Performance Studies on Heat Exchanger with Nano-Fluids

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Abstract— Shell and tube Heat exchanger using Nano fluid is a device in which the heat transfer takes place by using Nano fluid. In this the working fluid is Nano fluid. Nano fluid is made by the suspending Nano particles in the fluid like water, ethylene glycol and oil, hydrocarbons, fluorocarbons etc. Heat transfer is the exchange of thermal energy between physical systems. The rate of heat transfer is dependent on the temperatures of the systems and the properties of the intervening medium through which the heat is transferred. The three fundamental modes of heat transfer are conduction, convection and radiation. Heat transfer, the flow of energy in the form of heat, is a process by which a system changes its internal energy, hence is vital use in applications of the First Law of Thermodynamics. The direction of heat transfer is from a region of high temperature to another region of lower temperature, and is governed by the Second Law of Thermodynamics. Heat transfer changes the internal energy of the systems from which and to which the energy is transferred.

Keywords: Heat Exchanger, Nano-Fluids

Nomenclature

CR	: Compression Ratio
IP	: Injection Pressure
Bth	: Brake Thermal Efficiency
BP	: Brake Power
TDC	: Top Dead Centre
BTDC	: Before Top Dead Centre
UBHC	: Unburned Hydrocarbon
NO_X	: Oxides of Nitrogen
CO	: Carbon Monoxide
CI	: Compression Ignition
PME	: Poly Methyl Ester
CFD	: Computational Fluid Dynamics
SF C	: Specific Fuel Consumption
CV	: Calorific Value

I. Introduction

A Shell and tube heat exchanger is a device that allows heat from a fluid (a liquid or a gas) to pass to a second fluid (another liquid or gas) without the two fluids having to mix together or come into direct contact. The most common design has one fluid flowing through metal tubes and the other fluid flowing around the tubes. On either side of the tube, heat is transferred by Convection. Heat is transferred through the tube wall by conduction, woking of heat exchanger as shown in figure 1.1.

Nano fluids are a new class of fluids engineered by dispersing Nanometer-sized materials (Nanoparticles, Nano fibers, Nanotubes, Nanowires, Nano rods, Nano sheet, or droplets) in base fluids. In other words, Nano fluids are Nano scale colloidal Suspensions containing condensed Nano material. They are two-phase systems with one phase (solid phase) in another (liquid Phase). Nano fluids have been found to possess enhanced thermo physical properties such as thermal conductivity, thermal diffusivity, viscosity, and convective heat transfer coefficients compared to those of base fluids like oil or water.

It has demonstrated great potential applications in many fields. For a two-phase system, there are some important issues we have to face. One of the most important issues is the stability of Nano fluids, and it remains a big challenge to achieve desired stability of Nano fluids

Figure: 1.1 Working of Heat Exchanger

A. *Classification of Heat Exchangers*

Classification of Heat Exchangers by Flow Configuration
There are four basic flow configurations:

- Counter Flow
- Parallel flow
- Cross flow
- Hybrids such as Cross Counter flow and Multi Pass Flow

1) *Counter Flow*

As shown in Figure1.2 illustrates an idealized counter flow exchanger in which the two fluids flow parallel to each other but in opposite directions. This type of flow arrangement allows the largest change in temperature of both fluids and is therefore most efficient (where efficiency is the amount of actual heat transferred compared with the theoretical maximum amount of heat that can be transferred).

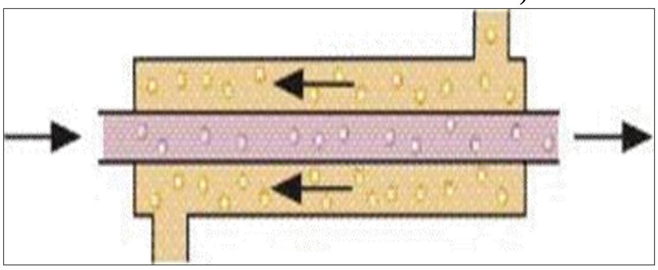

Fig. 1.2: Counter flow

2) *Parallel Flow*

In parallel flow heat exchangers, the streams flow parallel to each other and in the same direction as shown in Figure 1.3, this is less efficient than countercurrent flow but does provide more uniform wall temperatures.

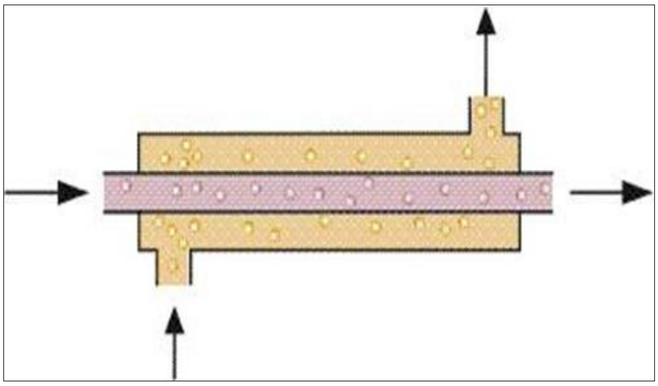

Fig.1.3: Parallel flow

3) Cross flow

Cross flow heat exchangers are intermediate in efficiency between counter flow and parallel flow exchangers. In these units, the streams flow at right angles to each other as shown in Figure 1.4.

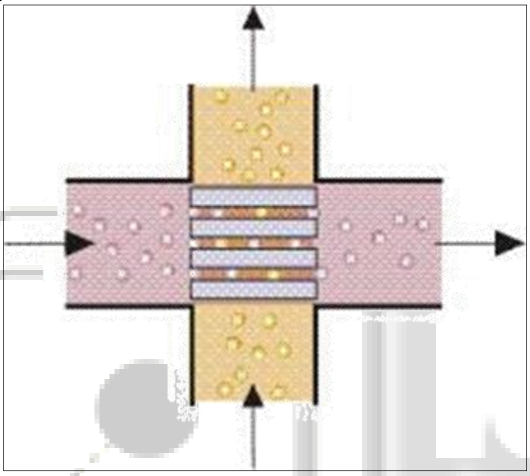

Fig. 1.4: Cross flow

4) Cross/counter flow

In industrial heat exchangers, hybrids of the above flow types are often found. Examples of these are combined cross flow/counter flow heat exchangers and multi pass flow heat exchangers. As shown in figure 1.5.

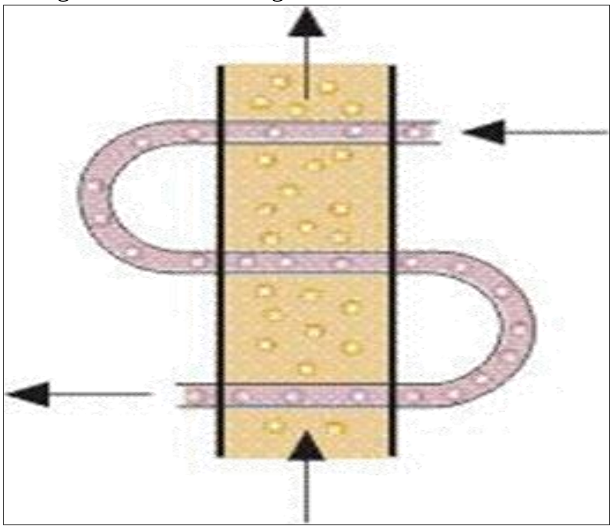

Fig. 1.5: Cross/counter flow

II. EXPERIMENTAL SET UP

The experiments were conducted on a computerized CI engine test rig shown in Fig.1.

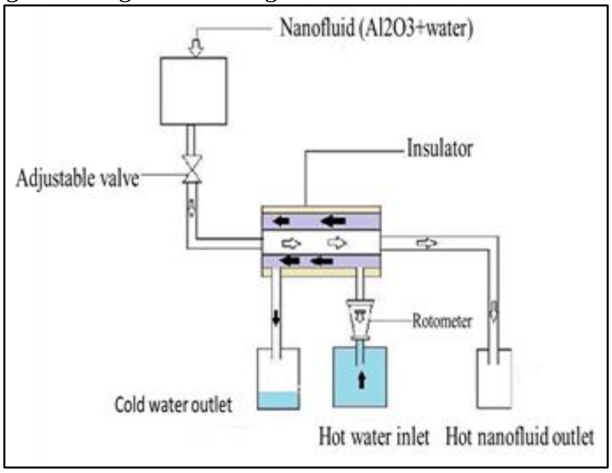

Fig. 1.6: Experimental set up

We selected the materials and required equipment. The calculations of parallel and counter flow heat exchanger are carried out for comparison.. The Assemble Copper tube and Cotton Thread Insulation is done

Fig. 1.7: Shell and tube Heat exchanger

SL NO	SPECIFICTION
01	Inner Pipe diameter - 12mm
02	Outer Pipe diameter - 18mm
03	Inlet temperature – 28’c
04	Hot water temperature – 70 - 80’c
05	Length of the device – 609mm
06	Flow rate – 0.5LPM to 2LPM.
07	Outer shell diameter – 130mm

Table.1.Shell and Tube Heat Exchanger Specification

III. EXPERIMENTAL PROCEDURE

A set of experiments were conducted for Doubled pipe Parallel and counter flow heat exchanger for both Water and Nanofluid, and experiments were conducted for Doubled pipe shell and tube heat exchanger for both Water and Nanofluid. Compare the effectiveness for both the fluids at different temperatures.

IV. RESULTS AND DISCUSSION

The results of the Heat Exchangers presented in Figs. 4-11. All comparisons have been made at different temperature of hot fluid and different flow rates.

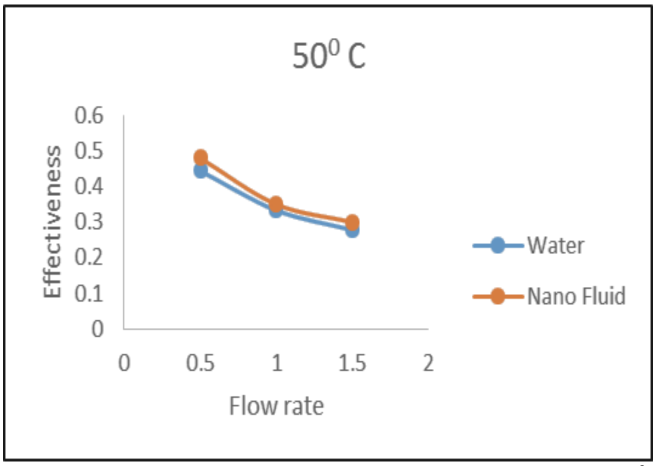

Fig. 1.8: Parallel and Shell and Tube Heat Exchanger at 50^0 C

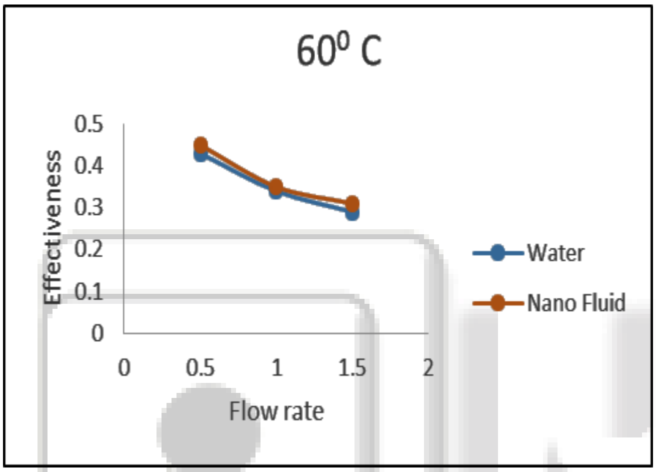

Fig. 1.9: Parallel and Shell and Tube Heat Exchanger at 60^0 C

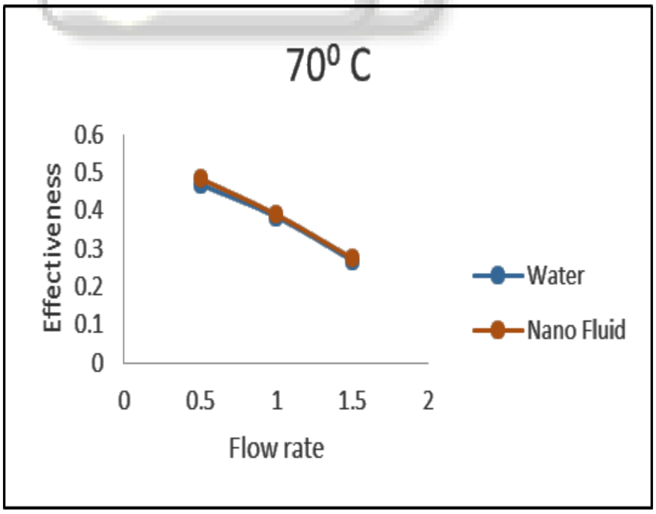

Fig. 1.10: Parallel and Shell and Tube Heat Exchanger at 70^0 C

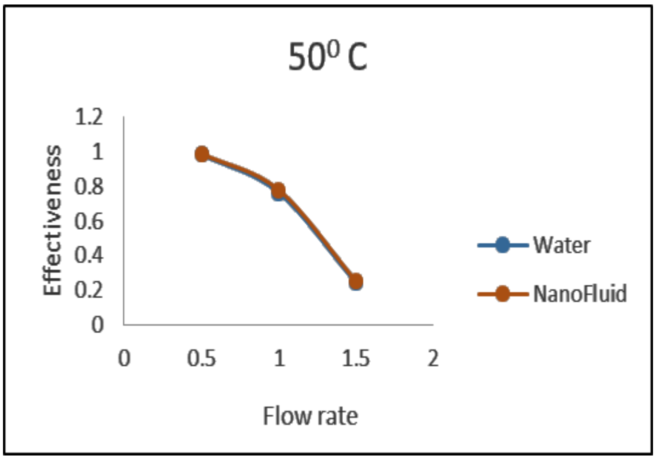

Fig. 1.11: Counter and Shell and Tube Heat Exchanger at 50^0 C

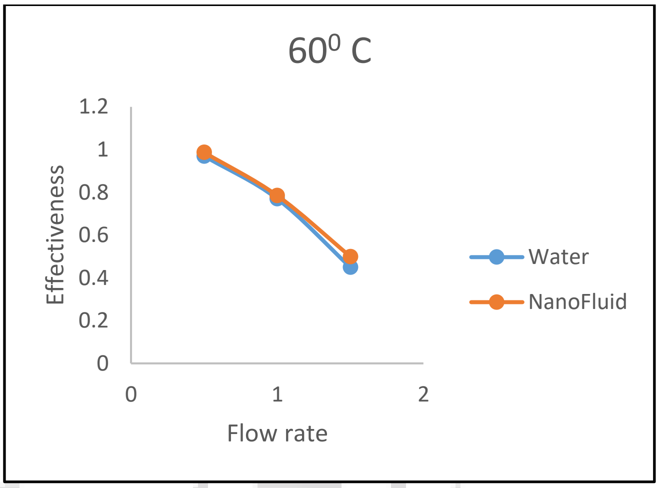

Fig. 1.12: Counter and Shell and Tube Heat Exchanger at 60^0 C

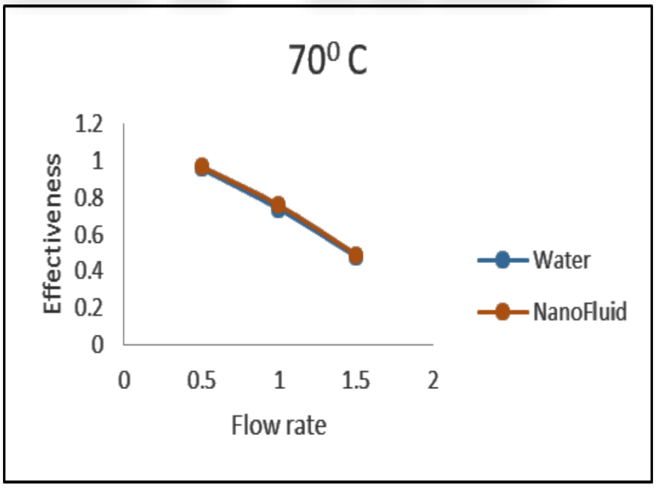

Fig. 1.13: Counter and Shell and Tube Heat Exchanger at 60^0 C

V. CONCLUSIONS

Heat exchangers are widely used in industries both for cooling and heating large scale industrial processes. The type and size of heat exchangers used can be tailored to suit a process depending on the type of fluid, its phase, temperature, density, viscosity, pressures, chemical composition and various other thermodynamic properties.

Experiments were conducted on various types of heat exchangers to compare their efficiencies, effectiveness and over all heat transfer coefficients

- A comparison of the results obtained on the Parallel flow heat exchanger and shell and tube Heat exchanger for different flow rates and temperature of both the fluids are shown in figures from 1.8 to 1.10, it is observed that in all graphs the nanofluid effectiveness is high compared to water. This is due to more amount of heat exchange takes place in nanofluids compare to water.
- In figure 1.8 and 1.9 the effectiveness of nanofluid is too high compared to water.
- A comparison of the results obtained on the counter flow heat exchanger and shell and tube Heat exchanger for different flow rates and temperature of both the fluids are shown in figures from 1.11 to 1.14, it is observed that in all graphs the nanofluid effectiveness is high compared to water. This is due to more amount of heat exchange takes place in nanofluids compare to water.

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