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HEAT TRANSFER IMPROVEMENT ON THE SHELL AND TUBE HEAT EXCHANGER USING NANO FLUIDS

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ABSTRACT

The main objective of this paper is the heat transfer improvement in the shell and tube heat exchangers using the nano fluids, Nano fluids are the fluids which is ceramic nano particles mixed with base fluids with this effects nanofluids got more thermal conductivity compare to base fluids and it is also vary with different nano particles, in this current research CuO, Al_2O_3nano particles are used for this research with the volume faction of 0.05% and the fluids heat transfer properties are validated through experimental methodology

Keywords: Nanoparticles, Al_2O_3 Nanofluids, Al_2O_3 Nanofluids, Heat Exchanger.

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INTRODUCTION

New technologies are needed to fulfil the demand for high heat flow processes to enhance heat transfer requirements. Furthermore, there is growing interest in improving the efficiency of existing heat transfer processes. Many active and passive techniques are used to enhance heat transfer in heat exchangers. Conventional heat transfer fluids such as water, air, lubricating oil, and ethylene glycol have very poor thermal conductivities compared with metal and metal oxides. Specific properties of conventional fluids can be improved by adding additives in liquid coolants to overcome this limitation. The heat transfer coefficient (heat transfer enhancement) can be enhanced by adding high thermal conductivity solid particles to the liquid coolant. To improve the heat transfer characteristics of conventional fluids, thermal conductivity improvement is the key idea. Conventional fluid's thermal conductivity enhancement by the suspension of solid particles, such as millimetre or Micrometer-sized particles, has been well-known for more than 100 years. But, larger particles cause many difficult problems such as agglomeration, clogging, erosion etc.

In the flow path of devices. Modern material synthesis technologies and processes overlay the way for synthesizing of different nanostructured materials, which possess quite other thermal, mechanical, electrical and optical properties from the analogous bulk materials. As the confluence of conventional modern nanotechnology and thermal science, Nanofluids have been identified as progressive heat transfer fluids to achieve enhanced thermal transport characteristics. Choi et al. from Argonne national laboratory of United States America first developed the concept of Nanofluids in 1995 and discovered its enhanced thermal features. The present research work is about the heat transfer enhancement on the shell and tube heat exchanger with Nano fluids CuO, Al2O3 and MWCNT the nano fluids performance can be identified through experimental methods

LITERATURE REVIEW

Mohammad Sikindar Baba et al. [4] This paper reports an experimental study of forced convective heat transfer in a double tube counter flow heat exchanger with multiple internal longitudinal fins using Fe3O4 /water nanofluid. Results indicates that the heat transfer rate is 80-90% more in finned tube heat exchanger compared to the plain tube heat exchanger for the higher volumetric concentration of nanofluid. The heat transfer rate in the finned tube heat exchanger is 90-98% higher than the heat transfer rate in plain tube heat exchanger for 0.4% Fe3O4-water nanofluid. The friction factor in finned tube is 3.75 times the plain tube friction factor for 0.4% Fe3O4-water nanofluid flowing at the rate of 2 LPM. D Han et al. [5] This study aims at experimentally investigating the effect of Al2O3 /water nanofluids on the heat transfer enhancement inside the double tube heat exchanger at variable inlet temperature. Al2O3 nanoparticle with concentration of 0.25% and 0.5% by volume concentration has been used at different inlet temperature. Results from the study shows that the heat transfer increases with the increase in temperature and volume concentration of nano-particles. Significant improvement over the water is seen with maximum Nusselt number increase up to 24.5% at 50°C inlet temperature. Maximum increase in convective heat transfer coefficient has been calculated of about 9.7% and 19.6% for 0.25% and 0.5% of volume concentration respectively. Maximum increase in convective heat transfer coefficient has been calculated of about 9.7% and 19.6% for 0.25% and 0.5% of volume concentration respectively Schematic diagram of experimental appratus used. K. Palanisamy et al. [6] This study investigates the heat transfer and the pressure drop of cone helically coiled tube heat exchanger using (Multi wall carbon nano tube) MWCNT/water nanofluids. The experiments results shown that 28%, 52% and 68% higher Nusselt number than water for the nanofluids volume concentration of 0.1%, 0.3% and 0.5% respectively. It is found that the pressure drop of 0.1%,0.3% and 0.5% nanofluids are found to be 16%, 30% and 42% respectively higher than water. The improved heat transfer coefficient is found to be 14%, 30% and 41% more than the water at 0.1%, 0.3% and 0.5% MWCNT/water nanofluid respectively.

MATERIALS AND METHODS

CuO,

Copper (II) oxide or cupric oxide is an inorganic compound with the formula CuO. A black solid, it is one of the two stable oxides of copper, the other being Cu_2O or copper(I) oxide. As a mineral, it is known as tenorite

Al_2O_3

Aluminium oxide is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3. It is the most commonly occurring of several aluminium oxides, and specifically identified as aluminium oxide.

Table 1: Material Properties

Material Properties	Water	Al_2O_3	CuO
Density(kg/m^3)	998	3890	6320
Specific Heat (j/kg.K)	4182	880	531
Thermal conductivity(w/m-k)	0.6	35	32.9
Viscosity(kg/m-s)	0.001003	-	-

Thermo Physical Properties of the Nano Fluids

The single-phase approach is chosen to calculate the thermo physical properties of Nano fluids as it is widely used in the literature. In this model the homogenous mixture is assumed prior to solving the governing equations of continuity, momentum, and energy for the single-phase fluid flow that the presence of nanoparticles is realized by modifying physical properties of the mixture fluid. It is assumed that there is no velocity difference between fluids and the particles, and the fluids and the particles are in thermal equilibrium.

Table 2: Nano Fluid Properties

Material Properties	Density (kg/m^3)	Specific Heat (j/kg.K)	Thermal conductivity (w/m-K)	Viscosity (kg/m-s)
Al_2O_3	1287.2	3184.115	1.1238	0.001254
CuO	1530.2	2432.83	1.1238	0.001254

Shell and Tube Heat Exchanger

A shell-and-tube heat exchanger is a class of heat exchanger designs. It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. The set of tubes is called a tube bundle, and may be composed of several types of tubes: plain, longitudinally finned, etc.

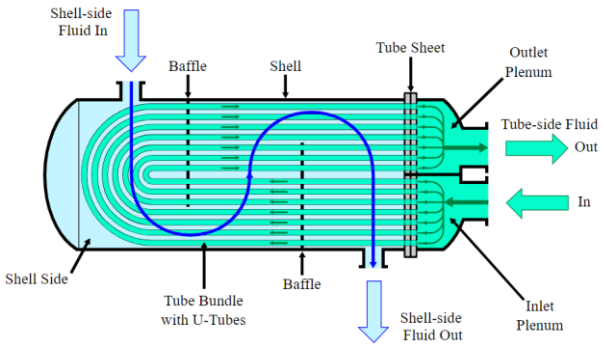

Figure: 1

EXPERIMENTAL METHODS

Results and Discussion

The heat transfer of a Nano fluid is expected to depend, apart from the flow configuration, on a number of material factors, such as thermal conductivity and heat capacitance of pure fluid and particles, volume fraction, viscosity, etc.

	Hot Water Outlet Temperature (^{0}C)
Plain Water	65
Al2O3 Nano Fluids	61
CuO Nano Fluids	56

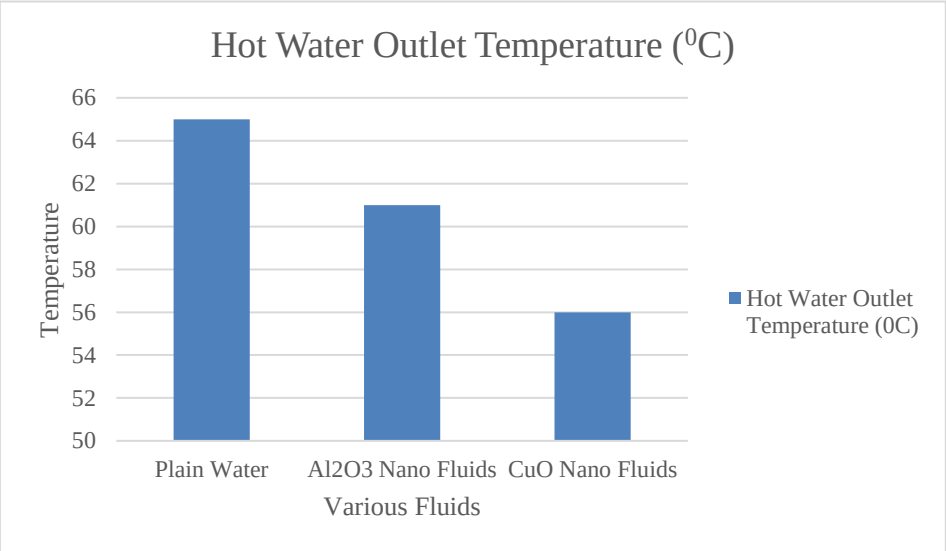

Figure: 2

	Cold Water Outlet Temperature (^{0}C)
Plain Water	33
Al2O3 Nano Fluids	40
CuO Nano Fluids	45

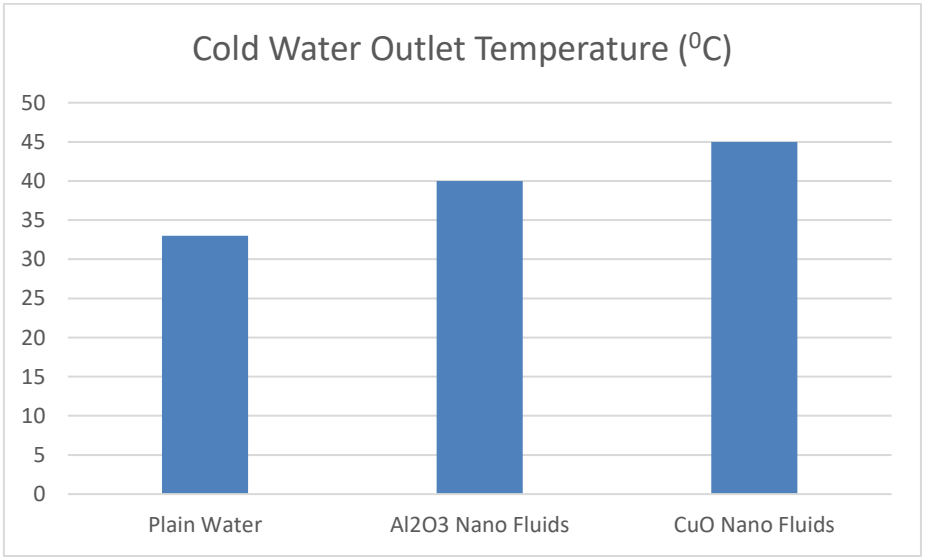

Figure: 3 Comparison of Friction Factor and Reynolds's Number

CONCLUSION

The heat transfer enhancement of the shell and tube heat exchanger system is improved by the Nano fluids, for this research CuO, Al2O3, MWCNT based nano fluids are used for this experiment with the volume fraction of 0.05% of the base fluid as a water, while comparing the results of outlet temperature of the hot water side and the cold water sides CuO Nano fluids gives the better results in the heat transfer functions, in cold water side maximum heat is absorbed and the maximum level of temperature is reduced.

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