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Performance Analysis of Pipe In Pipe Heat Exchanger using Nano Fluid

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ABSTRACT

Heat Exchanger is a very important device in every modern industry; in the time when resources are limited and there is tough competition in the market heat exchanger marks special importance. In this project the thermal performance analysis of a pipe in pipe heat exchanger is performed by varying the composition of nano fluids used, which is a mixture of Cuo and Glycol. An experimental analysis has been performed on pipe in pipe heat exchanger. The volume fraction of coolant varies. Experimental results like heat transfer rates, overall heat transfer coefficient, and heat exchanger effectiveness have been evaluate to assessing the performance of heat exchanger. The objective of this project is too determined whether the use of Nano fluids improves the heat exchangers performances and at what percentage of Nano-particles-coolant mixture the performance of pipe in pipe heat exchanger obtain maximum heat exchange rate and at what percentage.

Keyword: Pump, Rotameter, Nanofluid, Thermocouple, Tank & control valve.

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I. INTRODUCTION

Last decades, technology has undergone a considerable evolution in all different sectors of industry. In this way, the need to achieve better results through optimizing benefits, minimize losses and, above all, improve methods performance and also new properties, has led to a situation such that almost all research groups have discovered the benefit of nanotechnology on their respective fields of study. Thereby, heat transfer is not an exception, since is a very important issue that has to be taken into account for most present industrial processes such as power generation or chemical, physical and biological processes. On the other hand it is also essential for the field of refrigeration chambers, electronic cooling systems, data centers and power electronics. But heat transfer is not only needed at industrial scale, but also for environmental conditioning of homes, as well as private and public buildings. Thus, this makes it a matter which affects the whole society. However, traditional coolants like water, oils and ethylene glycol, are keeping stagnant because of their limitations regarding to increasing heat transfer capability. These liquids have constant values for their thermo-physical properties, so, the only way to improve their heat transfer features has to be done through the device, that is to say, through augmenting the heat exchange area or the flow rates of coolants.

Nevertheless, this solution implies a higher heat exchange potential, but it doesn't enhance the efficiency of the procedure, that is the relevant question. Therefore, all exposed before brings into existence of a demand to meet the needs showed before. Then, this is where nanotechnology appears as an option to consider, in order to analyzing the possibilities it offers to fix heat exchange transfer demands at industrial scale. In this case, there is a growing thought that considers this demand can be fulfilled through the usage of nanofluids. For this reason, at the moment, there are lots of research groups investigating this path, and some promising results are being observed although the physical background for nanofluids are still under research and development. Nanofluids are homogeneous mixtures of solids and liquids when these solid particles are smaller than 100 nm.

These added solid particles are supposed to improve thermo-physical properties and heat transfer behavior of its base fluid. Moreover, as was said above, traditional coolants are an option to be improved from thermo-physical view point in order to cover the needs of refrigeration in electronic systems; because of that, nanofluids are expected to fill this gap. Nano-Hex project is a project that KTH-Energy Technology is one of its partner and this project focus on important research about nanofluids, as is the world's largest collaborative project for development and research of nanofluid coolants. It is expected to develop and optimize safe processes for the production of high performance nanofluids coolants for use in industrial heat management. It will be done by developing an analytical model that can 20 accurately predict thermal performance (thermo-physical properties and behavior in industrial applications) of such nanofluids refrigerants.

This thesis is about experimental and modeling thermal properties like heat transfer rate and effectiveness, in addition to the evaluation of different flow rate of nanofluids behavior tested in a test section, which simulates a Al pipe. The aim of this thesis was to measure heat transfer rate and effectiveness of nanofluids in a small Al tube in order to evaluate their heat transfer performance based on different criteria.

II. METHODOLOGY AND MATERIAL

METHODOLOGY

A. Project Idea Generation
B. Literature Survey
C. Decide Objective & Project Work
D. Detailed Study of project
E. Selection Of Component
F. Fabrication
G. Assembly
H. Testing
I. Experimental Analysis.

MATERIAL SPECIFICATION

Heat Exchanger type : Pipe in Pipe
Nano Fluid used- Cuo
Upper Pipe Diameter : 76.2 mm (3 inch)
Inner pipe diameter : 25.4mm (1 inch)
Heat Exchanger length : 1 m (1000mm)
Piping – ½ inch UPVC
Temperature Indicator -Digital indicator.
Temperature Sensor type : PT100 (Range)

The following components of the drive will be designed.

- Pump
- Rotameter
- Tank
- Control valve
- Thermocouple.

III. PROBLEM STATEMENT

In a convectional heat exchanger we use the water or other fluids as a working fluid, to determine the performance of the heat exchanger. The performance of system depend upon the working fluid, as the fluid changes, COP change. So determine the performance of the heat exchanger we can use recent technology like Nano-fluids(CuO,Al2O3 etc). And the comparing the performance with convectional heat exchanger.

IV. DESIGN AND FIGURE

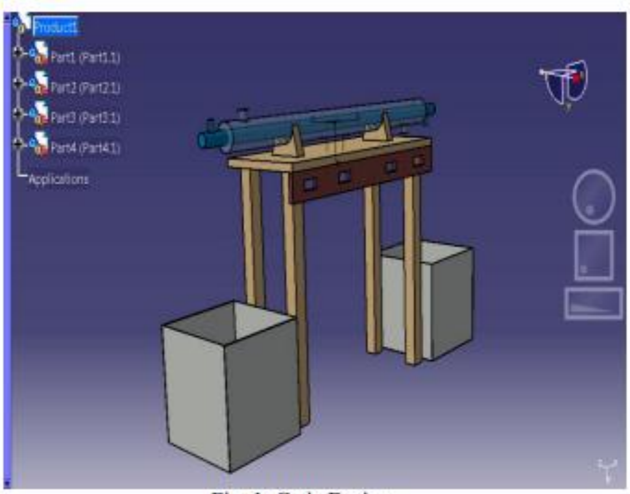

Fig. 1: Catia Design.

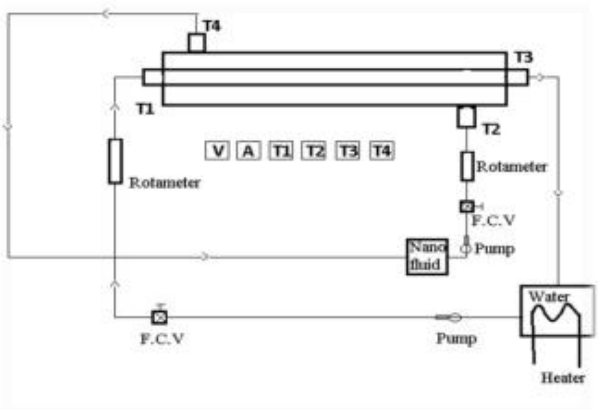

Fig. 2: Simple Working Diagram.

V. WORKING

Apparatus for double pipe heat exchanger The outer pipe is made up of MS material having outer diameter, inner diameter and length of 64 mm, 62 mm and 1 m respectively. The inner pipe is made up of Copper having outer diameter, inner diameter and length of 25 mm, 23 mm and 1050 mm respectively. Two valves are provided on each pipe which can be open and close one by one for counter and parallel flow operation. Two water tanks viz. (1) Cold Water and (2) Hot Water are provided with separate MS and Copper mono-block type centrifugal pump to circulate cold and hot water through pipes respectively. one immersion type heater of 2500 Watt capacity are located in hot water tank to heat the water. one Fitter make Rota meters, each of 0 – 9.0 lpm range are connected to measure the flow rate of cold water from the pipes. k type thermocouples are used to measure the inlet and outlet temperatures of cold and hot water flowing through the pipes. Digital temperature indicator is provided to indicate the temperature.

Experimental Procedure for Double Pipe Heat Exchanger

(1) Fill water in cold and hot water tank.
(2) Switch on the immersion type heater provided in the hot water tank and heat the water to the desired temperature.
(3) Switch "ON" the pump provided in hot water tank with bypass line valve fully open and supply valve fully closed to

ensure thorough mixing of water in the tank to ensure uniform temperature.
(4) Operate valves out of two valves provided on the panel in such a manner that the heat exchanger operates in parallel flow mode.
(5) Start supply of hot water to flow through inner pipe side. Adjust the flow rate to the desired value using the Rota meter.
(6) Start the supply of cold water on the outer pipe side. Adjust the flow rate to the specific value using rotameter.
(7) Observe the inlet and outlet temperature of both cold and hot water streams and record them after they achieve steady state condition.
(8) Record the flow rates of hot water and cold water with the help of rotameters.
(9) Repeat the procedure from 6 to 9 for different flow rates of cold and hot water.
(10) Alter the opening of valves out of two valves provided on the panel in such a manner that now, the heat exchanger operates in parallel flow mode.
(11) Repeat the procedure step number 6 to 10 for counter flow arrangement of double pipe heat exchanger.
(12) Drain the water through both the tanks after completion of experiments.

VI. SCOPE OF THE PROJECT

The scope of this work includes the following: A study of the effects of nanofluids volume fraction on the friction factor and Nusselt number by experimental work in the laminar condition at Reynolds number range from 250 to 2000. The experimental work includes test rig setup and connecting all devices for taking readings of temperature and pressure drop. Additionally, the nanofluids preparation processes and measurement of thermo-physical properties are conducted. Computational Fluid Dynamics (CFD) simulation studies of Newtonian fluid flow in a flattened tube provide an understanding of the fundamental flow behavior. Furthermore, the friction factor and heat transfer enhancement in the automotive cooling system are evaluated using finite volume technical. The CFD analysis of friction factor and Nusselt number will be validated with the experimental data. The heat transfer enhancement and performance efficiency are evaluated to determine the optimum nanofluid type as a coolant in the automotive cooling system.

SPECIFIC APPLICATIONS
Refrigeration system
Radiator.

RESULT TABLE :
TABLE NO.1

$\dot{m}$ (lpm)	Q_w (W)	Q_a (W)	Q_{avg} (W)	ε
10	5376.108	4620.24	4998.174	0.8594

Only for one reading.

VII. CONCLUSION

An experimental study of a double-pipe heat exchanger was performed using nanofluid. heat transfer rates were much higher in the counter flow configuration due to the larger average temperature difference between the two fluids. Also we conclude that nanofluids have greater performance than the conventional fluids. We achieved different temperature ranges and analyze the thermal conductivity as well as performance of nanofluid.

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