COMPUTATIONAL FLUID DYNAMIC ANALYSIS OF TUBE HEAT EXCHANGER HAVING DISCONTINUOUS HELICAL BAFFLES

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***ABSTRACT*: To expand the fulfillment of heat exchanger researchers had optimized the different process parameters on which the operation of heat transfer depends. To improve the heat transfer here in this work perforated irregular helical baffles are used to growing the heat transfer. Here in this effort square, circular and triangular perforated intermittent helical baffles were operating to increase the heat transfer rate. It also determine the effect of changing Reynolds number on heat transfer, to evaluate the effect of altered Reynolds number here it considered four altered Reynolds number that is 6000, 8000, 10000 and 12000. It also calculates the significance of Darcy friction factor for discrete perforated interrupted helical baffles at different Reynolds number. After doing the CFD analysis and mathematical calculation it is establish that the baffles having square perforation shows supreme heat transfer as compared to the other categories of perforation. For calculating the effect of dissimilar perforation shape on heat transfer thermal performance of heat exchanger were also calculated in this work.**

***Keywords*: Heat exchanger, perforated turbulator, thermal performance, heat transfer, flow behaviour**

1. Introduction

Heat exchanger is a mechanism that is typically used to happen the resolve of an equipment to switch heat among two procedure streams. The fluids may be detached by using a compact wall to save you intercourse or they will be in direct contact they are commonly used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The traditional illustration of a device is determined in associate degree inner combustion engine whereby a partying fluid known as engine fluid flows through radiator loops and air streams on the far side the loops, that refrigerates the fluid and heats the coming air. Another instance is that the sink that's a channel device that transmissions the warmth generated via associate degree electronic or a mechanical equipment to a fluid channels, oft air or a liquid fluid

Water to air heat exchanger can be selected on the basis of different application. It can be utilized for residential heating and dehumidification. Swirl flow device are one of the similar way for heat transfer enhancement which becomes popular due to low price. To find out the effect of different Reynolds number (Re) on heat transfer hear it considered four different Re of cold fluid that is 6000, 8000, 10000, 12000. To enhance the heat transfer from water to air baffles were placed in the outer surface of inner tube. Due to the baffles turbulence and contact time were increased which helps in increasing the heat transfer. In this work it considered three different shapes of perforated helical baffles that are triangular, square and circular perforated helical baffles to enhance heat transfer rate. Here it calculate the value of nusselt number for different Re and also calculate the value of friction factor for different nusselt number. To measure the heat transfer increasing due to baffles hear it also calculate the value of thermal performance for different perforated baffles.

2. Development of numerical model of heat exchanger

2.1 Development of solid model of heat exchanger

The solid model of heat exchanger is develop on the basis of geometry considered by Sheikholeslami et.al [21] considered during the experimental analysis the geometric specification of solid model of heat exchanger is given in the below table

Table.1 Value of geometric specification

Geometric specification	Values	
Inner pipe diameter (mm)	Inner diameter D_i	28
	Outer diameter D_o	30
Outer pipe diameter (mm)	Inner diameter d_i	50
	Outer diameter d_o	60

Pitch ratio (PR)	1.83
Open area ratio	0.0625
Fin thickness (mm)	2

The solid model of the heat exchanger is shown in the below fig.

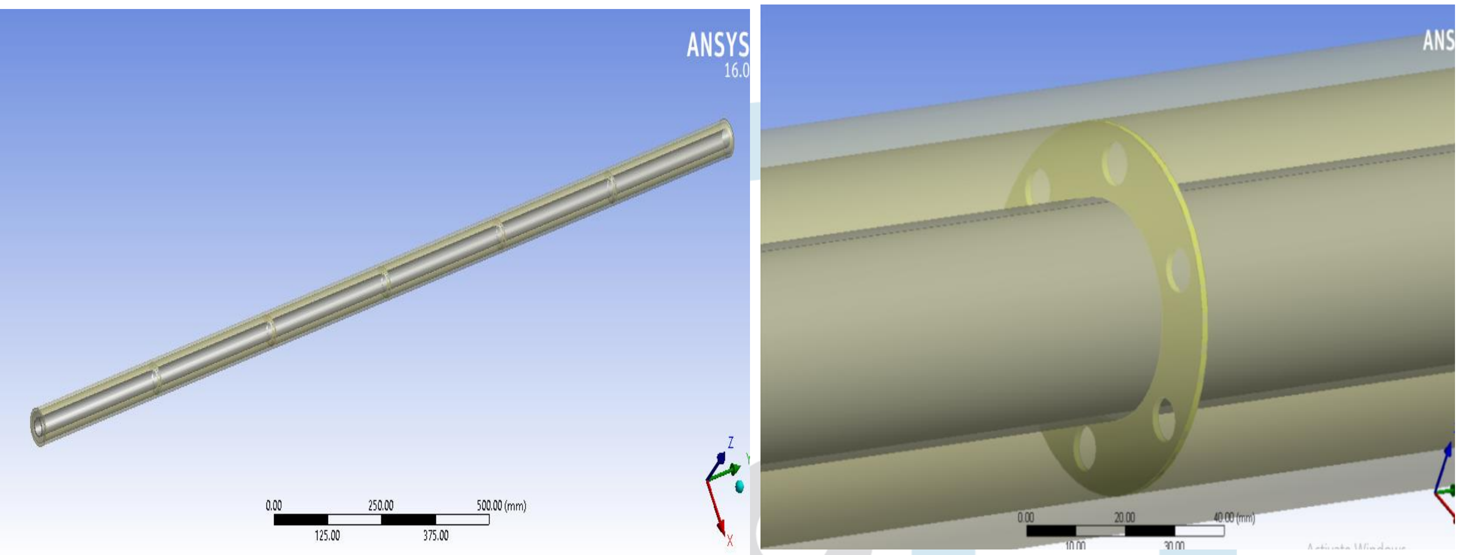

Fig.1 solid model of the heat exchanger with perforated helical baffles

2.2 Meshing

To perform the numerical analysis here it has to discretize the solid model in to number of elements. To perform proper mesh different meshing tool where use for the refinement of mesh. Mesh of the helical baffles heat exchanger is shown in the below fig.

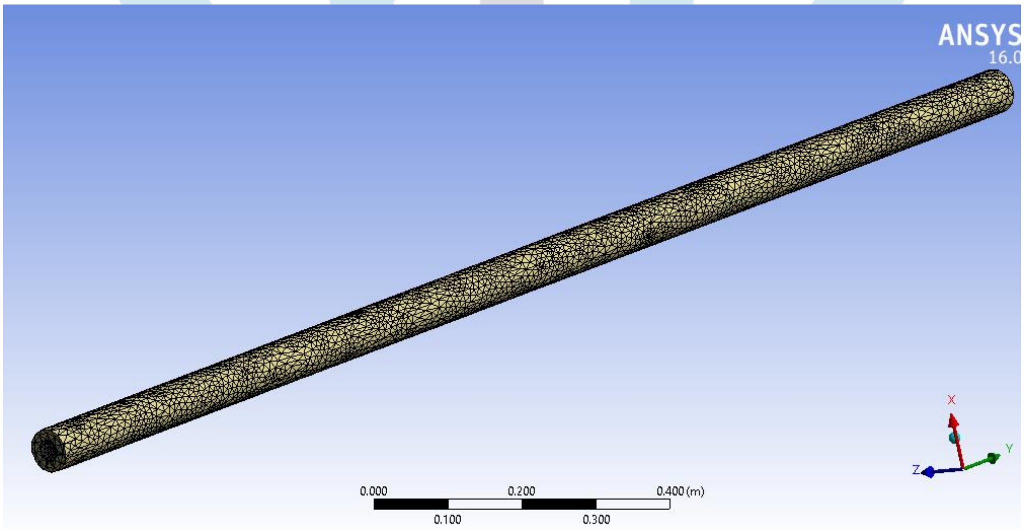

Fig.2 shows the mesh of the helical baffle heat exchanger

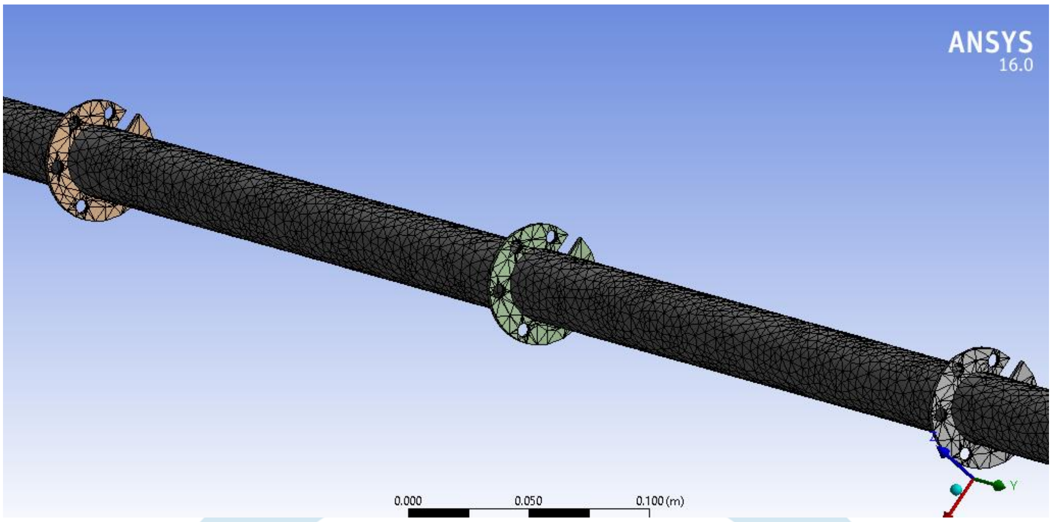

Fig. 3 showing the mesh of the helical baffle used in heat exchanger

2.3 Boundary condition

The temperature of warm fluid at inlet is 346.11 K and flowing at a velocity of 0.063 m/s. whereas cold fluid is flowing at a velocity of 0.9669 and temperature of cold fluid at inlet 301.16 K as considered during the experimental analysis performed by Sheikholeslami et.al [21].

3. Result

Here in this work, through numerical investigation it has calculated the value of Nusselt number for altered Re number. It also calculated the value of Darcy friction factor for with respect to different Re number of heat exchanger having different types of shape of perforation. To analyze the effect of different perforation of helical baffles on heat transfer here in this work three different type of perforation were considered. For analyzing the effect circular, square and triangular shape perforations where considered during the analysis. To calculate the heat transfer enhancement due to different types of perforation here it has calculated the value of thermal performance for different geometry of heat sink. During the analysis the velocity of hot fluid remain constant whereas the velocity of cold fluid Changes that is Re number varies 6000, 8000, 10000, 120000.

3.1 Validation of CFD model

For validating the CFD model of heat exchanger having helical discontinuous turbulator, here in this work it examine the heat exchanger having helical discontinuous turbulator with circular perforation were consider during the experimental analysis performed by Sheikholeslami et.al [21]. The inlet and outlet conditions of hot fluid and cold fluid were same as considered during the experimental analysis and calculating the value of nusselt number, Darcy friction factor. The contour of temperature and velocity for different Re numbers are shown in the below section

- **For Re 6000**

The temperature contours for 6000 Re number is shown below

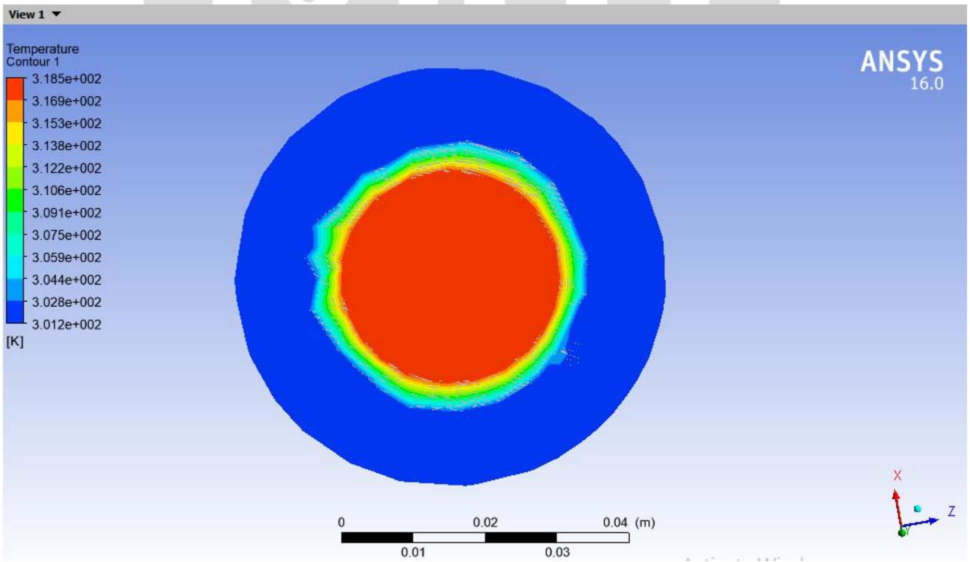

Fig. 4 temperature contour of hot fluid outlet for Re 6000

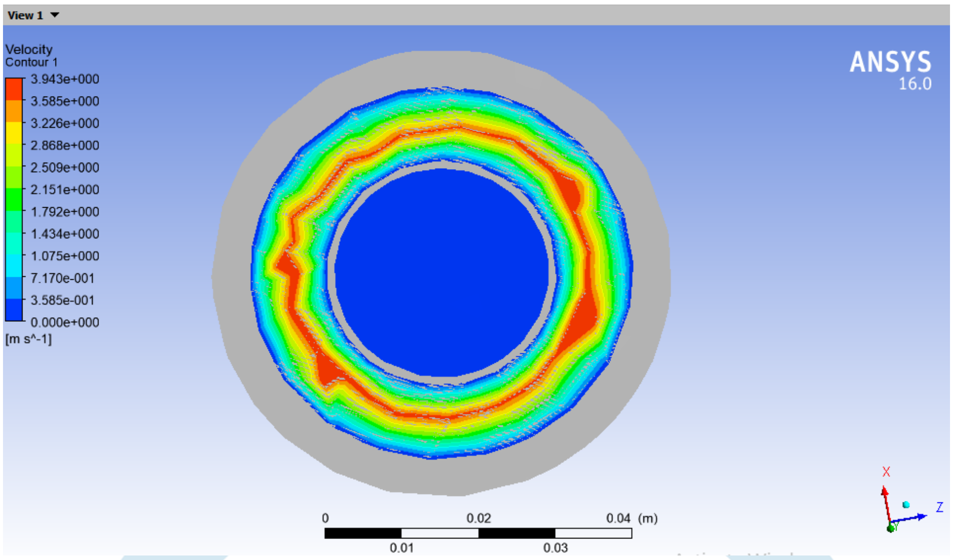

Fig. 5 Velocity contours of hot and cold fluid for Re 6000

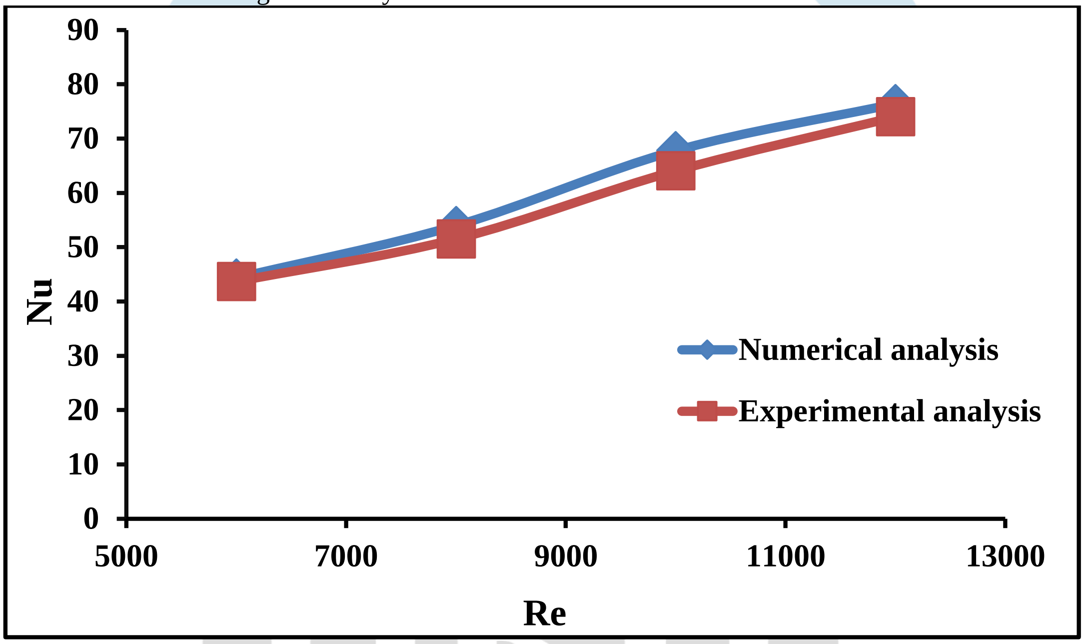

Fig. 6 shows comparison of Nu value

3.2 For Square Shape Perforation

Here shape of the perforation on discontinuous baffles is of square shape, during the analysis the boundary condition were same as considered during the analysis of heat exchanger having circular perforations. The velocity and temperature of hot and cold fluid will remain same as considered in circular perforation. The solid model of discontinuous helical baffles having square shape perforation were shown in the below fig.

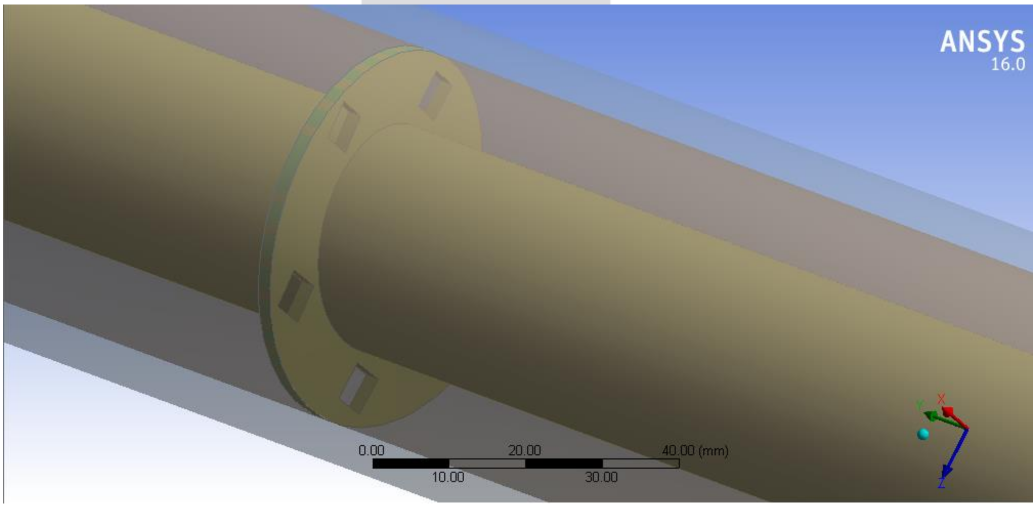

Fig. 7 solid model of heat exchanger with square perforation

3.3 For Triangular Shape Perforation

Here shape of the perforation on discontinuous baffles is of triangular shape, during the analysis the boundary condition were same as considered during the investigation of heat exchanger having circular perforations. The velocity and temperature of hot and cold fluid will remain same as considered in circular perforation. The solid model of discontinuous helical baffles having triangular shape perforation were shown in the below fig.

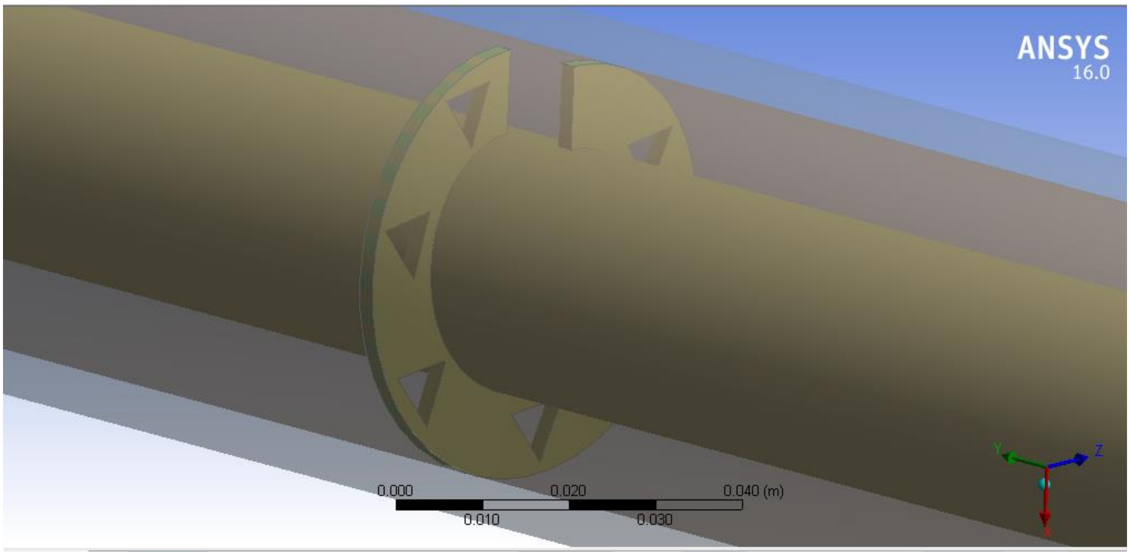

Fig. 8 solid model of heat exchanger having Triangular perforation

3.4 Comparison of Different perforations

To calculate the effect of different shapes of perforation o heat transfer, value of Nu and friction factor for different perforation at different Re number is compared in the below section. Table shows the evaluation of different parameter is

Table.2 Comparison of Nu number for different perforation shapes

Reynolds number	Nusselt number for circular perforate	Nusselt number for square perforate	Nusselt number for triangular perforate
6000	44.32	48.035	41.01
8000	53.98	57.238	48.69
10000	67.79	71.14	60.70
12000	76.44	79.3494	69.27

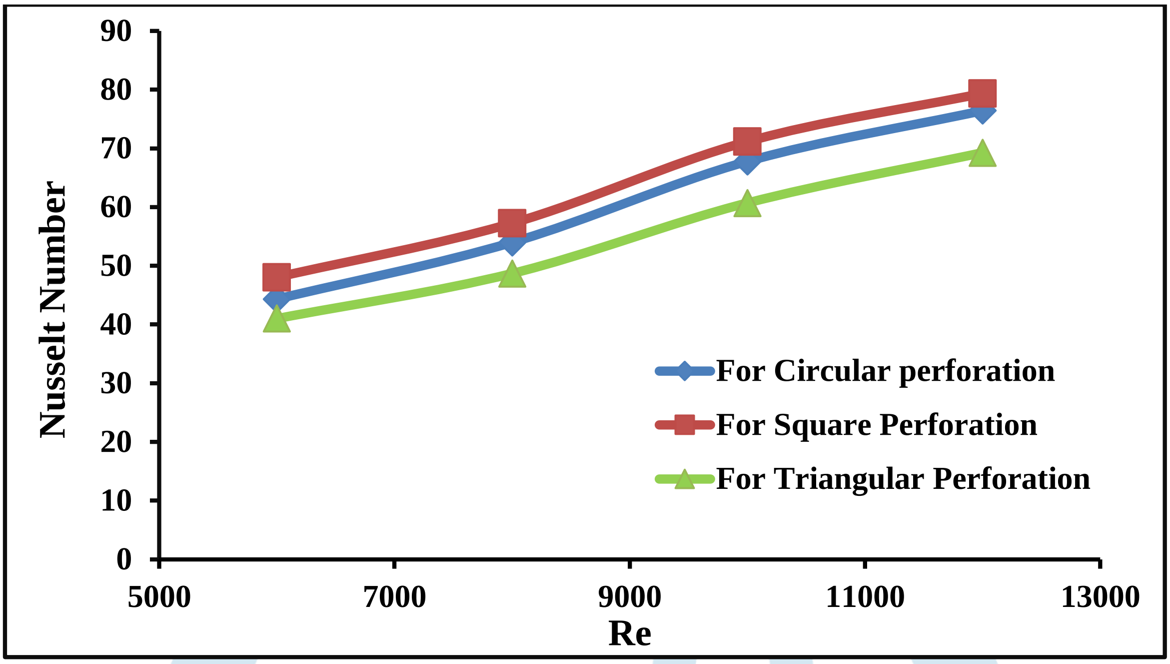

Fig. 9 comparison of Nu number for different perforation of discontinuous turbulator

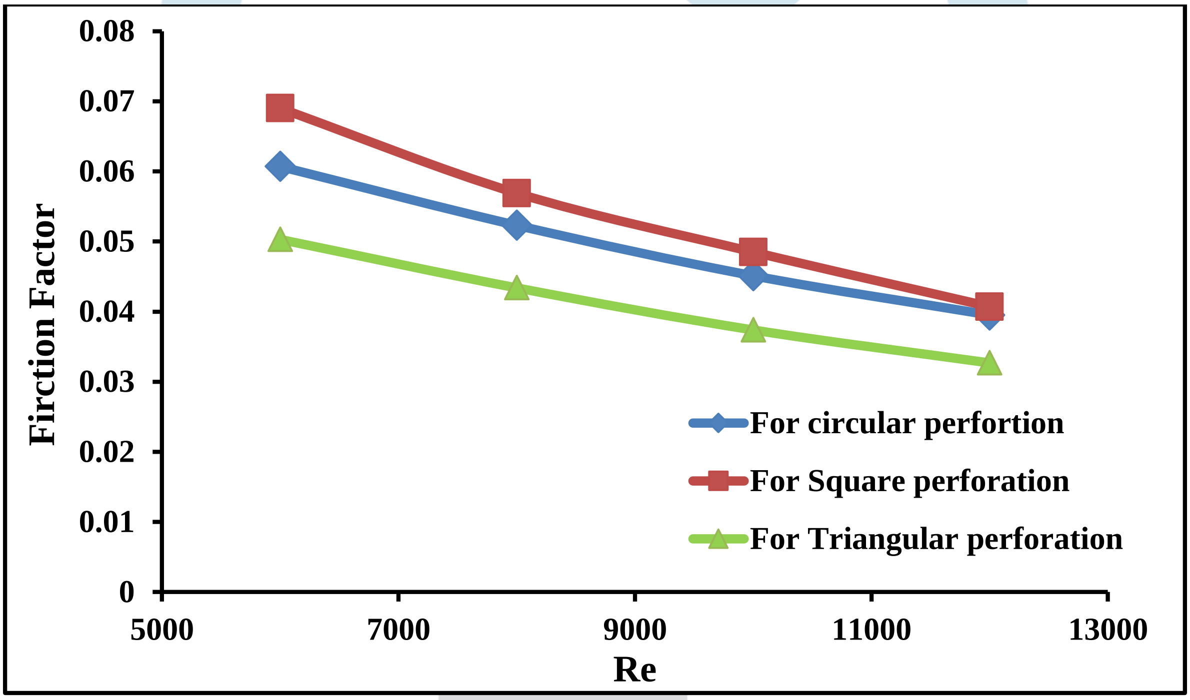

Fig. 10 comparison of friction factor for different perforation of discontinuous helical baffles

4. Conclusion

From the above analysis following conclusion where drawn

1. From the numerical investigation of discontinuous helical perforated baffles, it is determine that the heat transfer rises with increase in Re number.
2. The value of Nu number rises with rise in Re number of cold fluid flowing in the outer pipe.
3. The value of Nu number is greater for heat exchanger having discontinuous helical baffles with square perforation as compared to the heat exchanger with circular and triangular perforation.
4. Darcy fiction factor is reducing with increase in Re Number. Whereas the value of Friction factor is supreme for square perforation as compared to the other perforation shapes.

5. Form the numerical analysis it is determine that the heat transfer is supreme in case of heat exchanger having discontinuous helical baffles with square perforation.

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