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A Review Paper on to Investigate The Performance of a Flat Plate Solar Water Heater with Twisted Tape Inserts and Without Inserts

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ABSTRACT

Energy crisis is becoming a major problem which is faced by all over the world. In order to control this energy crisis problem many research are performed using renewable energy sources like using solar energy instead of electrical and fuel energy, because solar energy is free of cost and environmentally friendly. There have been many studies to improve the performance of the solar water heater. Heating water for domestic purpose is a simple and effective way of utilizing solar energy. Initial cost of solar water heating system is high but we get zero green energy cost.

The specific objective of this study is to find or develop new models and models that can improve the efficiency of the solar water heater. This investigation discusses improving the performance of a flat plate solar water heater by inserting the twisted tape type of insert in the riser tubes. They promote higher heat transfer coefficient by disturbing or altering the existing flow behaviour (except for extended surfaces) which also leads to increase in the pressure drop.

Keywords:—*Twisted Tape, Raynolds Number, Heat transfer enhancement, passive method.*

I. INTRODUCTION

Heat transfer enhancement or augmentation technique refers to the improvement of thermo hydraulic performance of heat exchangers. Existing enhancement technique can be broadly classified into three different categories :

1) Passive Technique
2) Active Technique
3) Compound Technique.

Passive Technique generally uses surface or geometrical modification to the flow channel by incorporating insert or additional devices. They promote higher heat transfer coefficient by disturbing or altering the existing flow behavior (except for extended surfaces) which also leads to increase in the pressure drop. Passive solar water heater system contain no electrical components, are generally more reliable, easier to maintain and possibly have a longer work life than active solar heater system. Solar water heaters help to avoid carbon dioxide, Nitrogen, Sulphur dioxide and the other air pollution. Insert refer to the additional arrangements made as an obstacle to fluid flow so as to augment heat transfer. Different types of insert are Porous Baffles, Mesh Insert, Helical screw inserts of increasing twist ratio, Incline angle of the springs, Tape with attached baffle.

There have been many studies to improve the performance of the solar water heater. The long term goal of research is to obtain scientific information, teaching materials and as the foundation of scientific development of energy conversion. The specific objective of this study is to find or develop new models and models that can improve the efficiency of the solar water heater. Research method conducted using the experimental method, and heating of working fluid that can improve the efficiency of flat plate solar water heater.

II REVIEW OF LITERATURE

[1] Alberto Garcia et al.,experimentally studied on three wire coils of different pitch inserted in smooth tube in laminar and transition regimes. Heat transfer experiments had been performed in the flow range: Re= 10-2500; Pr = 200-700. It conducted that at Reynolds number below 200, wire coils do not enhance heat transfer. For Reynolds number between 200 and 1000 wire coils increases heat transfer. At Reynolds number around 1000, wire insert increase the heat transfer coefficient up to eight times with respect to the smooth tube. The friction factor increase in the fully laminar region lies between 5 to 40 percent.

[2] P. Bharadwaj et al., their aim was to investigate experimentally determined pressure drop and heat transfer characteristics of flow of water for Laminar to fully turbulent ranges in a 75-start spirally grooved tube with twisted tape insert. They had been considered Laminar to fully turbulent ranges of Reynolds numbers. The grooves were clockwise with respect to the direction of flow and compared to smooth tube, the heat transfer enhancement due to spiral grooves is further augmented by inserting twisted tapes having twist ratios Y =10.15, 7.95 and 3.4.

They concluded that smooth tube shows that the spirally grooved tube without twisted tape yields maximum heat transfer enhancement in the laminar range than the turbulent range. Spirally grooved tube with twisted tape shows maximum enhancement in the laminar range than the turbulent range. Among the three twist ratios (Y = 10.15, 7.95 and 3.4) tested, heat transfer performance of clockwise twisted tape with Y = 7.95 is found to be the highest at in laminar, transitional and turbulent ranges of Reynolds numbers.

[3] D. Kishore et. el. experimental study of heat transfer characteristics with and without insert was found using water –water system on 1-2 pass shell and tube heat exchanger. Experimental results such as exchanger effectiveness, overall heat transfer coefficient were calculated using with and without insert. There is improvement in overall heat coefficient, efficiency in using twisted tape. In all the process industries the process variables like flow, pressure, level and temperature are the main parameters that need to be controlled in both set point and load changes. The transfer of heat is one of the main important operation in the heat exchanger. The transfer of heat may be fluid to fluid, gas to gas i.e. in the same phase or the phase change can occur on either side of the heat exchanger. The control of heat exchanger is complex due to its nonlinear dynamics. For this nonlinear process of a heat exchanger the model is identified to be First Order plus Dead Time (FOPDT). The conventional controller is designed in both with and without insert and compared with IMC based-PI controller based on settling time, rise time and it found to be IMC suitable for heat exchanger than the conventional PI tuning.

[4] Nabila Ihaddadene, Razika Ihaddadene, Azzeddine Mahdi In this research paper, an attempt has been made to come across the effect of multiple glazing covers on the efficiency of a solar thermal collector. This experimental investigation was carried out on an active solar energy demonstration system (ET 200), illuminated with a halogen lamp. Three commercial glass panes of 3 mm

thickness, having the same dimensions as that of the apparatus glazing, were used. Tests were done with and without the added glass panes, at a fixed water flow rate of 5.8 l/h, taking the whole surface of the collector maintained at an horizontal position. Experiments were performed with two positions of the light meter. In one position, it was placed in the middle of the collector surface. While, in the other, the light meter was placed in the middle of the upper glass added. Double, triple and quadruple glazing, reduce the amount of heat absorbed by water by deceasing water temperature difference between the inlet and outlet of the absorber. Double glazing decreased the efficiency of the solar collector with 15%. This efficiency was decreased by 29, 95% for triple glazing, and by 45,96% for quadruple glazing. The addition of glass panes above the collector surface, acts as a resistance to the spread of the energy transmitted by the halogen lamp, this effect reduces the performance of the solar collector instead of improving it, according to a linear equation with a high correlation coefficient.

[5] Bodius Salam*, et,el. An experimental investigation was carried for measuring tube-side heat transfer coefficient, friction factor, heat transfer enhancement efficiency of water for turbulent flow in a circular tube fitted with rectangular-cut twisted tape insert. A copper tube of 26.6 mm internal diameter and 30 mm outer diameter and 900 mm test length was used. A stainless steel rectangular-cut twisted tape insert of 5.25 twist ratio was inserted into the smooth tube. The rectangular cut had 8 mm depth and 14 mm width. A uniform heat flux condition was created by wrapping nichrome wire around the test section and fiber glass over the wire. Outer surface temperatures of the tube were measured at 5 different points of the test section by T-type thermocouples. Two thermometers were used for measuring the bulk temperatures. At the outlet section the thermometer was placed in a mixing box. The Reynolds numbers were varied in the range 10000-19000 with heat flux variation 14 to 22 kW/m2 for smooth tube, and 23 to 40 kW/m2 for tube with insert. Nusselt numbers obtained from smooth tube were compared with Gnielinski correlation and errors were found to be in the range of -6% to -25% with r.m.s. value of 20%. At comparable Reynolds number, Nusselt numbers in tube with rectangular-cut twisted tape insert were enhanced by 2.3 to 2.9 times at the cost of increase of friction factors by 1.4 to 1.8 times compared to that of smooth tube. Heat transfer enhancement efficiencies were found to be in the range of 1.9 to 2.3 and increased with the increase of Reynolds number.

[6] P. Promvonge In this paper it is observed that the use of conical ring inserts leads to considerably higher heat transfer rates than the plain tube for all arrangements. This indicate that effect of reverse flow and boundary layer description can help to enhance the convection heat transfer and momentum process.

a) The reverse flow region can improve convection so that it helps to increase the effective axial Reynolds number.

The heat transfer rate obtained from using the conical rings of DR, CDR and CR arrays with d/D = 0.7-0.5 are found to be around 197-333%, 138-234% and 91-175%, more than those of the plain tube, respectively.

Experiments performed in Horizontal pipes

III. Problem Formulation or Problem Definition

The various research has been observed in a horizontal circular tubes with Insert and without Inserts and it has been observed that smooth tube without using any inserts give less heat transfer coefficient than with the use of inserts. It has been observed that the heat transfer coefficient increases with increase in Reynolds number. As Reynolds number increases the water flow will cause more

turbulence, so due to which the heat transfer rate will increases. An experimental investigation carried out to find the overall performance of suitably designed flat plate solar water heater with passive heat transfer augmentation technique. The desired augmentation is attained with the help of inserts. In addition to this, the performance of insert is carried out to find the suitable design for the heat transfer augmentation. In this investigation, stress is given on to work dealing with insert into circular tubes (twist tap insert, screw tap insert, helical tap insert, wire mesh tape insert).

IV. METHODOLOGY

A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. These investigations will carry out on an active solar energy demonstration system illuminated with a high power lamp. The solar energy incident on the absorber panel coated with selected coating, transfer the heat to the riser pipes underneath the absorber panel. In these riser tubes we inserted the different types of inserts to make the flow turbulent because they promote higher heat transfer coefficient by disturbing or altering the existing flow behaviour which also leads to increase in the pressure drop. The water passing through the riser tubes gets heated up and is delivered to the storage tank. For wall temperature measurement, thermocouples are used at different place of heating surface. Moreover, one thermocouple is placed inlet and one thermocouple is placed at outlet to measure the inlet and outlet bulk temperatures, respectively. Manometer is used to measure the pressure drop within the tested tube.

V. CONSTRUCTIONAL FEATURES

The material selected for the tubes is glass as it easily available and ease in manufacturing. Twisted tape insert is also manufactured from aluminium. Twisted tapes is inserted in tube at different arrangements. As the main objectives of the project is to compare the performance of plain tubes and inserted tubes.The experimental setup consists of following components

Thermocouples: - Thermocouples are used to sense the temperature. Thermocouples are widely used type of temperature sensor and can also be used as a means to convert thermal potential difference into electric potential difference. In our project we are using eight copper-constantan thermocouples having range of 0 to 200 0C.

Rotameter: - The rotameter is used to measure the mass flow rate of water. The rotameter used in experimental setup is having a range of 0-25LPM.

Control Valve: - Control valve is used to regulate the mass flow rate of water. The control valve placed in the flow path of water and is given the knob having graduations in degrees. By varying the regulator we increase the mass flow rate of water and take various readings.

U tube manometer: - One U tube manometer is used to measure pressure drop across the duct

VI. OBJECTIVE

1. To investigate the performance of flat plate solar water heater with inserts and without inserts.
2. To investigate the effect of pressure drop on performance due to various inserts

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