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DESIGN AND FABRICATION OF DOUBLE PIPE HEAT EXCHANGER USING DIFFERENT HEAT TRANSFER ENHANCEMENT TECNIQUES

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Abstract— A Heat Exchanger is a device use for the heat transfer from one fluid to another, whether the fluids are separated by a solid wall so that they never mix or the fluids are directly in contact. To improve the heat transfer characteristic of double pipe heat exchanger, the various fin are installed on the outer surface of the inner tube and the level of turbulence increased and heat transfer characteristic of heat exchanger are increased up to 4 times than the plain tube. In many industries, we are using conventional heat transfer fluid such as water, mineral oil and ethylene glycol. However, the heat transfer efficiency decrease because of their low thermal conductivities. It has been found that the heat transfer rates of these conventional fluid can be increased by suspension of metallic nanoparticles. The suspended metallic nanoparticles can change the heat transfer characteristics of the base fluid.it is observed that there is an enhancement in heat transfer in the range approximately 12% - 16% There are Various Enhancement methods are used to increase performance of heat exchanger such as treated surfaces, rough surfaces etc.
Keywords— Double tube heat exchanger, Fins, Nano fluid.

I. INTRODUCTION

Double pipe heat exchanger is used in chemical industry. When to construct this type of heat exchanger, the size of material that is considered since it affected the overall heat transfer. Basically the heat exchanger has two types that are parallel flow heat exchanger, counter flow heat exchanger and efficiency of counter flow heat exchanger is high than the parallel flow heat exchanger. So it is widely used. After few years of research the fins has introduce in heat exchangers for improve performance. The fins increase the effective area of a surface than heat transfer will increase. Past few years' lot of modification are implemented in fin design for increase heat transfer rate in the heat exchanger. The reason for implementation of fin is increase the pressure drop.

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Fig.1 Double pipe heat exchanger

II. OBJECTIVES OF PROJECT

Main objective of our project is to reduce following problem:

- Our main aim of the project is to increase the performance of heat exchanger.
- Based on this concept the fins are placed over the inside copper tube so the cold fluid are passed over the fins in that time pressure drop of the fluid are increased so the heat transfer rate from hot fluid to clod fluid are increase

III. METHODOLOGY

To improve the heat transfer characteristic of double pipe heat exchanger, the various fin are installed on the outer surface of the inner tube and the level of turbulence increased and heat transfer characteristic of heat exchanger are increased.

There are Various Enhancement methods are used to increase performance of heat exchanger such as treated surfaces, rough surfaces etc.

3.1 Types of Fin

3.1.1 Hexagonal Fin and circular Fin

Fig.2 Hexagonal fin

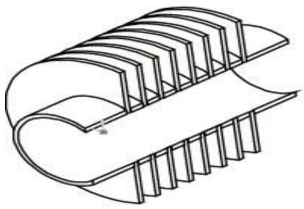

Fig.3 Circular fin

- The small shell and tube heat exchanger is modeled with sufficient details to resolve the flow and temperature fields. In existing model the heat transfer rate is low by using finned tube. Compare both existing and new model type heat exchanger over all heat transfer rate is increased and also the efficiency of the heat exchanger for semi-circle fins is increased.

3.1.2 Helical Fins on the Inner Rotating Tube

- The helical fins over the inner tube results into the increase in the heat transfer area. In addition to this the rotation of inner tube improve the turbulence and mixing of fluid molecules which is important to improve the heat transfer rate. The nusselt number for the inner tube with helical fins is 4 times higher than the plain inner tube at rest condition.

Fig.4 Helical Fins

3.1.3 Aluminium Fins with a Star-Shape Cross-Section

- The effects of star-shape fin inserts on the heat transfer rate and pressure drop in a double-tube heat exchanger. Based on the review, the following conclusions can be drawn:

1. The overall heat transfer coefficient in a concentric-tube heat exchanger was enhanced.
2. The rate of increase in the pressure drop was larger than the rate increase in the heat transfer rate, in general. We believe that a better heat transfer enhancement and lesser pressure drop could be achieved by making the fin thickness smaller so as to reduce flow restriction while maintaining a large surface area.
3. The benefit of a twisted fin may be obtained in a cross flow heat exchanger, where the twisted fin forces hot fluid to move circumferentially, while moving along the axial direction.

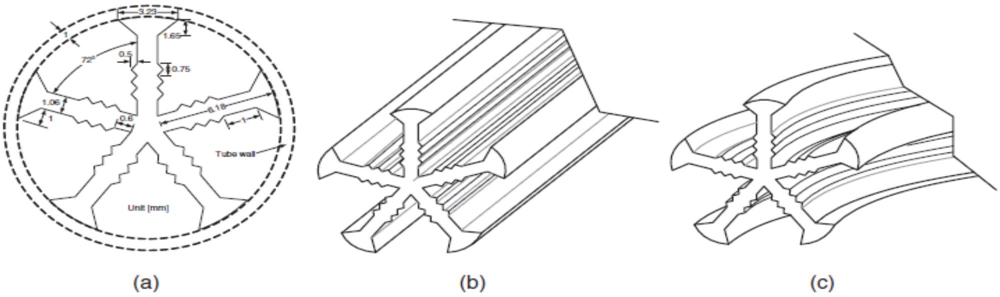

Fig.5 Star-Shape Cross-Section fin

3.2 FIN MATERIAL

Metal	Thermal conductivity (W/(m•K))
Silver	429
Copper	399
Gold	316
Aluminum	235
Yellow brass	120
Cast iron	80.1

Table 1

3.3 NANOFLUID

A Nano fluid is a fluid containing nanometer-sized (<100nm) particles, called nanoparticles. These fluids are engineered colloidal suspensions of nanoparticles in a base fluid .the nanoparticles used in nanofluids are typically made of metals, oxides, carbides or carbon nanotubes. Common base fluids include water, ethylene glycol and oil. Nan fluids have novel properties that make them potentially useful in many applications in heat transfer.

3.3.1Need of Nano fluids:

- Due to size of Nano particles, pressure drop is minimum.
- Higher thermal conductivity of Nano particles will increase the heat transfer rates.
- Nan fluids are most suitable for rapid heating and cooling systems.
- The Nusselt number enhancement with the use of nanofluids in the heat exchangers. Also, nanofluids implementation in the heat exchangers resulted in an increase in the required pumping power, in the most cases.

3.3.2 Types of Nano fluid

SERIAL NO.	MATERIAL	THERMAL CONDUCTIVITY (w/mk)
1	Engine Oil	0.15
2	Ethylene Glycol	0.25
3	Water	0.61
4	Silver	405
5	Alumina	200
6	Gold	319

Table .2

3.4 Preparation of Nano fluid

The two-step method was used because it's simpler technique and lower cost than the onestep method to prepare nanofluids. The Al2O3-water nanofluids with two different particle sizes. Every kind of nanofluids had all the mass fractions of 0.1%, 0.5 %, 1.0% and 1.5%. Fig.1 shows the common procedures to prepare nanfluids use the two-step method. The specific steps are as follows: weigh a certain amount of nanoparticles, Ethylene Glycol and distilled water obey their proportions. Add the nanoparticles and the ethylene glycol into the distilled water slowly to make the nanoparticles suspended better, and the nanoparticlessuspensions were obtained. Place the beaker containing the suspension on a magnetic stirrer and stir it for 30 minutes. Then make the suspension take ultrasonic vibration for 2 hours to get the nanofluids.

During the initial experiments, there appeared many bubbles at the surface of nanoparticles suspensions after magnetic stirring, these bubbles can adhere to the beaker wall when shift the suspension from a beaker to colorimetric tubes, which affected the mass fractions of the suspension in colorimetric tubes. This is because Ethylene Glycol has high surface activity, and air is easy to dissolve into the fluid in the stirring process, so that bubbles form easily. To solve this problem, the stirring speed was reduced from 1200r/min to 800r/min, and the stirring time was extended from 20min to 30min. It was confirmed that this method is effective to reduce the formation of bubbles, and improve the quality of the obtained nanofluids.

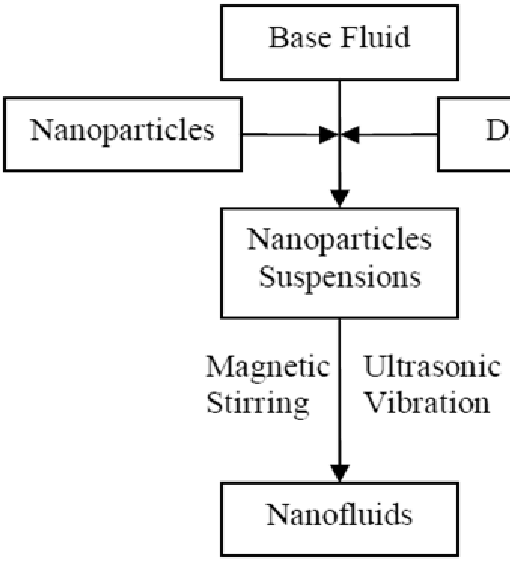

Fig. 6 Two Step Method

IV. EXPRIMENTAL SETUP

Description

The apparatus consists of a concentric tube heat exchanger. The hot water flows through inner tube and cold water flows through outer tubes. Direction of cold or hot fluid flow can be changed from parallel or counter to hot or cold water so that unit can be operated as parallel or counter flow heat exchanger. For flow measurement rotameters are provided a magnetic drive pump is used to circulate the hot water from a recycled type water tank, which is fitted with heaters and digital temperature controller.

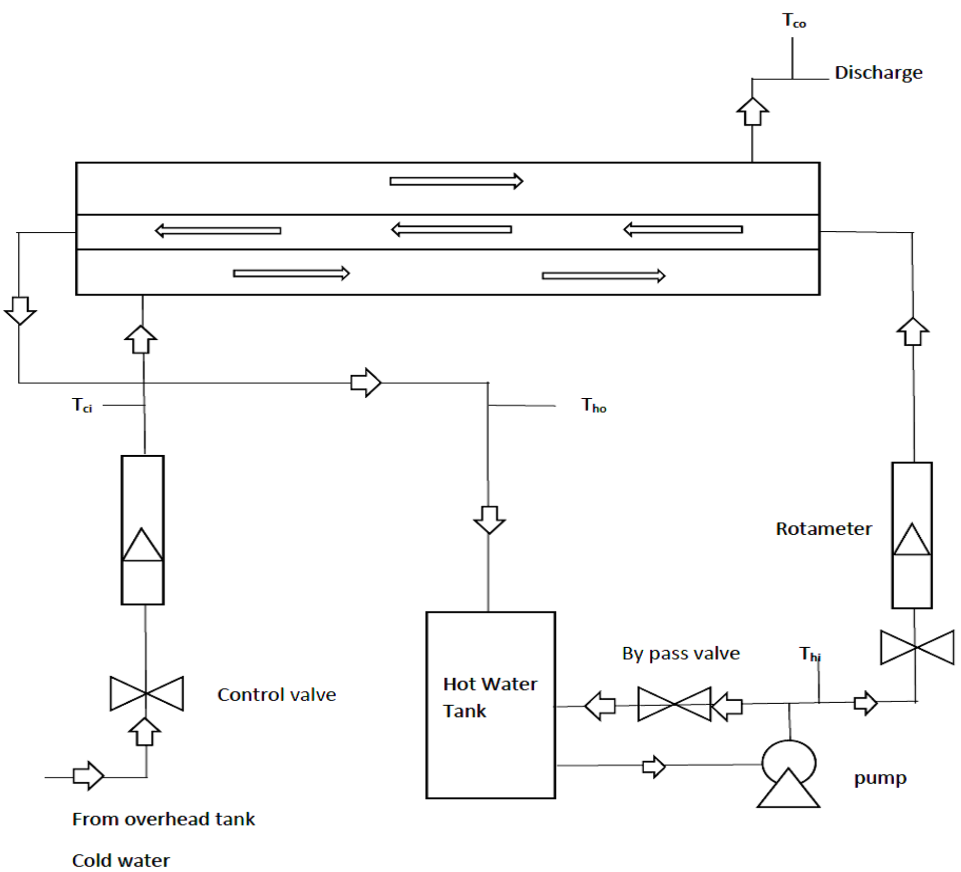

Fig.7 Schematic Diagram of Concentric tube heat exchanger

4.1 FABRICATED SETUP

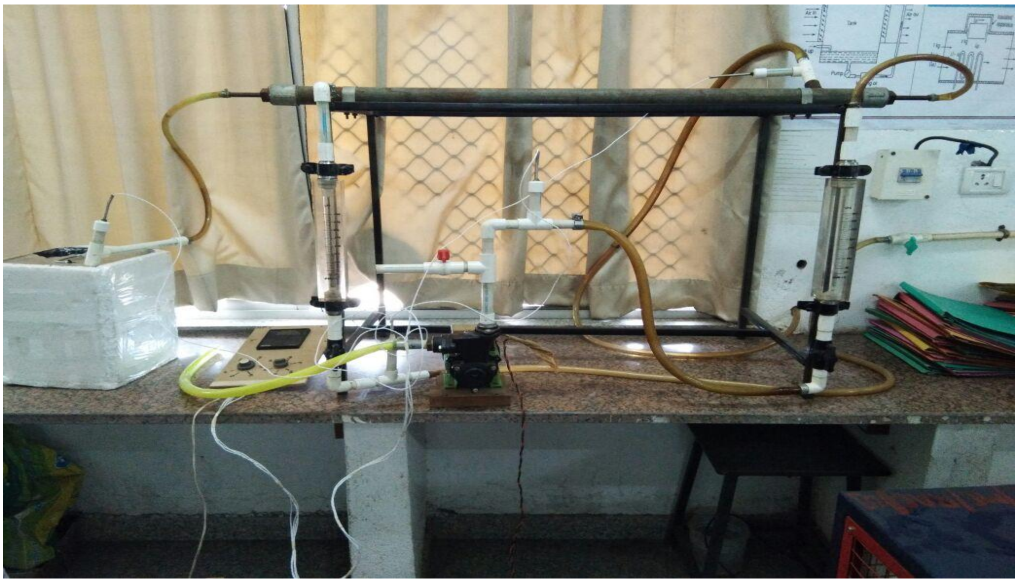

Fig.8 Fabricated setup

V. RESULT AND DISCUSSION

The experiment werer carried out to measure the change in mass flow rate of hot and cold fluid to investigate the effect of nano fluid. First, the test is carried out with water without fin and with fin, then adding nano particles in base hot fluid by 0.5% wt.

5.1 Analysis of heat transfer enhancement of simple water and without fin:

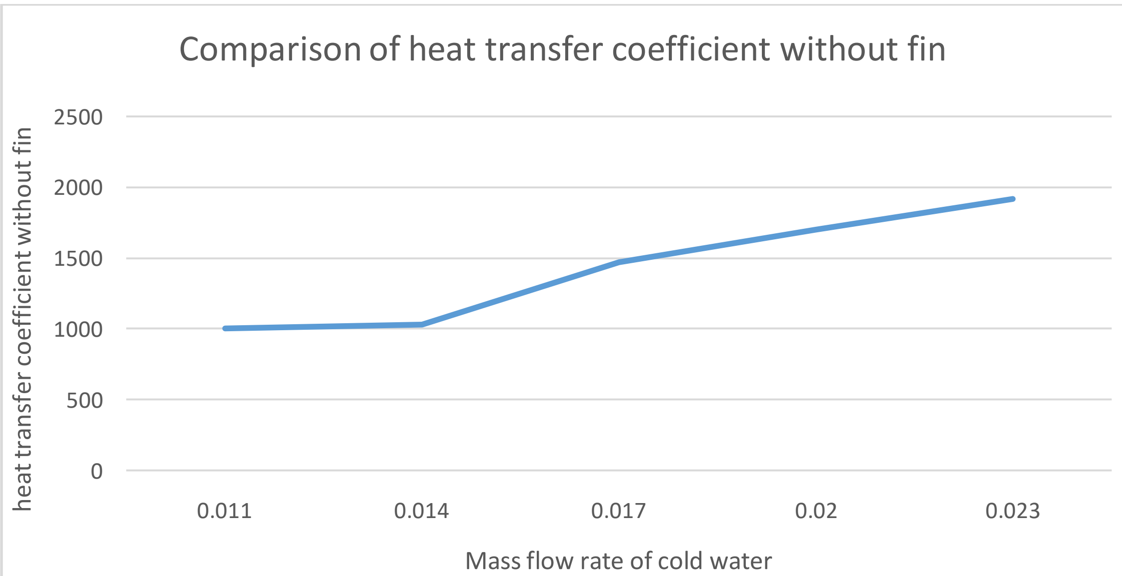

Fig.9 Heat transfer enhancement of simple water and without fin at various mass flow rate of cold water.

5.2 Analysis of heat transfer enhancement of simple water and with circular fin:

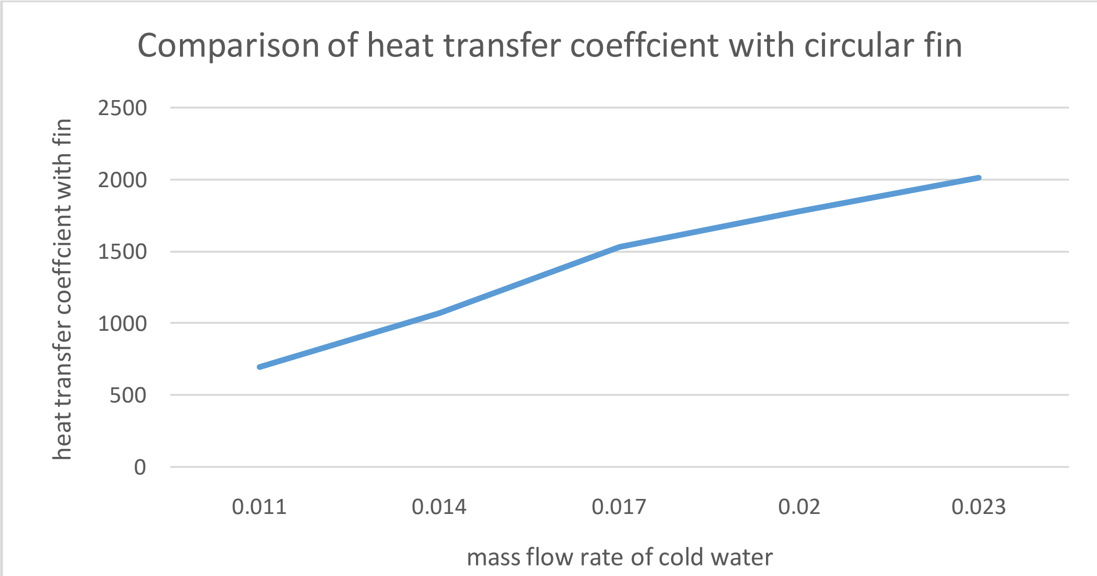

Fig.10 Heat transfer enhancement of simple water and with circular fin at various mass flow rate of cold water.

5.3 Analysis of heat transfer enhancement of simple water and with helical fin:

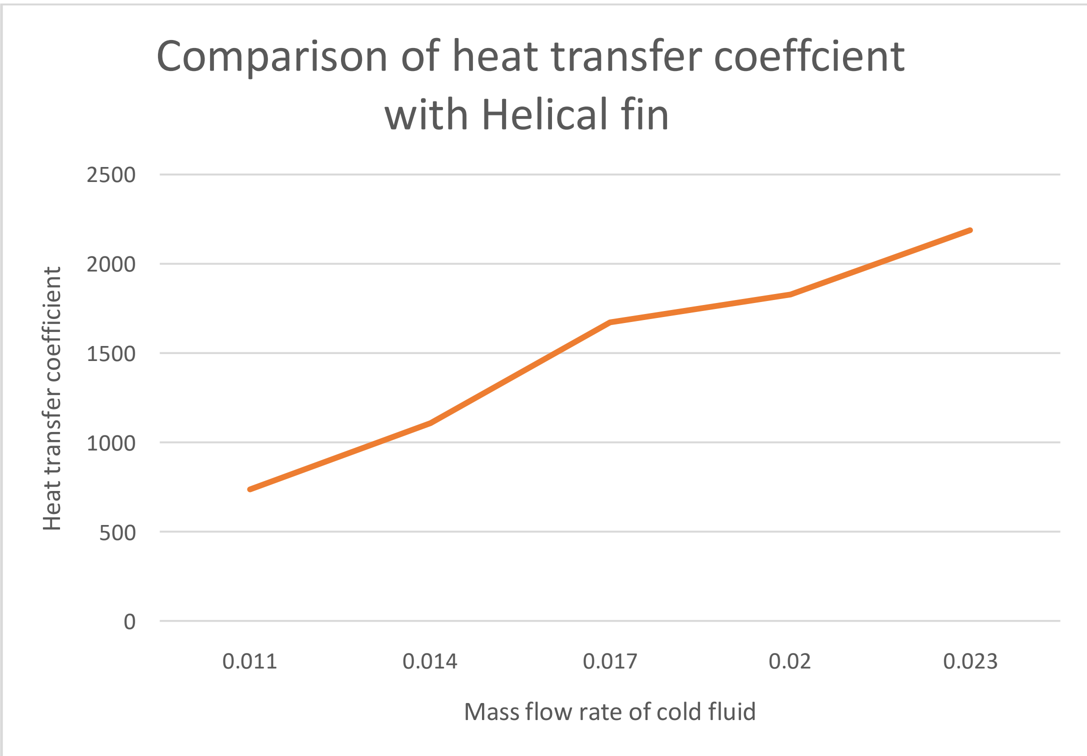

Fig.11 Heat transfer enhancement of simple water and with helical fin at various mass flow rate of cold water.

5.4 Analysis of heat transfer enhancement of simple water and with Nano fluid:

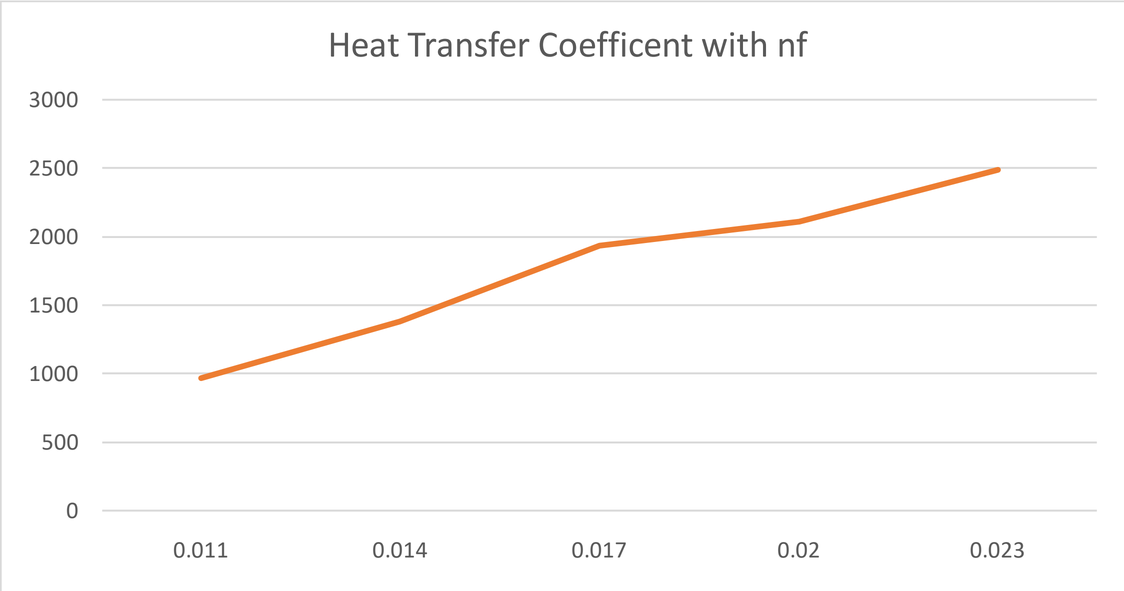

Fig.12 Heat transfer enhancement of simple water and with Nano fluid at various mass flow rate of cold water.

5.5 Analysis of heat transfer enhancement of simple water and without fin, with circular fin, with helical fin, with Nano fluid:

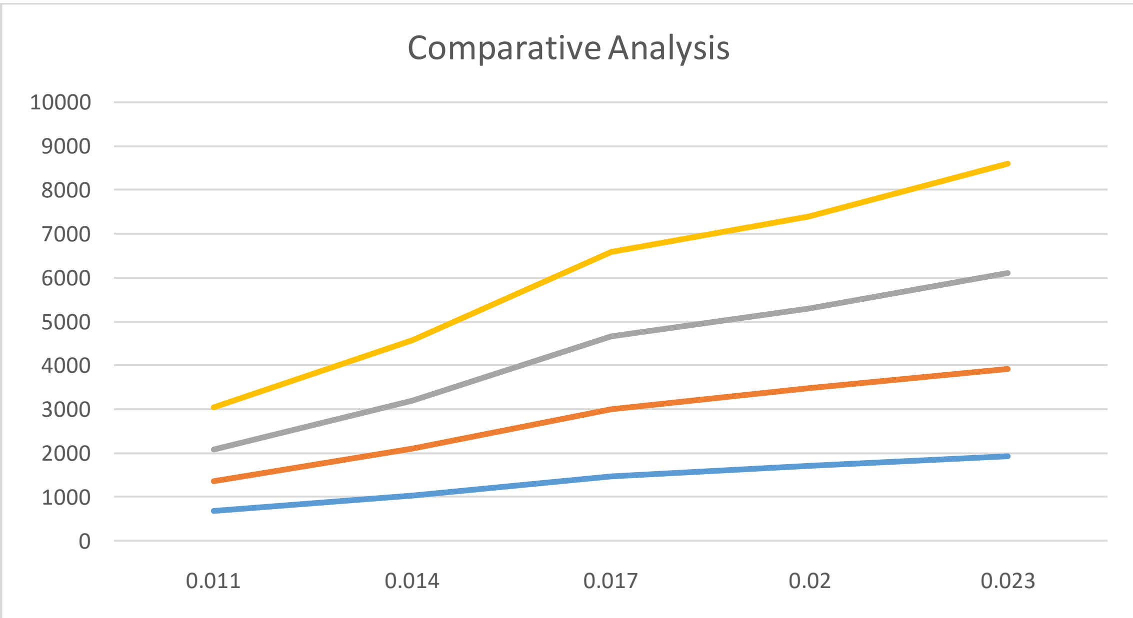

Fig.13 Heat transfer enhancement of simple water and without fin, with circular fin, with helical fin, with Nano fluid.

As shown in fig the heat transfer coefficient increase with increase in mass flow rate of cold fluid at hot water mass flow rate keep in constant at 225 LPH and inlet temperature of hot water 53.1 ^{0}C and cold fluid is 35.2 ^{0}C and mass flow rate 40 – 80 LPH. At this mass flow rate it is observed that there is a enhancement in heat transfer in the range approximately 12% - 16% using helical fin and nano fluid. It is also observed that there is enhancement in heat transfer using fin. Comparative analysis is shown in graph.

VI. CONCLUSION

- Due to temperature reduction and pressure drop in the heat exchanger the heat transfer rate and efficiency is low by using finned tube. In new model type heat exchanger over all heat transfer rate is increased and also the efficiency of the heat exchanger for circular fins is increased by 4% - 6%. Also the efficiency of double pipe heat exchanger for helical fin and nano fluid is increased by 12% - 16%. It is also observed that there is enhancement in heat transfer using helical and circular fin.

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