Review on Improving the Cooling Performance of Automobile Radiator with CuO/Water Nanofluid

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Abstract— In this review paper, we would like to review the use of CuO/water base nanofluid in place of coolant in the engine. Reason behind of this study is to increase radiator efficiency and increase heat transfer rate of radiator. By using nanofluid as coolant it can increase heat transfer rate of radiator. By changing the concentration of particle in different percentage in the base fluid we can increase the thermal conductivity and overall heat transfer co-efficient. By changing the parameter we can show its performance and characteristics.

Key words: Introduction, nanofluid properties, different concentration, Heat transfer co-efficient

I. INTRODUCTION

Cooling is the important challenges to obtain the best automotive design in multiple Aspects like Performance, fuel consumption. Automobile radiator is an important part of the engine cooling system. Due to limited space at the front of the engine compartment, the size of the radiator is limited and cannot be increased. Therefore, it is necessary to increase the heat transfer capacity of working fluids such as water and ethylene glycol in radiators because it has very low thermal conductivity.

A development in nanotechnology has been the introduce of nanofluids, i.e. suspensions of nanometer-size solid particles in place of common working fluids. Compared with conventional solid-liquid suspensions containing millimeter or micrometer sized particles, nanofluids as coolants in the heat exchangers have shown better heat transfer performance because of small size of suspend solid particles. It causes that nanofluids have a excellent thermal performance. Nanofluids have different properties that make them potentially useful in many applications. The theoretical models and equation such as Maxwell and Hamilton-Crosser are also available to predict the thermal conductivity of solid – liquid mixtures**.** The suspension of nanoparticles into the base fluids such as water or EG or conventional fluids is known as Nanofluids.

The increment of thermal conductivity for nanofluids also depends on the thermal properties of the base fluids with including their thermal conductivity. As for a given concentration of nanoparticles, results of previous investigations show that the percentage enhancement in the heat transfer coefficient will be greater when the base fluid has a lower thermal conductivity at different concentration. In general, the increment in thermal conductivity increases with an increase in temperature. Increasing the temperature increases the mobility of nanoparticles by intensifying the Brownian motion, which increases the thermal conductivity of nanofluids. Changes in temperature may also affect nanoparticle clustering which will change in the thermal conductivity.

II. THERMO PHYSICAL PROPERTIES OF FLUID AND NANOPARTICLES

Various properties of base fluid and particles such as thermal conductivity, specific heat and density compared with other fluid and base fluid increase thermal conductivity and density. Further with different concentration its thermal conductivity increase. The specific heat is one of the important properties and plays an important role in influencing heat transfer rate of nanofluids. Specific heat is the amount of heat required to raise the temperature of one gram of nanofluids by one degree centigrade. For a given volume concentration of nanoparticles in the base liquid, the specific heat can be calculated using the mixture formula. The specific heat of CuO Nanofluids at different temperatures is estimated for all the volume concentrations. The nanofluids possess unique features with regard to their thermal performances. The properties of nanofluids are different from the properties of conventional heat transfer fluids. The nanoparticles after large total surface area as a result of which higher thermal conductivities are expected in nanofluids. With increase in concentration of nanoparticle its thermal conductivity of nanofluid increases.

Physical Properties	CuO	Water
C_p (J/kg K)	540	4179
ρ (kg/m3)	6510	997
k (W/mK)	18.0	0.613

Table 1: Thermo physical properties of fluid and nanoparticles

III. LITERATURE REVIEW

Mostafa Jalal, et al. (2013) [1] studied convective heat transfer of a heat sink. Different parameters affecting the heat transfer characteristics were investigated so that the influence of each parameter can be determined. Three volumetric fractions of nanoparticles as = 4, 4.5 and 5 vol. % were used to prepare the nanofluid for the experiment. the Reynolds number varied from 400 to 2000, the convective heat transfer coefficients were determined. The results gained in the study showed that dispersion of CuO nanoparticles in water significantly increased the overall heat transfer coefficient while thermal resistance of heat sink decreased. The results also revealed that heat transfer improvement could be achieved by higher vol% of nanoparticles up to 5 vol%, however, the influence was somewhat similar for 4.5 and 5 vol%.

Eiyad Abu-Nada, et al. (2010) [2] studied of natural convection heat transfer characteristics in a differentially heated enclosure filled with a CuO-EG-Water nanofluid for different published variable thermal conductivity and variable viscosity models. The problem is given in terms of the vorticity-stream function formulation and the resulting governing equations are solved numerically using an efficient finite-volume method. Comparisons with previously published work are performed and the results are found to be in good agreement. Various results for the streamline and isotherm contours as well as the local and average Nusselt numbers are presented for a wide range of Rayleigh numbers (Ra¼ 103e105), volume fractions of nanoparticles (0≤4≤6%), and enclosure aspect ratios (½≤A≤2). Different behaviors (enhancement or deterioration) are predicted in the average Nusselt number as the volume fraction of nanoparticles increases depending on the combination of CuO-EG-Water variable thermal conductivity and viscosity models employed. In general, the effects the viscosity models are predicted to be more predominant on the behavior of the average Nusselt number than the influence of the thermal conductivity models. The enclosure aspect ratio is predicted to have significant effects on the behavior of the average Nusselt number which decreases as the enclosure aspect ratio increases.

S. Senthilrajab, et al. (2013) [3] studied experimental investigations of heat transfer coefficient of CuO/Water nanofluid are reported in this paper. The heat transfer coefficient of the CuO/water was measured with the help of double pipe heat exchanger. The nanofluid was prepared by dispersing a CuO nanoparticle in deionized water. CuO/water nanofluid with a nominal diameter of 27nm at different volume concentrations (0.1 &0.3 vol. %) at room temperature were used for this investigation. This experimental result showed that the convective heat transfer coefficient increases with an increase in time also the Nusselt number increases with increasing the liquid flow rate.

M. Sahooli, et al. (2012) [4] studied CuO/water nanofluid was synthesized by using polyvinylpyrolidone (PVP) as the dispersant. The nanofluid stability period and the heat transfer enhancement were determined by measuring the thermal conductivities. To study the nanofluid stability, zeta (ζ) potential, and absorbency were measured under different pH values and PVP surfactant concentrations; also thermal conductivity enhancement was measured based on different volume fraction of CuO nanoparticles and temperature. The results showed that the nano-fluid with PVP surfactant has a good stability of about a week in the optimum pH and PVP concentration which are 8 and 0.095, respectively. Furthermore, in the abovementioned concentration of pH and PVP, optimum CuO volume fraction of 6% was obtained, in which, the thermal conductivity enhancement is 17% at 25oC. Finally, with changing temperature at optimum values (for PVP surfactant and CuO nanoparticles), 31% increase in thermal conductivity was obtained at 50oC.

Navid Bozorgan et al. (2012) [5] studied application of CuO-water nanofluid with size of the nanoparticles of 20 nm and volume concentrations up 2% is numerically investigated in a radiator of Chevrolet Suburban diesel engine under turbulent flow conditions. The heat transfer relations between airflow and nanofluid coolant have been obtained to evaluate local convective and overall heat transfer coefficients and also pumping power for nanofluid flowing in the radiator with a given heat exchange capacity. In the present study, the effects of the automotive speed and Reynolds number of the nanofluid in the different volume concentrations on the radiator performance are also investigated. The results show that for CuO-water nanofluid at 2% volume concentration circulating through the flat tubes with *Renf* = 6000 while the automotive speed is 70 km/hr, the overall heat transfer coefficient and pumping power are approximately 10% and 23.8% more than that of base fluid for given conditions, respectively.

S. Zeinali Heris et al. (2012) [6] studied laminar flow forced convective heat transfer of CuO/water nanofluid in a triangular duct under constant wall temperature condition is investigated numerically. Sometimes, because of pressure drop limitations the need for noncircular ducts arises in many heat transfer applications. We used nanofluid instead of pure fluid because of its potential to increase heat transfer of system. In this paper, the effect of parameters such as nanoparticles diameter, nanoparticles concentration, type of nanoparticles and heat transfer comparison between nanofluid and pure fluid is studied. Comparison of convective heat transfer of nanofluid in isosceles triangular ducts with various apex angles is also presented. In this study, for the presence of nanoparticles, the dispersion model and for solving differential equations, the finite difference method is used. Numerical results indicate an enhancement of heat transfer of fluid with changing to the suspension of nanometer-sized particles in the triangular duct. Results also defined that equilateral triangular duct has a maximum heat transfer in comparison with other types of isosceles triangular duct.

M.T.Naik et al. (2013) [7] studied turbulent convection flow of CuO nanofluids of propylene glycol-water (30:70 by volume) as the base fluid and flowing in a circular tube, subjected to a constant and uniform heat flux at the wall, is numerically analyzed. The effects of nanoparticles concentrations and Reynolds number are investigated on the flow and the convective heat transfer behavior of CuO nanofluids. It is found that nanofluids containing more concentrations have shown higher heat transfer coefficient. The analysis is carried out in the nanoparticles volume concentration range from 0.1% to 1.2%. The heat transfer coefficient increases by 9% for 1.2% CuO nanofluids over the base fluid. The numerical results are compared with the experimental data and reasonable good agreement is achieved.

IV. CONCLUDING REMARKS

From the above review it is concluded that the concentration of CuO nanoparticle and base fluid improves the heat transfer co-efficient. The properties of CuO nanoparticle are specific heat 540 J/kg k, density 6510 kg/m3 and thermal conductivity 18.0 W/mk. The main aim of this study is to find out the concentration of nanoparticle in the base fluid which improves the heat transfer co-efficient.

V. SCOPE OF WORK

In the further experiment different concentration of CuO particle and base fluid is to be made and optimum concentration for the maximum heat transfer co-efficient is found out.

REFERENCES

[1] Mustafa Jala, et al. "Experimental Study of CuO/Water Nanofluid Effect on Convective Heat Transfer of a Heat Sink" 606-611, 2013.
[2] Eiyad Abu-Nada, et al. "Effect of nanofluid variable properties on natural convection in enclosures filled with a CuO-EG-Water nanofluid" in 2010.
[3] S. Senthilrajab, et al. "Analysis of Heat Transfer Coefficient of CuO/Water Nanofluid using Double Pipe Heat Exchanger" Number 5 (2013).
[4] M. Sahooli, et al. "Preparation of CuO/Water Nanofluids Using Polyvinylpyrolidone and a Survey on Its Stability and Thermal Conductivity" 23 Mar. 2012.
[5] Navid Bozorgan et al. "Numerical Study on Application of CuO-Water Nanofluid in Automotive Diesel Engine Radiator" September 29, 2012.
[6] S. Zeinali Heris et al. "CuO/ Water Nanofluid Heat Transfer Through Triangular Ducts" 2012.
[7] M.T.Naik et al. "Numerical Investigation of Turbulent Flow and Heat Transfer Characteristics of PGW-CuO Nanofluids"2013.

