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Enhancement of Heat Transfer through a Hole Type Twisted Tape Insert using 0.4% Concentration Cuo (Copper Oxide) Nano Fluid

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Abstract- Heat is transferred from one fluid to another fluid in the heat exchanger influenced by the motion of molecules of fluids in the heat exchanger tube. An experimental work was conducted for determining the enhancement of heat transfer in heat exchanger using water and nanofluid flowing through circular and horizontal duct inserted with rotating twisted tape. A stainless-steel pipe with outer diameter 34mm and internal diameter of 30mm with insertion of a test section length of 800mm, a stainless-steel twisted type tape with 2.37 twist ratio with holes of 2.5mm diameter with 40mm interval distance was pushed into the circular duct. The tape which is made to rotate inside the tube. An invariable heat of the tube was produced by using heaters located on the external part of the circular duct. The significant limitation of conventional fluids is its lower conductivity in the area of development of fluids for heat transfer that are needed in many applications. In this work, the suggestion of an advanced category of fluids, which can be produced by suspending Nanoparticles in establishing fluids are used. The suspension of Nanoparticles with the base fluid the thermo-physical attributes of Nanofluids are changed when compared with those of currently used fluids and this represents the hope for improved heat carrying capacity in the heat exchanger. The properties and possible use of the Nanofluids are estimated. In this investigation, an experimental study has been carried to determine the results of 0.4% concentration CuO (Copper Oxide) Nanofluid which is synthesized with water as base fluid in the place of currently used heat transfer fluids like water, etc. where we are comparing the experimental results obtained from experiments done on water and water based CuO Nanofluid at 0.4% concentration. The experiment is conducted using rotating hole type twisted tape with the speed varying from 0 to 300 RPM and flow rate is ranging from 1 to 3 LPM.

Keywords- Heat Exchanger, Fluids, Nano Particles and Nano Fluids.

I. INTRODUCTION

Heat exchangers are devices in which transfer of heat between two or more fluids take place due to difference in temperatures.

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To meet wide range of technical requirements, several types of heat exchangers are being potentially used in steam power plants, chemical processing industries, car radiators, radiators for space vehicles, and so on. Wide variety of heat exchangers are required for different kind of purpose with vary in the construction. Heat Exchangers are Classified as:

A. *Based on The Heat Transfer Process*- Indirect type and Direct type
B. *Based on Their Construction*- Tubular, Plate, Plate Fin, Tubular Fin, and Regenerative Heat Exchangers.
C. *Based on Flow Arrangement in Heat Exchangers*- Cross flow, Multipass flow, Counter flow, Parallel flow.

Heat Transfer Enhancement: The objective of heat enhancement is to optimize different factors like Capital Cost, Power Cost, Maintenance Cost and under the constraints of Space and Weight etc. Enhancement techniques for high rate of heat transfer is classified into three methods:

A. *Active Method*- This method is more composite in design view and use as these methods require external power to change the desired flow alteration and enhancement in the rate of heat transfer of heat exchanger. Suction and jet impingement, fluid vibration, electrostatic fields, surface vibration and mechanical assistance are some of the active methods
B. *Passive methods*- Passive methods do not need any external power like any active technique. These methods preferably use the power from the system itself. The alterations to the flow stream are done by surface or geometrical adjustments and by integrating some devices or the inserts which assists for the swirl motion of fluid.
C. *Compound methods*- When active and passive or even more techniques are simultaneously used to prevail the improvement in heat transfer to an extent more than when either of the technologies is used separately is termed as the compound method.

In this case we are experimenting with the Passive method of heat transfer enhancement.

Nanofluids: Nanofluids, made from colloids of base fluid and nanoparticles. Due to the suspension of nanoparticles the thermal properties of a base fluid are altered, in turn heat transfer rate is also enhanced. The thermal performance of conventional fluids used for heat transfer such as ethylene glycol, pumping oil, lubricant oil, and water is often not adequate for the application problems.

Adding of solid particles to these base fluids enhances the thermal characteristics and these suspensions of micrometre or larger size particles are usually not effective in microelectronics, data centres and micro-channels. Nanoscience and Nanotechnology have offered an economic solution by introducing Nanofluids which are some base fluids, mixed with Nanoparticles in the form of a colloidal solution to enhance the heat transfer rate.

II. EXPERIMENTAL WORK

Preparation of Nanofluid: The synthetization of CuO nanofluid which contains nano particles of size 30-50nm and density of 6400 kg/m^3 is being used in 0.4% concentration in water as base fluid. 1.6348 grams/ litre of CuO nano particle is dispersed with water along with sodium lauryl sulphate of same weight as a surfactant and is stirred in magnetic stirrer for 4 hours followed by sonication of 8 hours.

Heat Transfer Enhancement: Heat transfer enhancement carried out for base fluid (water) and CuO (Copper Oxide) nanofluid in a horizontal double pipe heat exchanger. The taken readings for base fluid and CuO (Copper Oxide) nanofluid were at constant flow rate at different temperatures of hot fluid. Plain water as thermo fluid was used first and then experiments were performed with CuO (Copper Oxide) nanofluid as a thermo fluid. Temperature readings were taken at inlet and exit positions of fluid at steady state.

Figure: 0.4% CuO (Copper Oxide) Nano Particle

III. RESULTS AND DISCUSSION

A. Reynolds Number (Re) table with water as fluid:

Sl No.	Flow Rate (LPM)	Reynolds No. (Re)	Prandtl No. (Pr)	Nu_{th}	h_{th}
1	1	903.45	5.23	4.36	91.26
2	2	1810.79	5.23	4.36	91.26
3	3	2701.35	5.23	13.25	277.36

B. Reynolds Number (Re) table with 0.4% CuO Nanofluid:

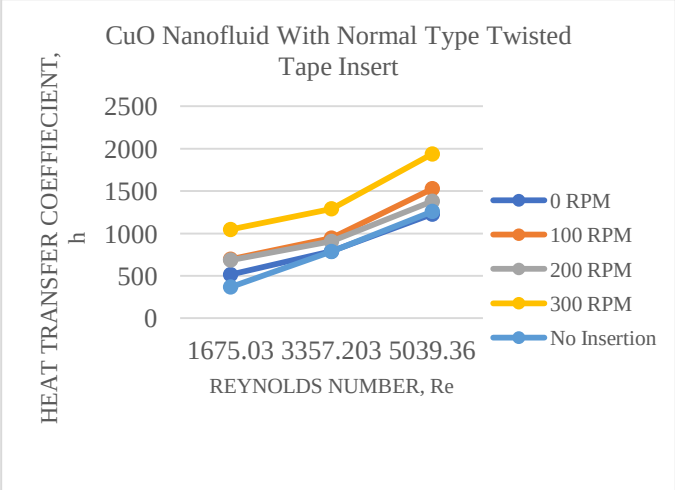
Sl No.	Flow Rate (LPM)	Reynolds No. (Re)	Prandtl No. (Pr)	Nu_{th}	h_{th}
1	1	1675.03	4.568	4.36	111.034
2	2	3357.203	4.568	18.65	474.9
3	3	5039.36	4.568	32.56	829.19

The above obtained results show the increase in Reynolds number between water as a fluid and 0.4% CuO Nanofluid with water base. This show the significant increase in the turbulence created by CuO Nanofluid compared to water as base fluid.

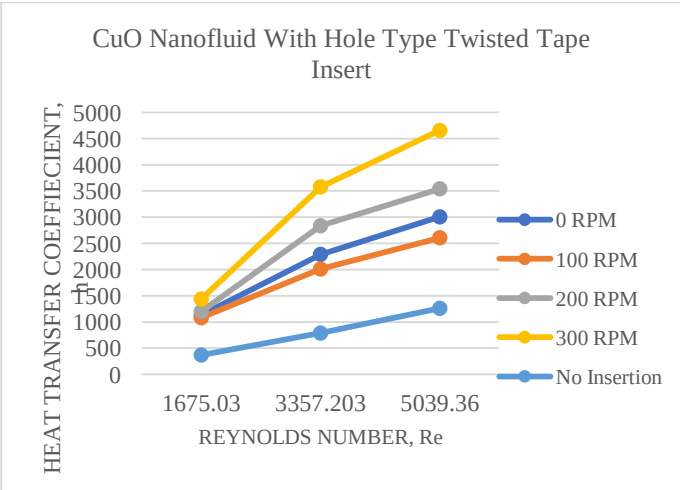
The further experimentation carried out with normal and hole type tape insert for the both fluids and the calculations done for the heat transfer coefficient rates followed by the calculation of Nusselt number.

The graph is plotted for heat transfer coefficient rates with respect to Reynolds number for normal type twisted tape and hole type twisted tape in 0.4% CuO Nanofluid as carrier.

A. Heat transfer coefficient vs Reynolds number for Normal Twisted Tape insertion:



B. Heat transfer coefficient vs Reynolds number for Hole type Twisted Tape insertion:



As observed from the graphs there is a significant increase in the Heat transfer coefficient at different speeds. The variation in the heat transfer coefficient in a hole type insertion is high than a normal type inserts,

the highest heat transfer rate is observed for 0.4% CuO Nanofluid in both the normal twisted tape and hole type twisted tape as compared to the same inserts in water as base fluid. And comparing normal twisted tape with hole type twisted tape it is that the hole type twisted tape has significantly higher heat transfer rates at higher speed and flow rates in both the fluid runs. And the 0.4% CuO nanofluid enhances heat transfer about approximately 150% compared to water at higher flow rates and speed.

IV. CONCLUSION

The heat transfer rate is majorly influenced by the flow rate of the fluid flowing in the system. Higher heat transfer rate can be obtained at higher Reynolds number. Due to insertion of normal twisted tape insert and hole type twisted tape insert cause the secondary swirling motion of the fluid inside the tube which generates the new thermal boundary layer for fluid flow. The inserted tape causes the turbulence motion of the fluid. And that of the rotating of twisted tube cause the more turbulence there by the heat transfer increases. In working fluid concern, the 0.4% CuO Nanoparticle suspended fluid cause the increased heat to transfer due to their enhanced thermal conductivity. The thermo-physical properties of the Nanofluid vary with particle volume concentration and with temperature. The use of nanofluids helps us in increased heat transfer so it is a better replacement fluid in the place of conventional heat transfer fluid.

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