Experimental Study of Pool Boiling Heat Transfer Coefficient for DI-Water-Based Nanofluids Containing Nickel Oxide in a Constant Magnetic Field

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Abstract

Enhancing the boiling efficiency helps improve the productivity of thermal systems. Given the effects of added nanoparticles and applied magnetic field on the boiling process, this study investigates the effects of nickel oxide (NiO) nanoparticle concentration with and without applied magnetic field. The studied nanofluid was synthesized by the two-step method and approved by TEM and DLS stability tests for resistance to flocculation. Five concentrations of nanofluid, namely 0.005, 0.01, 0.05, 0.1, and 0.2), were prepared using nanoparticles with an average size of 30 nm. Moreover, a DC magnetic field with a maximum current of 10 A and a strength of 1000 G in the metal core and 300 G at the center of the core was used to evaluate the effects on nanoparticle boiling. The boiling heat transfer coefficient (BHTC) of deionized (DI) water was then compared with a plot of the Rohsenow correlation in three regions to validate the results and showed remarkable consistency. Moreover, experimental data indicated that the magnetic field affected the shape of DI water bubbles during boiling while improving the fluid's BHTC. It was also found that a 0.005 volume fraction of added NiO nanoparticles results in an average 35 % improvement, whereas at the 0.2 volume fraction, increased sedimentation drastically impacts the BHTC. The magnetic field improved the BHTC by nearly 10 % at a 0.005 volume fraction, while higher concentrations reversed the effects of the magnetic field. By hindering bubble generation, nanoparticle sedimentation on surfaces also drastically affects the BHTC.