Experimental Investigation for Enhancement of Heat Transfer in Automobile Radiator by Using Hybrid Nanofluid

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Abstract: From the several decades, research on hybrid nano fluids has been increased quickly and reports reveal that hybrid nano fluids are beneficial for heat transfer. The heat transfer enhancement of nanofluids is fundamentally subject on thermal conductivity of nanoparticles, particle volume concentrations and mass flow rates. Under consistent particle volume concentrations and flow rates, the heat transfer enhancement only depends on the thermal conductivity of the nanoparticles. The thermal conductivity of nanoparticles may be adjusted or changed by preparing hybrid (composite) nanoparticles. Hybrid nanoparticles are defined as nanoparticles composed by two or more different types of nano particles. They are nanometres sized particles. The fluids prepared with hybrid nanoparticles are known as hybrid nanofluids. The motivation for the preparation of hybrid nanofluids is to obtain further heat transfer enhancement with enlarged thermal conductivity of these nanofluids. One of the methods is the combination of two or more nanoparticles and it is known as hybrid/composite nanofluids which can give better performance of heat transfer. Thus, the present study focused on different nanofluid MgO, CuO, MgO+ CuO (50%+50%) water and EG base fluid. The MgO-CuO hybrid nanofluids are prepared using two-step method for different concentration. Experimental setup will be prepared to measure heat transfer rate with different types of Nanofluid. Experiment will be carried out with two Nano fluids MgO, CuO and their mixture.

***Index Terms* – Hybrid Nanofluid, Nano Particles, Volume Concentration, Stability, Heat Transfer,**

I. INTRODUCTION

A Nano fluid is a fluid containing nanometre estimated particles, called Nano particles. Nano fluids are fluids which involve a base liquid with Nano-sized particles (1– 100 nm) suspended in it. These particles, for the most part metal or metal oxide, it increment conduction and convection, considering more heat transfer.The heat transfer fluids for example water, engine oil, ethylene glycol, propylene glycol are mostly used in automobile radiator. The heat transfer performance of the above fluid is very poor due to the low values of their thermal conductivity.

In latest decades, the researchers have been work on the improvement of convective heat transfer enhancement upgrade methods. We know that, solid materials have higher thermal conductivity with compare to base fluid. The regular fluids have generally low thermal conductivity compared with solid nano-particles. The mixing of micron sized particles as an additive in a base fluid enhanced the heat transfer. Some disadvantages of the micron-sized particles are large sized particles, they created some problems such as clogging, settle down quickly, erosion of the heat transfer machine and pressure drop increases quickly [3].

Be that as it may, the simple scattering of solid particles in base fluids leads to their sedimentation and resulting stopping up of the flow passages; additionally, the particles cause disintegration on the flow passage walls, while expanding the pressure drop over the establishments. Later on, Masuda et al. [1] dispersed micro meter size solid nano particles in base fluids and observed thermal conductivity enhancement, but also problem in particle sedimentation in the base fluid, which reduces the enhancement in thermal conductivity.

In 1995, Choi [2] prepared nanofluids (fluids containing nanometres size solid particles) and observed marked enhancement of thermal conductivity. The scattering of nanometres size particles in base fluids presents higher particular surface area than regular colloidal suspensions and is steadier than regular slurries. To observe the heat transfer performance, the experimental study is conducted at the different working temperature for different volume concentration.

II. EXPERIMENTAL SET UP

The schematic view of the test facility will be developed to study the heat transfer performance of the nanofluid in an automobile radiator is shown in Fig.1. The test facility consists of the test section, ac-power supply, coolant supply system, cooling, and instrumentation scheme for measuring the temperature. An automobile radiator which is a cross flow heat exchanger is selected as a test section for the present investigation. The closed storage tank is used to store coolant. A centrifugal pump is used to supply coolant from the storage tank to the inlet of the test section.

The outlet supply from the test section is sent back to the storage tank and used to recirculate through the test section. The flow rate of the nanofluid is controlled by using bypass valve arrangement and the remaining fluid is sent back to the storage tank. A calibrated flow meter was used to measure the liquid flow rate. An electrical power supply (220 V, 15 A, ac) is provided to the heating elements in order to heat the coolant in the storage tank.

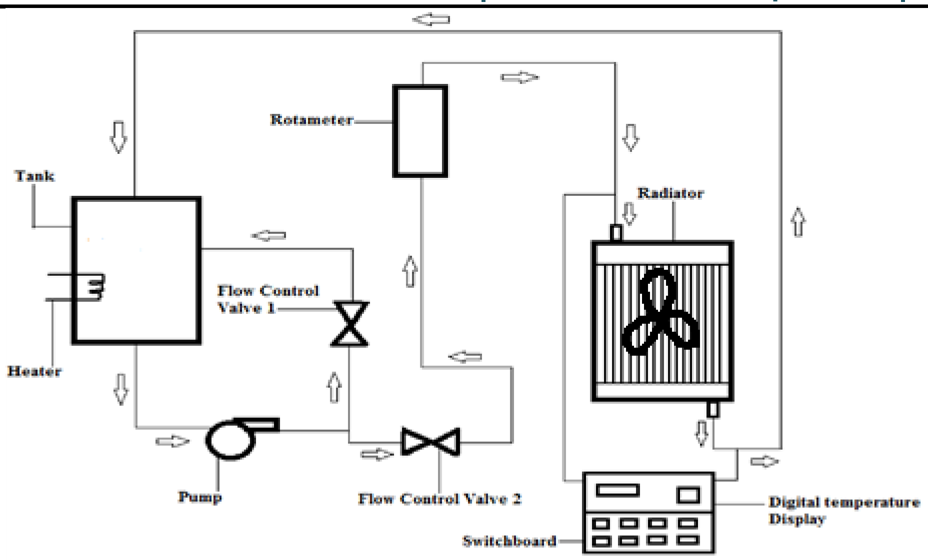

Figure 1 Schematic view of the test facility developed to study the heat transfer performance of the nanofluid in an automobile radiator

A. Experimental Parameters range

Inlet temperature : 70°-90°
Mass flow rate : 4 lpm- 10 lpm
Different nanofluid : MgO, CuO, MgO+ CuO (50%+50%)
Volume concentration: CuO (0.1%, 0.4%, 0.6%),MgO (0.1%, 0.4%,0.6%)
Air side mass flow rate kept constant throughout experiment (v = 10 km/hr)
Range of Reynold Number used (Water) Re 6000 -10000
Range of Prandtl Number (Water) Pr 1.99 – 2.25
For Air Re =796 constant, Pr = 0.69 Constant

B. Physical properties of Nanofluid.

Table 1 Physical properties of Nanofluid.

Properties	Copper oxide	Magnesium oxide
Chemical formula	CuO	MgO
Color	Black	White
Morphology	Spherical	Polyhydrel
Average particle size (nm)	30-50	30-50
True Density (Kg/m^3)	6400	3580
Specific Heat (J/kg K)	351.02	955
Thermal Conductivity (W/mK)	20	48

C. Equation for Calculation of hybrid Nanofluid

$$(\rho_{CuO+MgO})_p = \frac{\rho_{CuO}\, w_{CuO} + \rho_{MgO}\, w_{MgO}}{w_{CuO} + w_{MgO}}$$

$$Volume\ Concentration\ \phi = \frac{\frac{(W_{CuO+MgO})_p}{(\rho_{CuO+MgO})_p}}{\frac{(W_{CuO+MgO})_p}{(\rho_{CuO+MgO})_p} + \frac{W_{water}}{\rho_{water}}}$$

$$\rho_{hnf} = (1-\phi)\,\rho_{bf} + \rho_p\,\phi$$

$$(Cp_{CuO+MgO})_p = \frac{Cp_{CuO}\, w_{CuO} + Cp_{MgO}\, w_{MgO}}{w_{CuO} + w_{MgO}}$$

$$Cp_{hnf} = (1 - \phi)\, Cp_{bf} + Cp_p\, \phi$$

III. RESULTS AND CONCLUSION

Experiment has been carried out for MgO, CuO, MgO+CuO nanofluid with three different vol. concentrations 0.1%, 0.4%, 0.6% and results are compared. Figures show comparison of heat transfer rate at different volume concentration of nanofluids with mass flow rate. its shows that heat transfer with nanofluid found increased with increasing mass flow rate from 4 lpm to 10 lpm. Also increase in volume concentration from 0.1% to 0.6% increase the heat transfer rate. Also there is a different inlet temperature are used in the experiment.

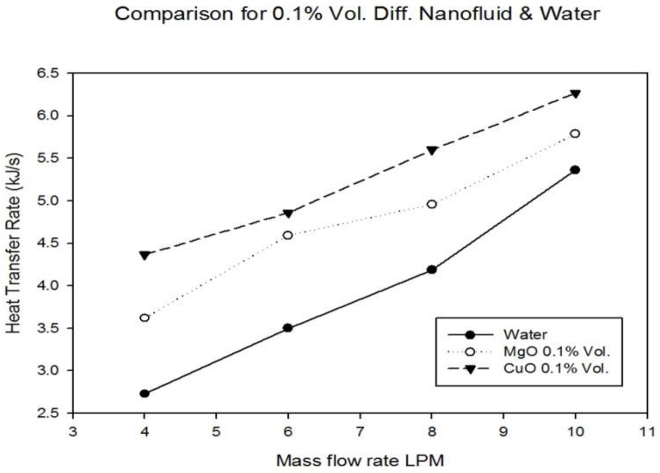

Figure 2 .Comparison between Water, CuO and MgO Nanofluid at 0.1% Vol. Concentration for Heat transfer

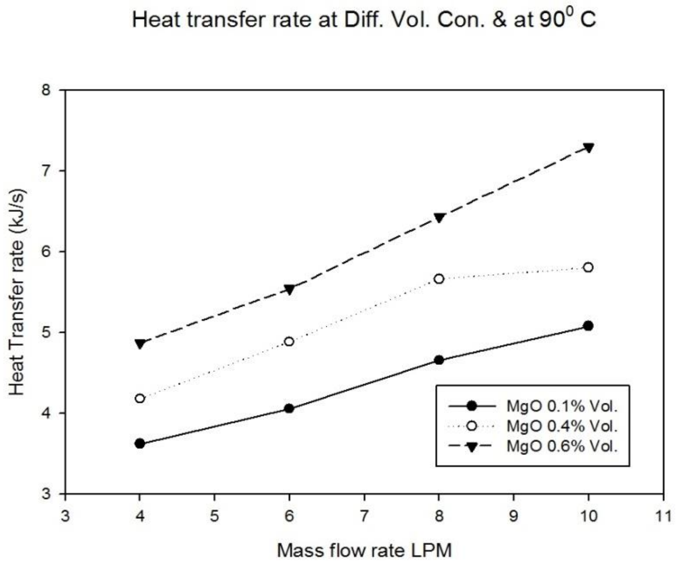

Figure 3 .Effect of MgO-water Nanofluid for Different Vol. Concentration

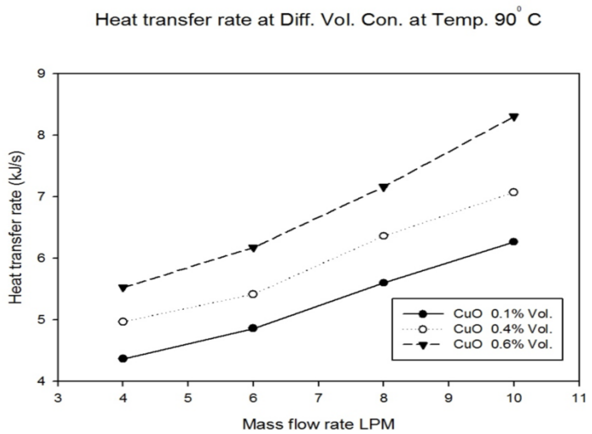

Figure 4. Effect of CuO-water Nanofluid for Different Vol. Concentration

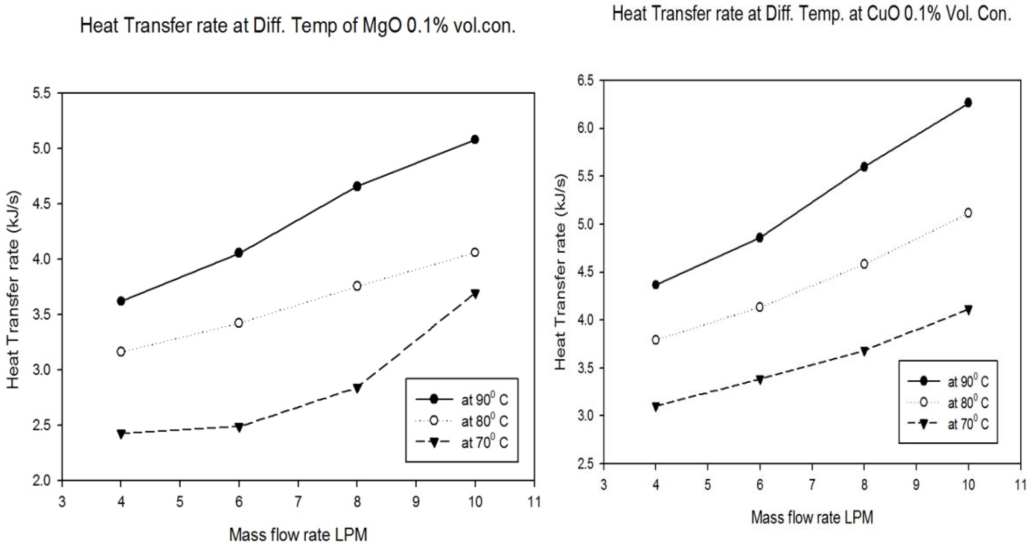

Figure 5 .Effect of Different Inlet Temperature CuO- water and MgO- water Nanofluids at 0.1% Vol. Concentration

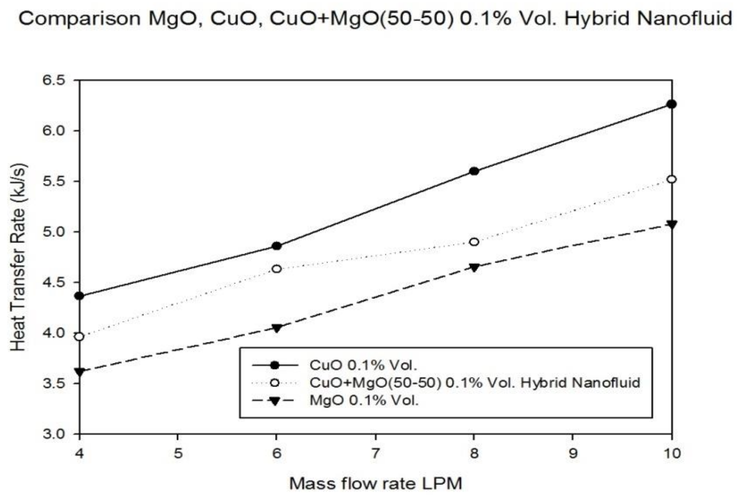

Figure 6 . Comparison between CuO-Water, MgO-Water and CuO-MgO (50-50) Hybrid Nanofluids at 0.1% Vol. Concentration for Heat transfer

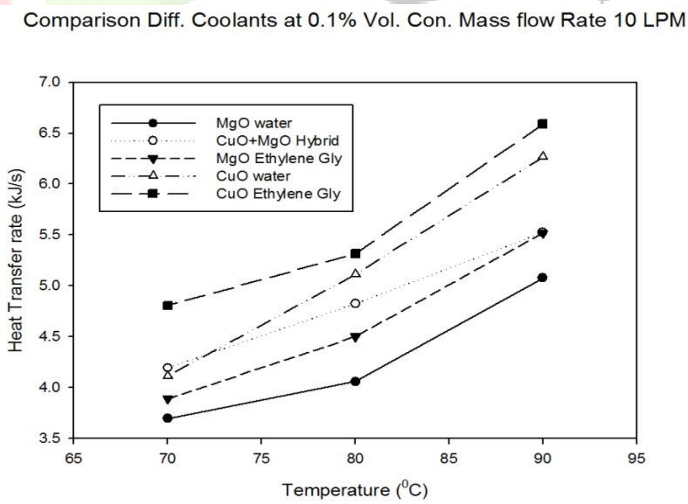

Figure 7 . Comparison between CuO-Water, MgO-Water and CuO-MgO (50-50) Hybrid Nanofluids at 0.1% Vol. Concentration for Heat transfer

In this experimental study, the impacts of using a hybrid nanofluid in a car radiator were examined. A critical enhancement in heat transfer rates was observed using (CuO+MgO+EG) nanofluid in comparison to the base fluid. The experimental outcomes demonstrated that Nu number enhanced with the expansion in flow rate and volume concentration of nanofluid. Additionally, the expansion in radiator inlet temperature expanded the Nu number. The outcomes showed that using nanofluids can expand the heat transfer rate. Along these lines, this gave promising approaches to designers to grow profoundly smaller and powerful radiators for cars. Decreasing in weight of a cooling system can decrease the fuel consumption. Also, it can provide more effective cooling and increment the lifetime of a car.

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