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HEAT FLOW ANALYSIS OF CONCENTRIC TUBE PARALLEL FLOW HEAT EXCHANGER WITH HELICAL INTERRUPTER

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***Abstract*— The heat exchanger is an important device in almost all of the mechanical industry, as in case of process industries it is a key element. thus from long many researchers in this area are working to improve the performance of these heat exchangers in terms of heat exchangers heat transfer rate. Here it is an attempt to enhance the heat rate in concentric tube parallel flow heat exchanger by inserting a helical interrupter inside the heat exchanger tube.**

***Keywords*— Heat exchanger, Concentric tube, Parallel flow, Wire coil helical Interrupter inserts**

1. INTRODUCTION

The heat exchangers have an important role in the energy storage and recovery. Due to the development of modern technology, the heat exchangers required in variousindustries for high heat-flux cooling to the level ofmegawatt per meter square. At this level, cooling with conventional fluids such as water and ethylene glycol and so forth, are challenging. Hence, it is necessary to increase the heat transfer performance of working fluids in the heat transfer devices. Heat transfer augmentation techniques (passive, active and compound) are commonly used in areas such as process industries, heating and cooling in evaporators, thermal power plants, air-conditioning equipment, refrigerators, radiators for space vehicles, automobiles, etc. The rate of heat transfer can be increased passively by increasing the surface area, roughness, and by changing the boundary conditions. The active method involves addition of nanosized, high thermal conductivity, and metallic powder to the base fluid, to increase the heat transfer rate. Such a fluid is termed as nanofluid. Passivetechniques, where inserts are used in the flow passage to augment the heat transfer rate, are best suited compared to active techniques. Because the insert manufacturing process is simple and these techniques can be easily applied in an existing application.

2. LITERATURE REVIEW

[1] Mallikarjun.C. Math , Syed Sameer , Rangu P (2016) came to conclusion After all theoretical and practical calculations and testing prototype for different flows. we can conclude that Copper naturally being

good conductor of heat, it accelerates heat transfer rate immensely. Copper also has high metallurgical qualities like rustproof, antifouling, corrosion free, cheap and easily available makes it very useful for heat exchanger. Inserts are used in copper tubes. Inserts are twisted helically, such that water flowing through tubes moves in helically rotation and inserts push them towards the wall of copper tubes which helps in heat transfer. Also inserts increase turbulence of water inside the tubes. With external fins made on copper tubes, it increases contact surface (surface area) for convection heat transfer. Fins also make cold water turbulent while flowing from tubes surface. In result of this, they found 20.15% of increase in heat transfer theoretically.

[2] M. Mulla, (2014) they did the experimental study on heat transfer and friction factor characteristics flowing through laminar flow in tubes of shell and tube heat exchanger fitted with twisted tapes with baffles. They concluded that during the experimentations if heat exchangers operate under laminar flow condition at low flow rate, the twisted tapes with baffles are goes to increase the heat transfer coefficient and pressure drop. For the experimentation the twisted tapes inclination with baffles in are at 450 which is at normal axis of twisted tape. Which is fitted in heat exchanger, for the Reynolds number range from 200 -600. During the experimentation the result shows that the Nusselt number is increased for same flow rate in tubes with twisted tape with baffle as compared to plain tubes as well as tubes with typical twisted tapes. They obtained highest heat transfer coefficient for tubes fitted with twisted tape with baffle compared to the plain tubes as well as tubes with typical twisted tapes for same Reynolds number and for same flow rate. They also found that for higher Pressure drop value in twisted tape with baffle as compared to in plain tubes with typical twisted tapes for same flow rate and Reynolds number. And they finally conclude that using twisted tapes with baffles on tubes, the thermal performance of the shell and tube heat exchanger under the laminar conditions it can increased up to 150% -160% as compare to plain tube.

[3] Jagpreet Singh, et al., [2014] they did the experimental study on cconvective heat transfer characteristics on heat exchanger using twisted tapes different cuts shapes i.e. square, circular and triangular respectively and of different materials i.e. GI, Al and Cu are inside the inner tube of single unit on heat transfer and friction factor for heating of water for Reynolds number range 500-3000 was studied experimentally. They conclude that with maximum inlet and outlet, minimum temperature difference is observed in the pipe with Cu insert. This indicates that the average Nusselt number becomes higher for pipe with Cu insert as that of Al insert and without insert. They observed that with gradual change in the pressure drop in changes with Reynolds number. It was shows that dependency on temperature of fluid viscosity, and increasing contraction and expansion pressure losses in inlet and outlet of the pipe.

[4] M.J.Patel, (2014)they did the review on the Enhancement in Heat Exchanger using twisted tape Insert. They concluded that, if twisted tape insert made of Metallic wiry Sponge than it was helpful to increase the

Rate of Heat transfer in tube. Similarly, if twisted Tape with Spiral Section which had the largest surface and contact Area with fluid so it was increases the heat transfer rate.

3. METHODOLOGY

Considering the concentric tube parallel flow heat exchanger.

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Preparation of helical interrupter.

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Performing the experiment without interrupter for different flow

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Insertion of helical interrupter inside the hot tube of Heat

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Repeat the above experiment for previous values of flow rates with interrupter

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1		Cold water outlet (Tco)	7	Rotometer (Hot water)
2		Cold water inlet (Tci)	8	Concentric tube
3		Hot water inlet (Thi)	9	Temperature indicator
4		Hot water outlet (Tho)	10	Channel changer
5		Stand	11	Fuse
6		Rotometer (Cold water)	12	Geyser

↓

Analyse and compare both the results

4. EXPERIMENTATION

The apparatus consists of a concentric tube heat exchanger. The hot fluid namely hot water is obtained from the gyser (heater capacity 3 kW) & it flows through inner tube. The cold fluid i.e. cold water can be admitted at any one of the ends enabling the heat exchanger to run as a parallel flow exchanger. Measuring jar used for measure flow rate of cold water and hot water. These can be adjusted by operating the different walls values provided. Temperature of the fluid can be measured using thermo-couples with digital display indicator. The outer tube is provided with insulation to minimize the heat lose to the atmostphere

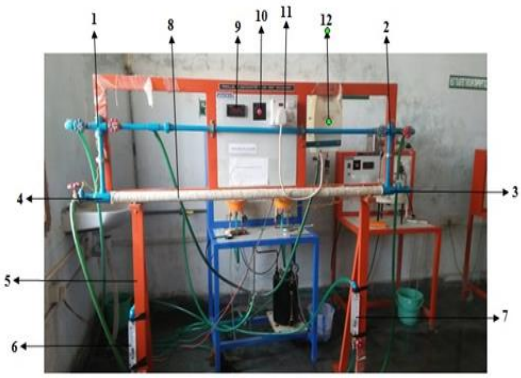


Figure 4.1 Heat exchanger

Table 4.1: specification of the setup

Table 4.2: Description of heat exchachanger

Sl. No	Name of the specification	Details
1	Specimen material	Copper tube
2	Size of the specimen	ϕ12.5mm x 1500mm long
3	Outer shell material	G.I2
4	Size of the outer shell	ϕ40mm
5	Geyser Capacity	1 litre, 3 kW

4.1.HELICAL INTERRUPTER

The helical interrupter is made from stainless rod spiraled around with cooper coil in this project. The stainless steel rods are from alloyed steel with 12% chromium. The steel can be alloyed with alloying elements (e.g. manganese, silicon, nickel, titanium, copper, chromium, and aluminum). This interrupter spiraled with cooper wiring creates turbulence for normal flow of water inside the concentric tube of heat exchanger.

Figure.4.2 Helical interrupter

Table 4.3. Specifications of the Helical Interrupter

Sl.no	Name of the Specification	Value
1	Length of Helical interrupter	1500 mm
2	Average pitch of cooper spirals on interrupter	6mm
3	Cooper wire diameter	1mm
4	Stainless steel rod	3mm
5	Helical Interrupter (Complete) diameter	4mm

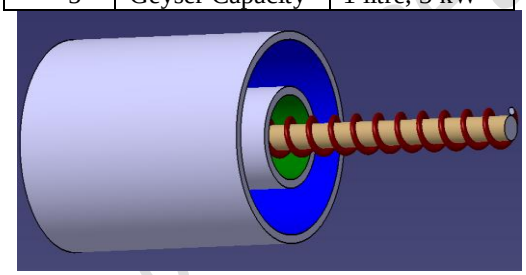


Figure. 4.3. Insertion of helical Interrupter in the concentric tube

5.RESULTS AND DISCUSSION

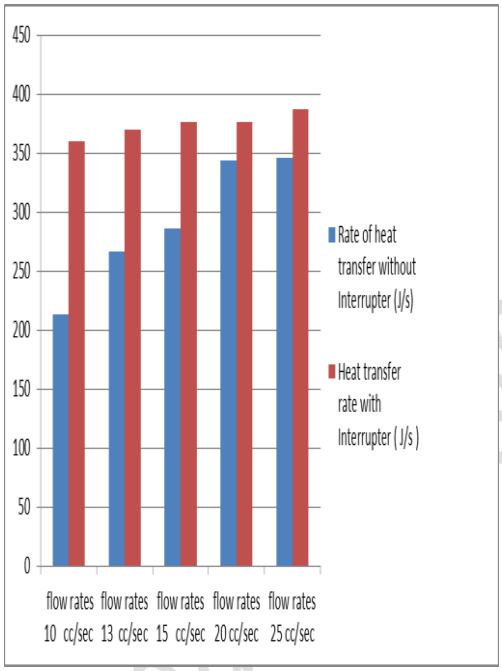
It can be observed from the above Graph 5.1 that, the rate of heat transfer is higher in case of haet exchanger with interrupter compared to HE without interrupter for all the flow rates. The highest increment is found for the flow rate 10 cc/sec which is 68.62%. This is due to the turbulence created by the helical interrupter near the inner surface of the tube wall. The helical shape of the interrupter disturbs the flow. The disturbed fluid can transfer more heat than the bulk fluid.

It can be observed from the above Graph 5..2 that, the rate of LMTD is higher in case of heat exchanger with interrupter compared to HE without interrupter for all the flow rates. The highest increment is found for the flow rate 10 cc/sec which is 33.82%. This is due to the turbulence created by the helical interrupter near the inner surface of the tube wall. The helical shape of the

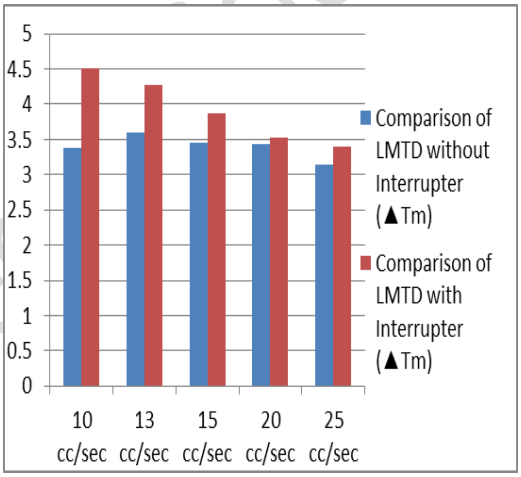
interrupter disturbs the flow. The disturbed fluid can transfer more heat than the bulk fluid.

It can be observed from the above Graph 5.3. that, the rate of Overall Heat transfer coefficient is higher in case of heat exchanger with interrupter compared to HE without interrupter for all the flow rates. The highest increment is found for the flow rate 10 cc/sec which is 26%. This is due to the turbulence created by the helical interrupter near the inner surface of the tube wall. The helical shape of the interrupter disturbs the flow. The disturbed fluid can transfer more heat than the bulk fluid.

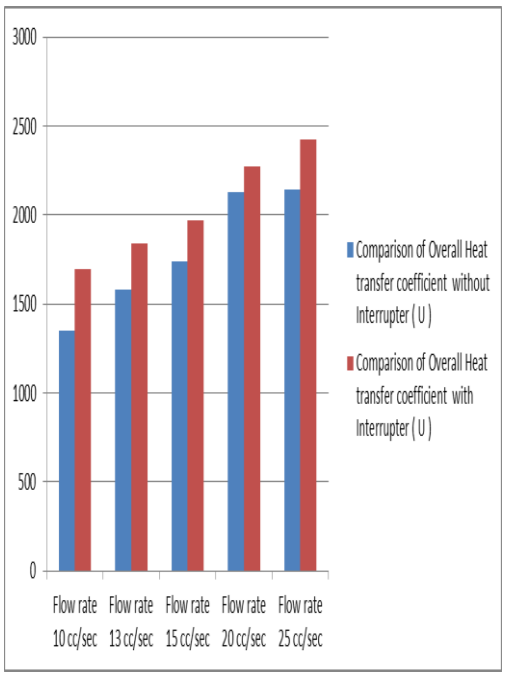
It can be observed from the above Graph 5..4 that, the rate of Data of Effectiveness is higher in case of heat exchanger with interrupter compared to HE without interrupter for all the flow rates. The highest increment is found for the flow rate 10 cc/sec which is 30%. This is due to the turbulence created by the helical interrupter near the inner surface of the tube wall. The helical shape of the interrupter disturbs the flow. The disturbed fluid can transfer more heat than the bulk fluid.



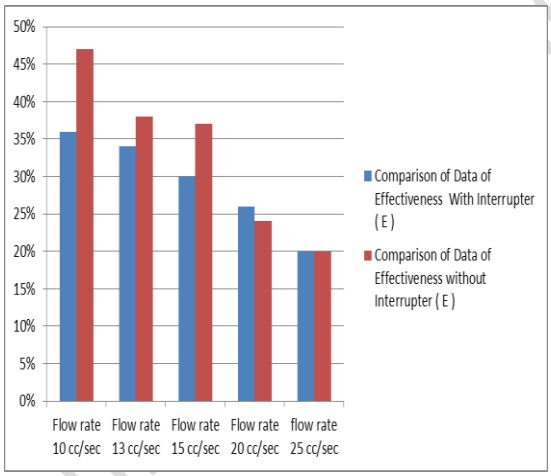
Graph: 5.1



Graph: 5.2



Graph: 5.3



Graph: 5.4

5. CONCLUSIONS

It can be concluded from the present work that;

- Rate of heat Transfer in case of heat exchanger with helical interrupter is higher for all the flow rates. And the highest increment is found for the flow rate 10 cc/sec, which is 68%.
- LMTD in case of heat exchanger with helical interrupter is higher for all the flow rates. And the highest increment is found for the flow rate 10cc/sec, which is 33.82%.
- Overall heat transfer coefficient in case of heat exchanger with helical interrupter is higher for all the flow rates. And the highest increment is found for the flow rate 10cc/sec, which is 26%.
- Effectiveness in case of heat exchanger with helical interrupter is higher for all the flow rates. And the highest increment is found for the flow rate 10cc/sec, which is 30%.

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