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Effects of natural-based SiO_2 nanocoolant on car radiator: Thermal profile

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ABSTRACT

Nanofluid as a transport medium has a great deal of potential in heat transfer engineering applications. In this work, nanosilica was derived from natural sources, rice husk through incineration and chemical treatment process. Various SiO_2 nanoparticle volume concentrations (0–1 vol%) were dispersed in EG/water binary mixture assisted by ultrasound technique to produce SiO_2 nanocoolant. Scanning Electron Microscopy (SEM) was used to identify the surface morphology and size of the nanosilica. Furhermore, the study was further conducted in a car radiator to determine the thermal profile consists of the effect of nanoparticle concentration and the longevity testing of the nanocoolant. Findings show that nanosilica particles were in range of 15–25 nm with irregular shape. Moreover, the heat transfer performance was enhanced as the SiO_2 concentration was increased. Apart from that, SiO_2 1 vol% shows a great thermal behaviour as it takes a shorter time to achieve and maintain at optimal working temperature compared to other samples. Apart from that, it can be observed that SiO_2 nanocoolant possesses slightly higher properties than the base fluid and conventional coolant. The results also revealed the average heat transfer coefficient is directly proportional to the volume concentration of nanofluids and the heat transfer performance of the radiator increased with the inclusion of nanoparticles to the base fluid.

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1. Introduction

Nanofluids are combination of nanometer sized particle and fluids. In general, the size of these nanoparticle varies from 1 to 100 nm in size. Normally, Nanofluids are produced by dispersing nanometer scale solid particles into base fluids such as water, engine oil and ethylene glycol. Nanotechnology is widely used in heat transfer devices to improve thermal performance in industries sector for example transportation, heating or cooling processes, energy supply and production, electronics microelectronics and other micro-sized applications [1]. The type of nanoparticles used is directly dependent on the enhancement of a required property of the base fluid. All physical mechanisms have a critical length scale, below in which the physical properties of materials are changed. Therefore, particles less than 100 nm exhibits properties that are considerably different from those of conventional solids. Fundamentally, it can be concluded that studies on metallic nanofluids have opened a new horizon with highly enhanced thermal conductivity with low particle volume fraction. Osman, Sharifpur [2]prepared Aluminum Oxide (Al_2O_3) nanofluids by dispersing Aluminum Oxide nanoparticles into water based with and without presence of surfactant. Nanofluids was prepared by using one step method and mentioned that the nanofluids showed enhancement in terms of heat transfer coefficient up to 54% in the transition flow regime and 11% in the turbulent regime for 1 vol% concentration. Kaggwa, Carson [3] studied the effect of surfactants on viscosity and stability of activated carbon (C), alumina (Al_2O_3), and copper oxide (CuO) in water (H_2O) and ethylene glycol as base fluids. The results showed that surfactants assist in increased the viscosity of C/EG and Al_2O_3/H_2O up to 67.5% and 261.3% respectively. In addition, they also found that the addition of Arabinogalactan

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