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Experimental Analysis of Double Pipe Heat exchanger with circular fins using Al_2O_3 /EG -Water Nano fluid

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Abstract— Experimentally study on a counter flow double pipe heat exchanger using by Water / Water and then adding 0.5 wt.% the Al2O3 nanoparticles in base cold fluid with circular fins. Nano fluid is a fluid having Nano size particles, dispersed in the conventional base fluids such as water, engine oil, ethylene glycol, which tremendously enhances the heat transfer characteristics of original fluid. Because of this fluid containing suspensions of metallic nanoparticles and have higher thermal conductivity. The heat transfer coefficient of the Al2O3 –Water nanofluid flowing in a counter flow concentric tube heat exchanger under turbulent flow conditions are investigated. The results show that the convective heat transfer coefficient of nanofluid is higher than that of the base liquid by about 13% – 16%. The heat transfer coefficient of the nanofluid increases with an increase in the mass flow rate of the hot water and nanofluid.

Keywords- Al2O3 nanoparticles, Double pipe heat exchanger, circular fins, heat transfer coefficient

I. INTRODUCTION

Heat exchangers play an important part in the field of energy conservation, conversion and recovery. Several studies have focused on direct transfer type heat exchanger, where heat transfer between fluids occurs through a separating wall or into and out of a wall in a transient manner. There are two important phenomena happening in a heat exchanger: fluid flow in channels and heat transfer between fluids and channel walls.

Thus, improvements to heat exchangers can be achieved by improving the processes occurring during those phenomena. Firstly, the rate of heat transfer depends on the surface area to volume ratio, which means the smaller channel dimensions provide the better heat transfer coefficient. Secondly, improving the properties of the heat transfer fluids (nanofluids) can yield higher heat transfer coefficient in a heat exchanger. In recent years, modem technologies have permitted the manufacturing of particles down to the nanometer scale, which have created a new class of fluids, called nanofluid.

The application of nanofluids or fluids containing suspensions of metallic nanoparticles to confront heat transfer problems in thermal management is one of the technological uses of nanoparticles that hold enormous promise today. Experiments have shown that nanofluids have improved thermal conductivities when compared to the base fluids and enhancement in the heat transfer coefficient.

In the present study, we have fabricated double pipe heat exchanger to investigate the thermal performance of heat exchanger using nanofluid. We have experimentally analyses effect of addition of 0.5 % Al_2O_3 nanoparticles mixed in ethylene glycol and added in base hot fluid using counter flow concentric tube heat exchanger.

II. WORK METHODOLOGY

Fins are quite often found in industry, especially in heat exchanger industry as in finned tubes of double-pipe, shell-and-tube and compact heat exchangers. As an example, fins are used in air cooled finned tube heat exchangers like car radiators and heat rejection devices. Also, they are used in refrigeration systems and in condensing central heating exchangers. Moreover, fins are also utilized in cooling of large heat flux electronic devices as well as in cooling of gas turbine blades. Fins are also used in thermal storage heat exchanger systems including phase change materials. Fins as passive elements for enhancing heat transfer rates are classified according to the following criteria.

(1) Geometrical design of the fin.
(2) Fins arrangements.
(3) Number of fluidic reservoirs interacting with the fin.
(4) Location of the fin base with respect to the solid boundary.

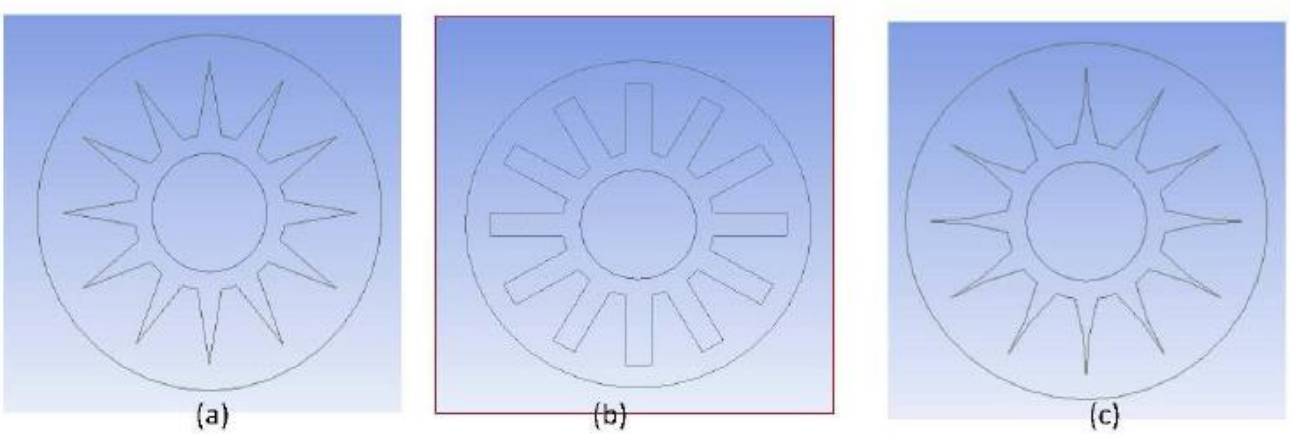
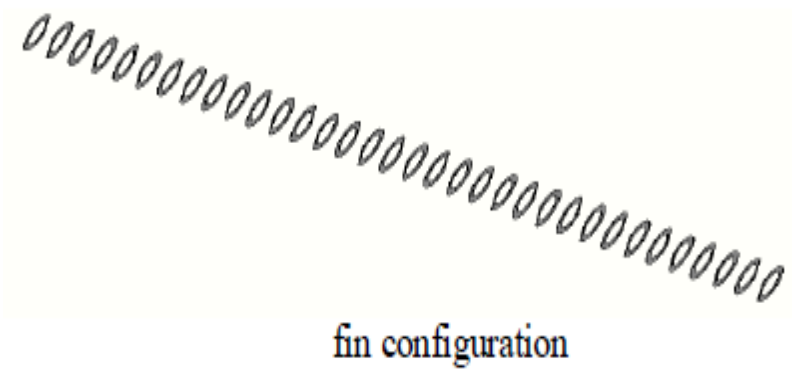


Fig. 1 Different types of finned configurations (a) triangular, (b) rectangular and (c) concave parabolic (d) Circular fins



2.1 WHAT IS NANOFLUID?

Nanotechnology provides new area of research to process and produce materials with average crystallite sizes below 100 nm called nanomaterials. When these nanoparticles are suspended in conventional fluids (water, oil, ethylene glycol) called "nanofluids". A study of Kakac and Pramuanjaroenkij resulted that the nanolayer works as a thermal bridge between the liquid base fluid and the solid nanoparticles and a nanofluid consists of the liquid base fluid, the solid nanoparticles and the nanolayers. Nanofluids clearly exhibit improved thermo-physical properties such as thermal conductivity, thermal diffusivity, viscosity and convective heat transfer coefficient. The property change of nanofluids depends on the volumetric fraction of nanoparticles, shape and size of the nanomaterials as shown by Yang. Increased thermal conductivity of nanofluid in comparison to base fluid by suspending particles.

III. EXPERIMENTAL SETUP

3.1 DESCRIPTION:

From overhead tank, Cold water flows through pass though the rotameter and enters in outer tube in one direction only and from tank by means of pump hot water flows over the inner tube in outer tube. Direction of cold fluid flow can be changed from parallel or counter to hot water so that unit can be operated as parallel or counter flow heat exchanger. Flow rates of hot and cold water are measured using rotameters. A pump is used to circulate the hot water from a water tank, which is fitted with an immersion heater.

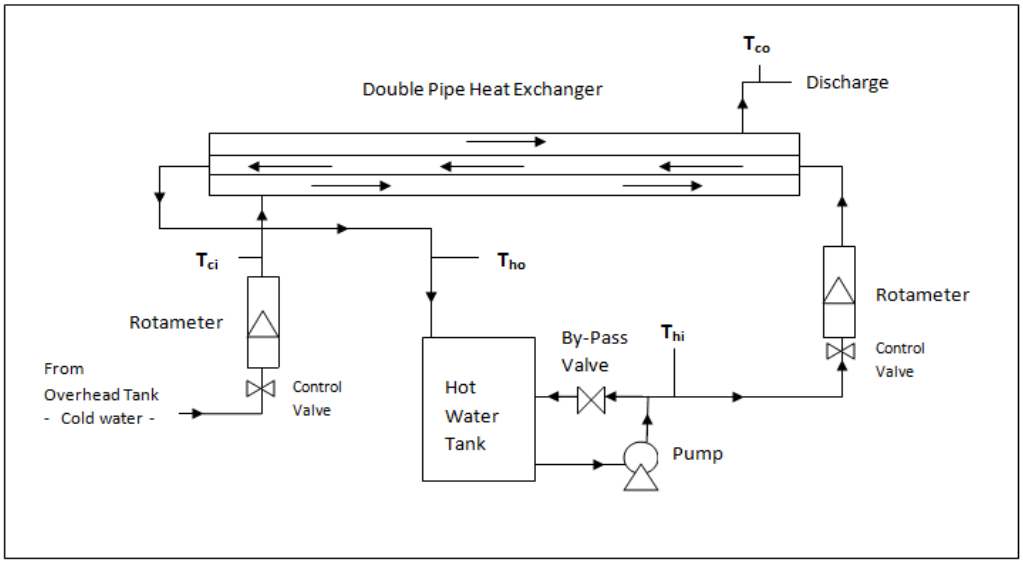


Fig.2 Schematic of Experimental Set up

3.2 FABRICATED SET UP

After assembling all parts according to line diagram our experimental set up is as shown in image

Fig.3 A Real Fabricated set up

IV.RESULTS AND DISCUSSION

The experiments were carried out to measure the change in mass flow tare of hot and cold fluid to investigate the effect of Nano fluid. First, the test is carried out with Water / Water without fin and with fin , then adding Nano particles in base hot fluid by 0.5% wt.

Comparative analysis of heat transfer enhancement of simple water and without fin, water with fin and Al_2O_3 Nano fluid

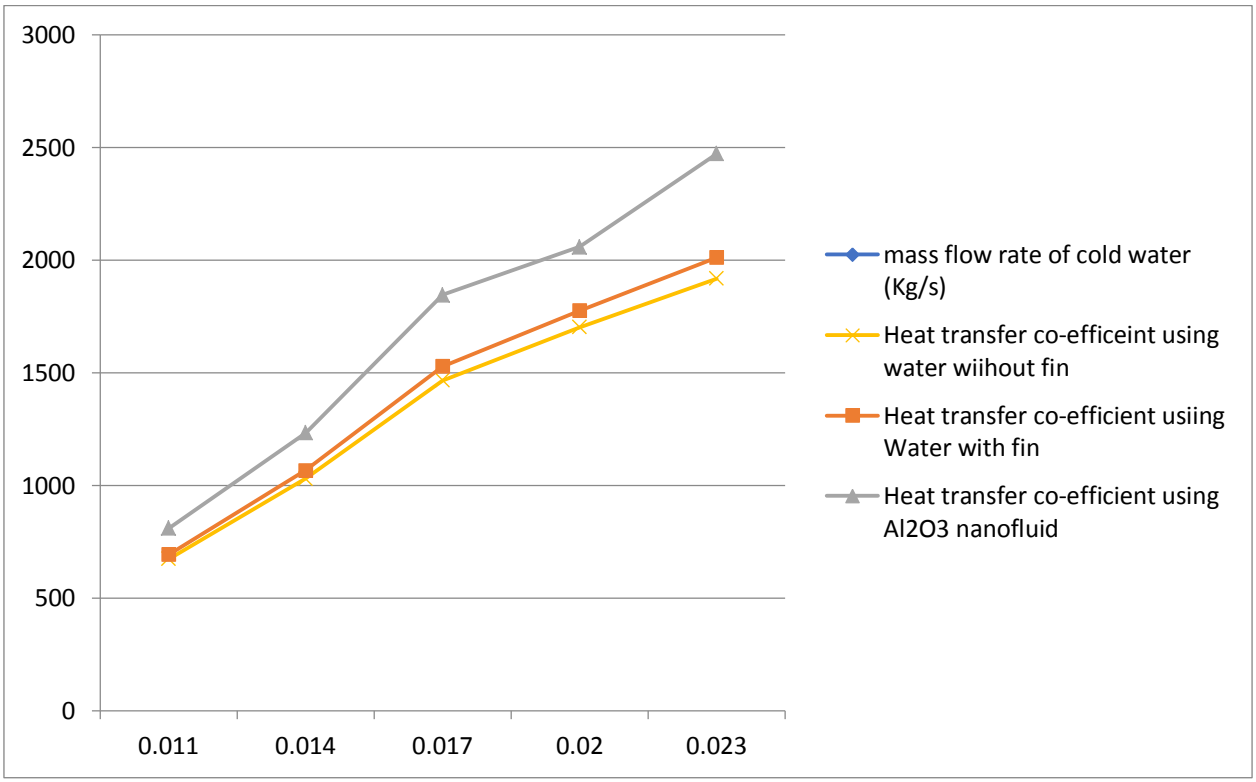


Fig.4 Comparison of heat transfer coefficient obtained from water and that from the O.5% wt. of Al2O3 nanoparticles dispersed in water.

As shown in fig. 7.1, the heat transfer coefficient increases with increases 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 is 53.1 °C and Cold fluid is 35.2 °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 fin and Nano fluid. It is also observed that there is enhancement in heat transfer using fin. Comparative analysis is shown in graph.

v. CONCLUSION

The convective heat transfer performance and flow characteristic of a Al_2O_3 – water nanofluid prepared by mixed with ethylene glycol, flowing in a fabricated counter flow concentric tube heat exchanger with fins is experimentally investigated. Experiments are carried out to study the effects of the mass flow rate of the cold fluid as well as hot fluid on the heat transfer coefficient and flow characteristics.

The following conclusions have been obtained:

- The use of Al_2O_3 – water nanofluid significantly gives higher heat transfer coefficients in the range approximately 13% - 16% than those of the pure base fluid. There is an enhancement in the heat transfer process because the suspended ultra-fine particles remarkably increase the thermal conductivity of the nanofluid.

- The convective heat transfer coefficient, overall heat transfer coefficient and effectiveness increases with an increasing Reynolds number and an increasing mass flow rate of the cold fluid and hot fluid.

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