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Heat Transfer analysis using CuO/Water Nanofluid at different concentrations using Double Pipe Heat Exchanger

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ABSTRACT

Experiments of heat transfer using CuO as nanofluids were carried out and results are reported in this paper. The heat transfer effectiveness of the CuO/water was measured with the help of pipe in pipe heat exchanger. The nanofluid was prepared by dispersing a CuO nano particle in deionized water. CuO/water nanofluid with a nominal diameter of 35nm at different volume concentrations (1% & 2% vol. conc.) at room temperature were used for this investigations. This experimental result showed that the convective heat transfer increases with an increase in nanoparticle concentration and also the dependency on fluid flow rate is shown.

Keywords : Heat transfer coefficient, nanofluid, effectiveness

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I. INTRODUCTION

Cooling is very important for having better performance and safety. Vast range of products such as computer, car, high power laser system. Increase in the heat load and heat fluxes due to higher power requirements and smaller sizes for the coolers in the product is one of the technical challenge faced by almost all the industries like microelectronics, power plants, transportation, manufacturing, etc. There are many cooling technologies such as single-phase liquid cooling and two-phase liquid cooling technology, direct immersion cooling and spray cooling. Development of the nano materials has led to the birth and advancements of conventional technologies. It has made it possible to structure a new type of heat transfer fluid formed by suspending nanoparticles (dia. < 70 nm)[1] in conventional base fluid such as water, ethylene glycol etc. Nanofluids have properties better than those of their base fluids. The rapid fluid mixing effects strengthens the energy mixing inside the nano fluids by modifying the temperature profiles. Experimental data indicates that particle size, volume fraction and properties of the nanoparticles influence the heat transfer characteristics of nano fluids[1].

This paper shows the research work on heat exchanger using CuO- Water Based nano fluid.

II. PREPARATION OF NANOFLUID

In the present study CuO nanoparticle was purchased from Gandhi chemicals Limited, Pune, India. The deionized water was used as a base fluid for this study. The nanofluids of different volume concentrations were prepared by dispersing different quantity of CuO nanoparticles in deionized water. The solution was agitated using high frequency motor [2] for 1hour to disperse the nanoparticle uniformly. Following this, the nanofluid was mixed thoroughly after fixed time intervals of half an hour to obtain uniform dispersion of nanoparticles in the deionized water. The physical properties of nanoparticle and base fluid used are shown.

Table 1: Properties of CuO nanoparticle and water

Thermal, Physical properties	Water	CuO
Density(kg/m^3)	1000	6310
Specific heat(J/kg K)	4187	550.5
Viscosity(N-s/m^2)	0.0019	-
Thermal conductivity(W/m K)	0.628	32.9

III. EXPERIMENTAL SETUP

The setup used in this experiment as shown in Fig.1. This experimental setup consists of two tanks (A and B) with a capacity of 10ltrs which were used to store the water. 2000W heater is fitted in the tank 'A' to heat the water. Two 12/18W centrifugal pumps were used to circulate the water through the double pipe heat exchanger. One pump is used to circulate the cold water in the outer tube and the other pump is used to circulate the hot water in the inner tube. The outer pipe of the test section is made of Mild Steel (MS), 76 mm diameter and length of 100cm. The inner pipe is made of Copper of 25.4mm inner diameter with the heat exchanger length of 113cm. For reduction of the heat loss to the surroundings the heat exchanger [4] is perfectly insulated by using black cotton cloth and ropes. Four B-type digital thermometers were used to measure the temperatures of the hot and the cold fluids at the inlet and outlet side of the tube.

A rotameter and flow control valve is fitted between the heat exchanger and cold fluid tank to vary the flow rates for different observations.

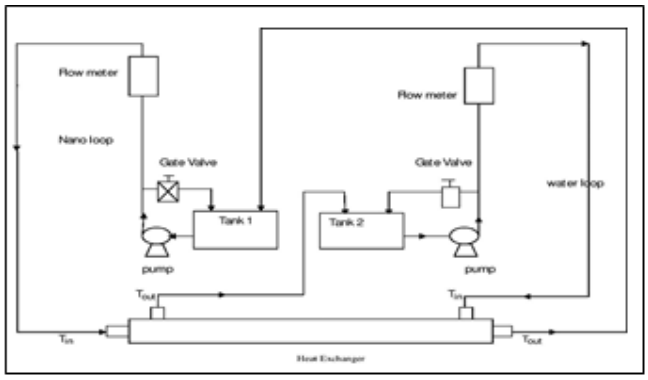

Fig 1: System diagram[6]

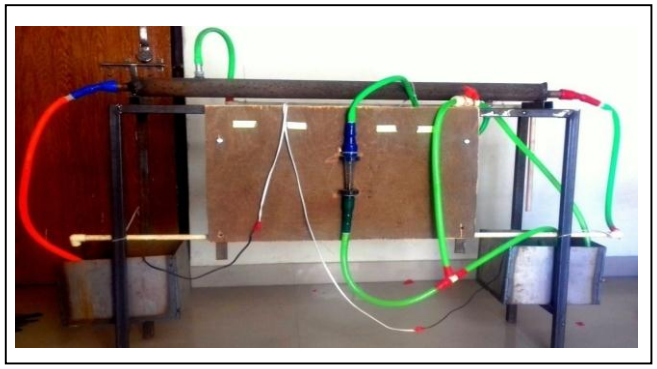

Fig 2:Experimental setup

IV. OBSERVASTION TABLE

A) Water:

Sr. No.	ṁ (lpm)	Thi (°C)	Tho (°C)	ΔTh (°C)	Tci (°C)	Tco (°C)	ΔTc (°C)
1.	5.5	70	47.9	22.1	32.4	44.4	12
2.	3.5	70	48.4	21.6	32.4	43.2	10.8

B) 1% CuO:

Sr. No.	ṁ (lpm)	Thi (°C)	Tho (°C)	ΔTh (°C)	Tci (°C)	Tco (°C)	ΔTc (°C)
1.	5.5	70	46.9	23.1	32.4	45.1	12.7
2.	3.5	70	47.3	22.7	32.4	44.6	12.2

C) 2% CuO:

Sr. No.	ṁ (lpm)	Thi (°C)	Tho (°C)	ΔTh (°C)	Tci (°C)	Tco (°C)	ΔTc (°C)
1.	5.5	70	45.8	24.2	32.4	45.7	13.3
2.	3.5	70	46.2	23.8	32.4	45.2	12.8

V. RESULT TABLE

A)Water:

Sr. No.	ṁ (kg/sec)	Qwh (W)	Qwc (W)	Qavg (W)	ε
1.	5.5	8651.80	4697.81	6674.80	0.5877
2.	3.5	5381.13	2690.56	4035.84	0.5744

B) 1% CuO:

Sr. No.	ṁ (kg/sec)	Qwh (W)	Qwc (W)	Qavg (W)	ε
1.	5.5	9043.29	4894.44	6968.86	0.6240
2.	3.5	5655.17	2992.02	4323.59	0.6132

C) 2% CuO:

Sr. No.	ṁ (kg/sec)	Qwh (W)	Qwc (W)	Qavg (W)	ε
1.	5.5	9473.92	5125.67	7299.79	0.6537
2.	3.5	5929.21	3139.17	4534.19	0.6429

1. With 1% CuO, effectiveness is increased by 6.17 % as compared to water without nanofluid.
2. With 2% CuO, effectiveness is increased by 11.23 % as compared to water without nanofluid.

3. With 2% CuO, effectiveness is increased by 4.75 % as compared to water with 1% CuO.

VI. CONCLUSION

1. The convective heat transfer and effectiveness of CuO/water nanofluid flowing in a double pipe counter flow heat exchanger was investigated. The nanofluid was prepared by dispersing CuO (27nm) particles in water.
2. This experimental result showed that the effectiveness of nanofluids were remarkably increased compared to base fluid (water).
3. The enhancement of heat transfer is directly proportional to the particle volume concentration.

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