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Heat Transfer Enhancement of a Chevron-Type Plate Heat Exchanger Using Water Based Titania Nanofluid

Ramtin Barzegarian[1], Mostafa Keshavarz Moraveji[2], Alireza Aloueyan[3], Tooraj Yousefi[4]
[1]Department of Mechanical Engineering, Islamic Azad University, Science and Research Branch
14778-93855, Tehran, Iran
ramtinbarzegarian@asme.org; moraveji@aut.ac.ir
[2]Department of Chemical Engineering, AmirKabir University of Technology (Tehran Polytechnic)
15875-4413, Tehran, Iran
[3]Department of Mechanical Engineering, Islamic Azad University, South Tehran Branch
Tehran, Iran
aaloueyan@gmail.com
[4]Department of Mechanical and Industrial Engineering, Ryerson University
ON M5B2K3, Toronto, Canada
tooraj.yousefi@ryerson.ca

Extended Abstract

In today's modern world, despite invention of new methods to exploit renewable energies, it seems fossil fuels play the major role in human's life as yet. Reduction of these energy sources due to population growth, persuade more investigators to find practical solutions for saving energy. One of these proposed solutions is using nanofluids in heat transfer equipment instead of common fluids such as water, mineral oil and ethylene glycol, which was offered by choi [1] for the first time in 1995. Nanofluids are novel fluids which are made by adding and dispersing nanoscale metal and metal oxide particles in the mentioned working fluids in order to improve their heat transfer characteristics [2-8]. On the other hand, plate heat exchanger is very prevalent in many applications such as water heaters, thermal storage systems, waste heat recovery, free cooling, heat pump isolation, cooling tower isolation and the like because of its higher performance, smaller size and lower production cost rather than other types of heat exchangers. Thanks to corrugated plates, plate heat exchangers provide a wide heat transfer area in the lowest volume possible and also heat transfer enhancement by increasing of turbulence intensity even at lower Reynolds number (Re≥100) [9,10]. The aim of the current experimental research is an investigation on the effect of using water based TiO_2 (titania) nanofluid as hot fluid on heat transfer performance of a chevron-type plate heat exchanger (chevron angel=45°). For this purpose, titania nanoparticles with 20 nm diameter and cetyltrimethylammonium bromide (CTAB) as surfactants were used to produce aqueous TiO_2 nanofluids at 0.08, 0.2 and 0.4% volume concentration of suspended nanoparticles. The main role of Surfactants in nanofluids preparation is improving the solubility of nanoparticles in base fluid by decrement of its adhesion. The experiments have been done under various Reynolds numbers of nanofluid (turbulent regime). The results show a substantial enhancement in Nusselt number and overall heat transfer coefficient by increment of nanoparticles volume fraction at a specific Reynolds number and also it can be seen that, heat transfer characteristics of heat exchanger increase through rising Reynolds number of working fluid. The mean enhancements in Nusselt number of nanofluid are around 3.9, 9.6, and 19.5% at 0.08, 0.2 and 0.04 vol. %, respectively. Also the average enhancements of nanofluid overall heat transfer coefficient at mentioned volume fractions are reported about 1.63, 3.96 and 7.63%, respectively. These augmentations could be originated from nanofluid thermal conductivity enhancement rather than base liquid as well as Brownian motion of nanoparticles in fluid. Finally, the empirical results were compared with the correlation proposed by Kim [11] which is authentic for water to water plate heat exchanger in single phase conditions. Regarding to the comparative results, an acceptable compliance was observed between both experimental and predicted data.

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