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Performance on Buoyancy Driven Flow in Square Duct Fitted with Twisted Strip

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Abstract: ***This experimental investigation aims to study the effect of inlet fluid on flow and heat transfer characteristics for buoyancy driven flow in square tube fitted with twisted strips. Twist pitch, heat supply, inclination of the tube and Inlet fluid temperature were changed during experimentation. The study revealed that with increase in pitch the percentage enhancement in heat transfer coefficient decreases. With decrease in the pitch the flow rate decreases. Moreover with increase in inlet fluid temperature both heat transfer coefficient and flow rate tends to decrease. Perhaps it is due to higher heat loss at the tube surface which results in reduction in Rayleigh number.***

Keywords: buoyancy driven flow, twisted strip, inlet fluid temperature.

I. INTRODUCTION

The heat exchange equipment can be made more efficient by using various techniques such as coiled tubes internal fins, twisted drips etc. The use of these techniques enhances the heat exchange. The entire analysis is carried out for specific application i.e. solar water heaters. The waters flows through the copper tube due to thermo siphon effect. Twisted strip is one of the techniques, which enhances the heat transfer [1, 2, 3, 4, 5,]. The literature survey reveals that enough information is not available for the heat transfer and flow characteristics in inclined duct with insertions subjected to variable inlet fluid temperature. The study of these parameters is very much essential to select the optimum cross section of the tube to obtain maximum efficiency for given collector area. The present work is therefore undertaken.

II. EXPERIMENTAL SET UP

The test set up and methodology adopted by Prayagi S.V. and Thombre S.B [1] was used for experimentation. Twisted strip was placed in a long square tube. The tube surface was subjected to uniform heat flux. For, this a 90 –gauge nichrome wire was wounded on the tube surface. The parameters varied are as given below.

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Table-I: Detail of the experimental set-up

Sr. No.	Parameter	Range
1	Tube Length	150 cm
2	Pitch / Diameter	19.5. 10,8,3.37
3	Hydraulic Diameter of the tube	15 cm
4	Inclination of the tube	45^0
5	Heat flux supplied	200 W/m^2 to 1500 W/m^2
6	Type of insulation used	Glass wool

The test set-up was validated for the following two situations which can be easily created on the set –up

1) Natural convection heat transfer from vertical tubes with air as working fluid and
2) Forced convection laminar flow inside a duct.

The heat transfer characteristics obtained were compared with those reported by Dyer [4]. The agreement in data is within ±10%.

III. RESULTS

HEAT TRANSFER CHARACTERISTIC

Figure 1 reveals that the heat transfer coefficient has a maximum value at (P/d)=3.37. It may be noted here that higher value of pitch to diameter ratio indicates little disturbance in the flow field leading to less turbulence in the flow and thus less percentage enhancement in the heat transfer coefficient. However the heat transfer coefficient is more for lower value of pitch to diameter ratio (i.e. more disturbances and more turbulence).

Typically for the P/d= 19.5 the enhancement in heat transfer coefficient is between 5-10% and for P/d=10 it is between 10-15%. Similarly for pitch parameter P/d= 8 the increase in the heat transfer coefficient it is around 10%where as for P/d=3.37 it is nearly 20%.

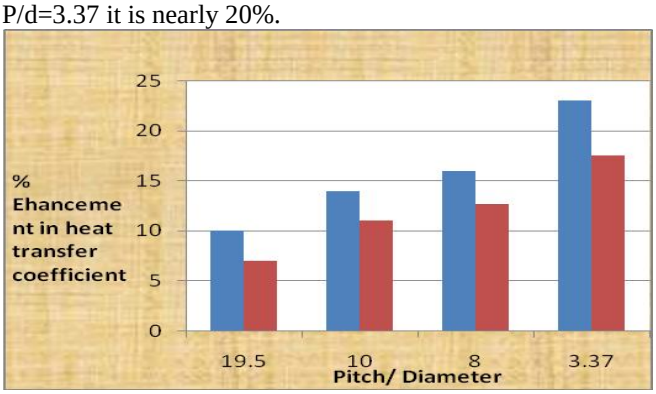

Fig.1. Comaparison of Percentage Increase In Heat Transfer Coefficient

Further, it is observed that the heat transfer coefficient decreases with increase in the inlet fluid temperature. This may be attributed to more heat loss at the tube surface.

IV. FLOW CHARACTERISTIC

Figure 2 indicates that the buoyancy induced flow rate tend to decrease with decrease in the value of pitch parameter. From the figure it can be noted that the reduction in flow rate ranges from 10-30%, since the small pitch offers resistance to flow.

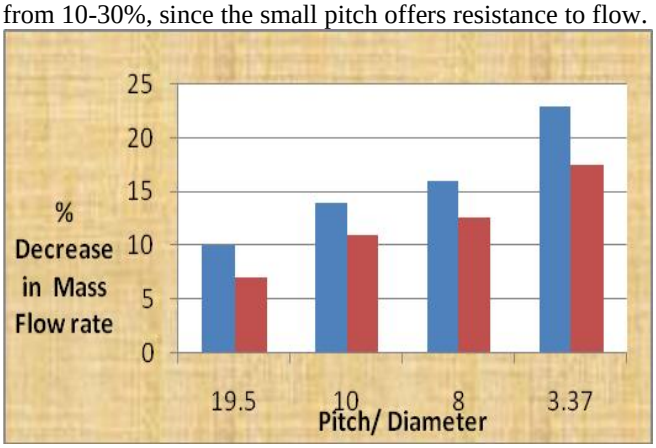

Fig.2. Comaparison of Percentage Decrease In Mass Flow Rate

V. CONCLUSION

Extensive experimentation was performed and sufficient data was generated and analyzed to establish heat transfer and flow characteristics for buoyancy induced flow. The main conclusions are as given under

1. The heat transfer coefficient was found to increase with the decrease in pitch parameter
2. The induced flow rate decrease with decrease in the pitch parameter
3. Heat transfer coefficient and Mass flow rate decreases with increase in inlet fluid temperature.

VI. FUTURE WORK

1. Experiments may be performed to study the buoyancy induced flow with mixed and nucleate convection mode of heat transfer inside inclined tubes.
2. Using the correlations developed, dimensionless optimizing of solar domestic water heating system may be taken up.

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