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Heat Transfer Enhancement in Tube using Rotating Twisted Insert

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***Abstract:** An experimental investigation is carried for heat transfer enhancement with the help of square cut circular insert for heat exchanger applications. This experimental investigation is for measuring tube side heat transfer coefficient friction factor, Reynolds number of air for turbulent flow in circular tube fitted with square ut circular ring insert. An experimental setu consist of blower, flow control valve to maintain measured quantity of flow, orifice meter is used for flow measurement and pressure drop is measured along test section and orifice plate with 2 U-tube manometers. A stainless steel tube of SS304 material having 40mm I.D and 50mm O.D and 1250mm length is used. A mild steel plate of 3mm thickness 10mm width and is used as the insert. The enhancement devices of the twisted insert show a considerable improvement of Nusselt number and friction factor relative to the plain section without inserts and smooth tube acting alone. The Nusselt number is found to increase with increase in the Reynolds number of individual iterations of twisted inserts. The highest Nusselt number is found to be 82.83 with twisted inserts in the tube and Reynolds number of about 27262.8. The friction factor is found to increase with decrease in the Reynolds number and vice versa. The friction factor is maximum for the tube with twisted inserts and about 0.0246 and lowest for the tube without inserts of about 0.02189. The heat transfer coefficient for convective transfer of heat is found out to be maximum for the tube with twisted inserts. The maximum value of h is 54.75 W/m²K for a Reynolds of about 27262.8.* ***Keywords:** Twisted insert, Dimensional analysis, Heat transfer augmentation, Nusselt no, Reynolds no.*

I. INTRODUCTION

The heat exchangers have many applications in the industry. Its performance depends on its design, heat transfer rate, type of medium, pressure drop etc. Its heat transfer rate can be increased my changing the fluid stream inside the heat exchanger. It is done by placing the obstacle in the flow called as insert. Heat transfer rate can be enhanced by using different methods. Those are as follows:

A. Active Techniques

These techniques are more complicated for the design and use point of view. It requires external power source to enhance the heat transfer rate. It has limited application due to requirement of external power source.

B. Passive Techniques

These techniques use surface of geometrical modifications to the flow channel by incorporating inserts or additional devices. This technique does not require any external power; rather they use power form system itself. Ultimately leads into a rise in fluid pressure drop. This method gives higher heat transfer rate as compared with the extended surface.
There are various passive techniques as given below:

1) *Treated Surfaces:* Treated surfaces are used in condensing and boiling and this technique includes application of coating.
2) *Extended Surfaces:* Fins are the example of extended surfaces and fins are used in heat exchanger to enhance heat transfer.
3) *Displaced Enhancement Devices:* These devices are used in forced convection. Various inserts are inserted to displace fluid from core to surface side.
4) *Swirl Flow Devices:* Rotating type of flow generated by using these devices. Inlet Vortex Generators, Twisted Tape Inserts are the different types of swirl flow devices.

C. Compound Techniques

It is a hybrid method where both active and passive techniques are combined to increase the heat transfer rate. As this method uses passive technique since it doesn't require any external power source. Due to this advantage it is widely used in the industries.

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Use an inserts is more effective for heat enhancement techniques as compared to other techniques due to following reasons:

1) Cost is low.
2) Easy to install and removal.
3) Maintenance cost is low.
4) Simple manufacturing process with low cost.

a) Experimental Setup

Diagram of Experimental Setup

b) Insert

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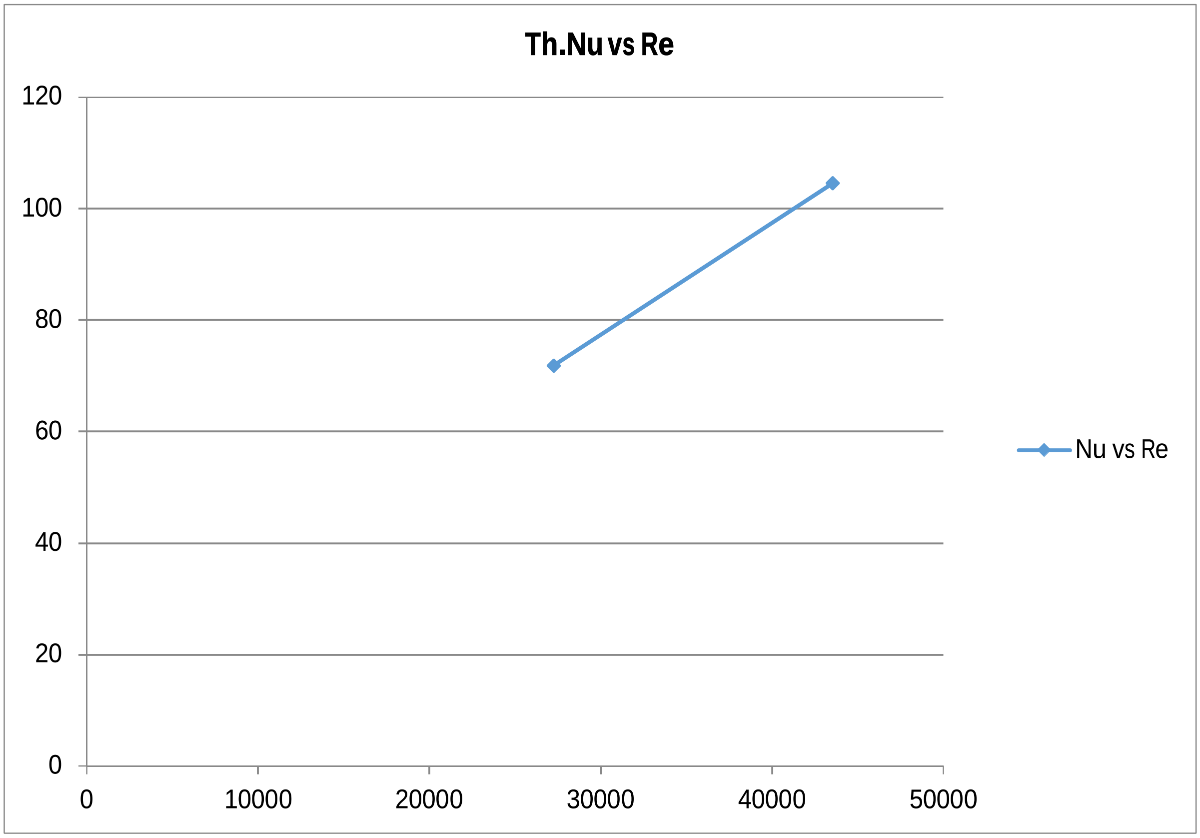
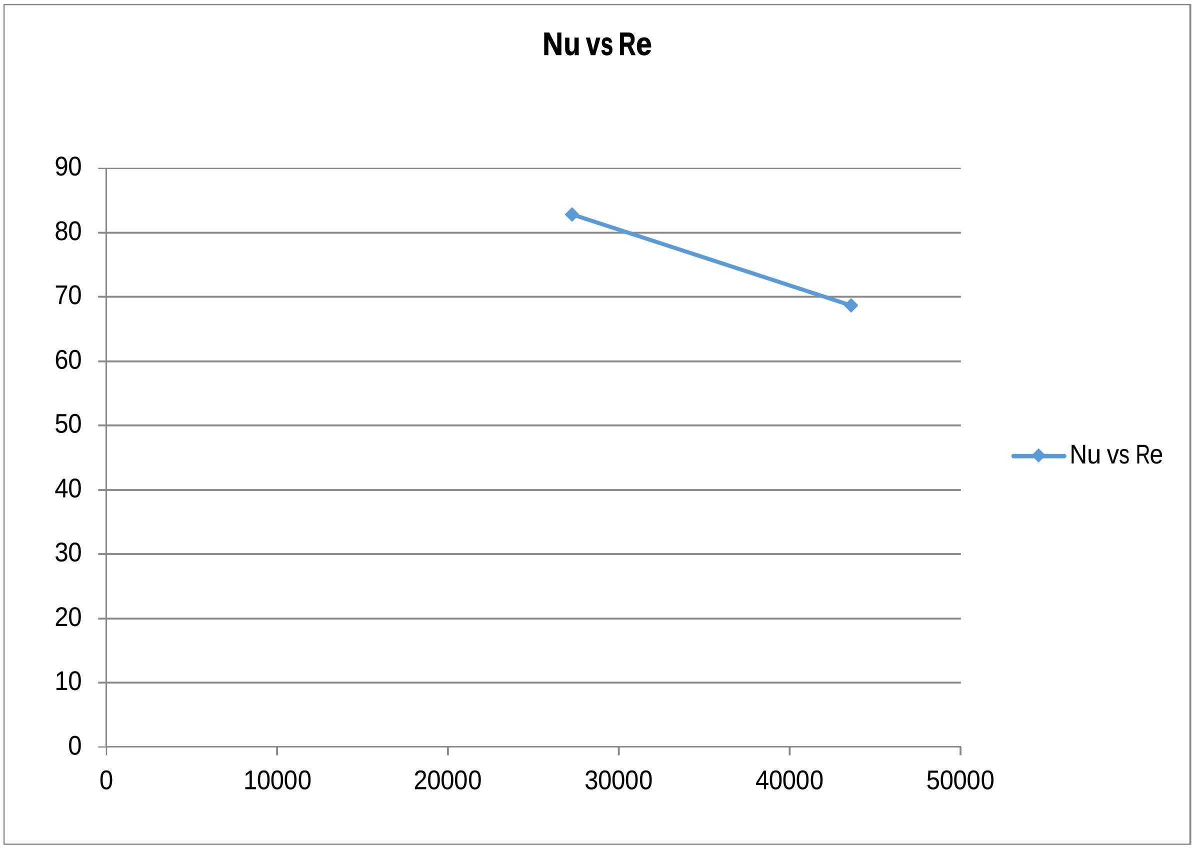
Diagram Of Twisted Insert

c) Graphical Representation

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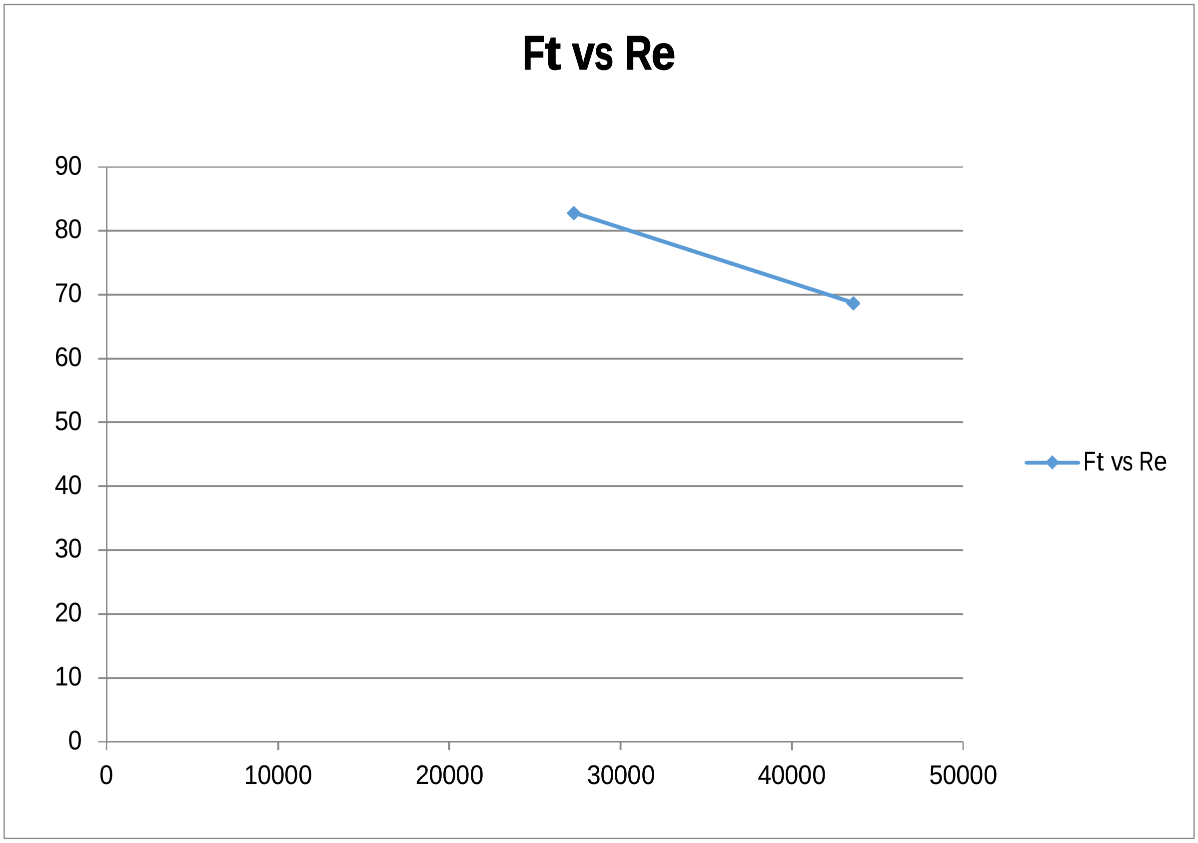
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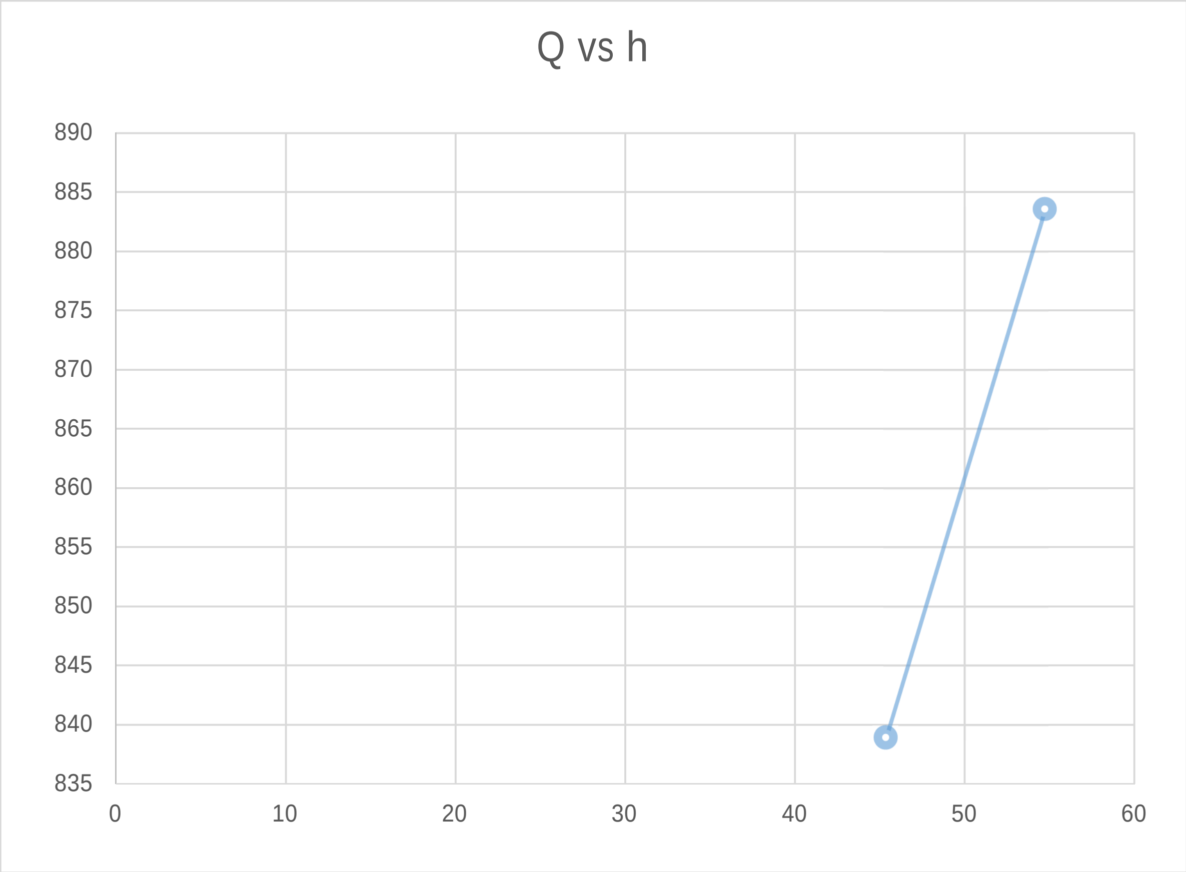

II. CONCLUSION

Heat transfer enhancement in a tube inserted with circular square cut inserts at 18° angle from each other to generate swirl flow is studied experimentally in this present study. The work has been conducted in the turbulent flow regime (Reynolds number in between 27000 to 45000) using air as the working fluid. The findings of the work can be drawn as follows:

A. The enhancement devices of the twisted insert show a considerable improvement of Nusselt number and friction factor relative to the plain section without inserts and smooth tube acting alone.

B. The Nusselt number is found to increase with increase in the Reynolds number of individual iterations of twisted inserts.

REFERENCES