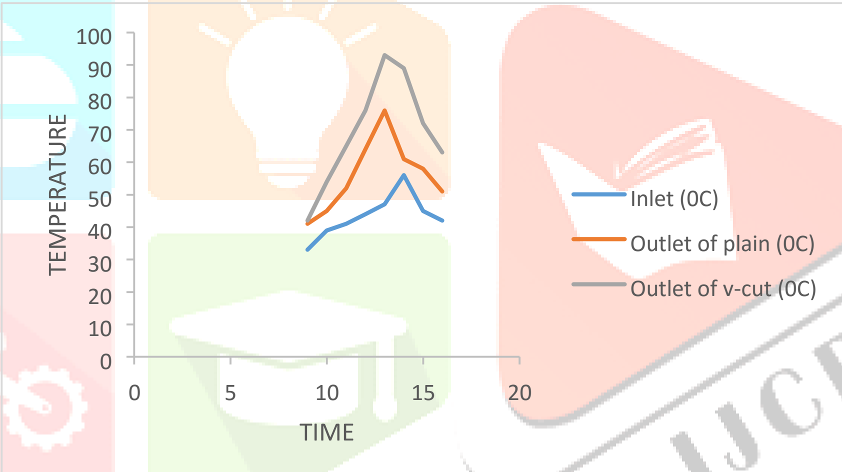

Fig 4 Temperature difference of various tube inserts

VII. CONCLUSION

The thermal efficiency curves of two solar collectors, a standard and an enhanced collector were obtained. The enhanced collector was modified inserting v-cut twisted tape of dimensionless pitch p/D=1 each riser. The thermal efficiency increments depend on the operating flow rates. For a flow rate of 144 l/h (0.04 kg/s) the efficiency optical factor was found to increase by 15%. The collector with inserts enhances heat transfer and as a consequence the absorber temperature is reduced. This means a reduction in the thermal losses as well as a decrease of the loss coefficient by 30%. In order to account for the overall enhancement (thermo-hydraulic performance) that v-cut twisted tape inserts promote in the solar collector, the ratio of useful power and pressure loss between both solar collectors were computed.

As a final conclusion, according to the present work, v-cut twisted tape devices can be successfully inserted within the flow tubes in solar water heaters for enhancing heat transfer rate.

VII. REFERENCES

[1]. S.Vijayakumar, R.Vinoth, K.Abinash,P.Praveen. Enhancement of heat transfer rate in a solar flat plate collector using twisted tapes and wire coiled turbulators. World Academy of Scince, Engineering and Technology, International Journal of Mechanical and Mechatronics Engineering Vol:8,No:2,2014.

[2]. Ritesh K.Sambare, Dr.Sunil. V.Prayagi. Enhancement of Heat Transfer in Solar Collector with Nano fluid : A Review. International Journal of Engineering Research & Technology(IJERT) ISSN: 2278-0181 Vol.3 Issue 11, Nov-2014.

[3]. R.Herrero Martin, A.Garcia Pinar, J.Pérez Garcia.Experimental heat transfer research in enhanced flatplate solar collectors. World Renewable Energy Congress 2011- Sweden 8-13 May 2011, Linkõping, Sweden.

[4]. Indrakant Singh, Dr.Nilesh Diwakar. Heat transfer Enhancement Using Different Geometry of Twist Tape Turbulators: A Review. Dept of Mech. Engg. Truba Institute of Engg. & Information Technology, Bhopal,MP,India-462038.

[5]. Braa Khalid Ameen, Mustafa B.Al-Hadithi, Obaid T.Fadhil. Heat transfer Enhancement of Flat-Plate solar Collectors for Water Heating in Iraq Climate Conditions. Al-Nahrain University, College of Engineering Journal (NUCEJ)Vol.18 NO.2, 2015pp.259-272.