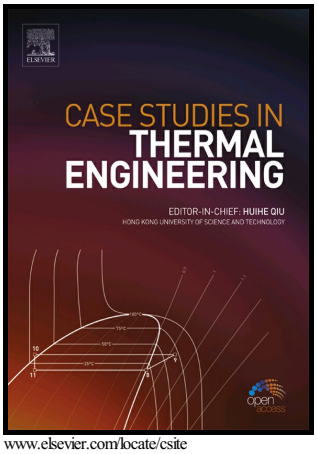

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Experimental Investigation of Heat Transfer Potential of Al_2O_3/Water-Mono Ethylene Glycol Nanofluids as a Car Radiator Coolant

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Abstract
In this research, the heat transfer potential of Al_2O_3/Water-Mono Ethylene Glycol nanofluids is investigated experimentally as a coolant for car radiators. The base fluid was the mixture of water and mono ethylene glycol with 50:50 proportions by volume. The stable nanofluids obtained by ultra-sonication are used in all experiments. In this study nanoparticle volume fraction, coolant flow rate, inlet temperature used in the ranges of 0.2-0.8%, 4-9 l per minute and 65-85^{0}C. The results show that the heat transfer performance of radiator is enhanced by using nanofluids compared to conventional coolant. Nanofluid with lowest 0.2% volume fraction 30% rise in heat transfer is observed. Also the estimation of reduction in frontal area of radiator if base fluid is replaced by Nanofluid is done which will make lighter cooling system, produce less drag and save the fuel cost.

Keywords: Nanofluids; Car radiator; Nusselt number; Frontal area

1. Introduction

Day today the people's needs own automotive vehicle to make their work faster and simpler. So by seeing the increasing demand of vehicle, automotive industries continuously doing development for making high efficient and economical engines which consumes less fuel to attract the customers. There are various ways to increase the efficiency of engine like by using optimized design of engine which reduce the weight of automotive and efficient engine cooling system which will increase the performance of vehicle. Use of optimized designed fins and micro size tube is most conventional way to increase the performance of radiator is now reached to its limit. Another way of enhance the cooling effect is use of efficient coolant in the vehicle radiator. As conventional coolant is the mixture of water and ethylene glycol as anti-freeze agent to increase the boiling point and reduce the freezing point of water. By adding the anti-freeze in water make it possible to use water for wide range of temperature but for that we have to compromise the heat transfer performance of the radiator as the heat capacity of mixture is less that of water.

Solid particles having size less than 100 nm has different thermal properties than the conventional solid particles. As nanometer size particles has large surface area as compare to micro size powder which enhance heat transfer rate. Choi [1] proposed the concept of adding the nanometer sized solid particles in conventional heat transfer fluid and by preparing stable fluid can enhance the heat transfer characteristics which he named as Nanofluids at Argonne National Laboratory of USA. Enhancement in thermal properties is depends on the method of preparation, particle size, type of particle etc. Now a days researchers also starts investigating the potential in hybrid Nanofluid to get more benefit in heat transfer rate. Nor Azwadi Che Sidik [2,3] has discussed the challenges to preparation of stable hybrid Nanofluid and enhancement in the thermal properties. Dattatraya Subhedar and Bharat Ramani [4] also observed that thermal conuctivity of Nanofluid is increases linearly as the volume concentration is increases, with 0.8 % volume fraction of Al_2O_3 nanoparticles of size 20 nm in water/MEG base fluid 8.5 % enhancement in thermal conductivity is observed.

So to overcome the difficulty of heat transfer by using water with Ethylene Glycol it is necessary to add metallic or non-metallic oxides nanoparticles to enhance the thermal properties of the mixture. Enhancement in heat transfer by using nanofluids will make possible in reduction in frontal heat transfer area of the radiator. Improved thermal properties of nanofluids also allow circulating nanofluids with lower flow rate than the base fluid for the same heat transfer which in turn reduces the pumping power required than the base fluid. To understand the potential of nanofluids for car radiator the literature survey is carried out, few critical findings of them are discussed here.

S. Zenali Heris et.al.[5] have experimentally investigated the performance of CuO/EG-water as a coolant in car radiator. In their study they used nanofluids with 0.05-0.8% volume fraction of CuO. For 0.8 % nanofluids the gain in the heat transfer coefficient they found 55% compared to the EG-water