Numerical modeling of heat transfer performance and optimization of car radiator using (H_2O/Al_2O_3) nanofluids as coolant

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Abstract

The combustion of fuel in an engine is an exothermic reaction that releases a tremendous amount of heat. Some of this heat is escapes with the exhaust gases while the remaining is absorbed by the engine parts. Excessive heating of the engine cylinder can lead to the premature detonation of the air-fuel mixture in the cylinder, piston scuffing, damage of valves and guides, thermal stress buildup and gasket failure. Most engines utilize a liquid cooling system to transfer the heat from the engine to the surroundings. The radiator is a vital part of an automobile cooling system. Water and other coolants such as ethylene glycol are usually applied to dispel heat from the engine to the environment through the radiator. Nanofluids have a higher thermal conductivity than water and ethylene glycol, and for this reason, it has been receiving attention as a better alternative to the conventional coolants. In this study, the thermal performance of water and aluminum oxide nanofluids were investigated numerically. The radiator understudy was a crossflow radiator. Solidworks 2017 flow simulation software was used to carry out the numerical investigation. The same inlet temperature, flow rate and environmental conditions were used for both the water and nanofluid coolant operating in the radiator. Four different concentrations of the nanofluid were considered in this study, to determine the effect of concentration on the performance of the radiator. At a 1% concentration of Al_2O_3, the enhancement in the heat transfer rate and heat transfer coefficient (coolant side) are 0.86% and 6.98% respectively. While at 4% concentration, the enhancement in heat transfer rate and heat transfer coefficient is 12.03% and 14.31% compared to water. The results of this study prove that nanofluid is a better heat transfer fluid compared to water and serve as a better alternative for application in car radiators.

Keywords: Car radiator heat exchanger heat transfer coefficient heat transfer rate nanofluids solidworks