International Communications in Heat and Mass Transfer 38 (2011) 1470–1473

Contents lists available at ScienceDirect

International Communications in Heat and Mass Transfer

journal homepage: www.elsevier.com/locate/ichmt

Experimental investigation of pool boiling characteristics of low-concentrated CuO/ethylene glycol–water nanofluids ☆

Saeed Zeinali Heris

Department of Chemical Engineering, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, Iran

ARTICLE INFO

Available online 16 August 2011

Keywords:
Heat transfer enhancement
CuO/ethylene glycol–water nanofluids
Pool boiling

ABSTRACT

Boiling heat transfer performance of nanofluid has been studied during the past few years. Some controversial results are reported in literature about the potential impact of nanofluids on heat transfer intensification. Whereas the mixtures of ethylene glycol and water are considered the most common water-based antifreeze solutions used in automotive cooling systems, the present study is an experimental investigation of boiling heat transfer of CuO/ethylene glycol–water (60/40) nanofluids. The results indicate that a considerable boiling heat transfer enhancement has been achieved by nanofluid and the enhancement increases with nanoparticles concentration and reaches 55% at a nanoparticles loading of 0.5%.

1. Introduction

Many devices and systems, such as high-power motors and automobiles require effective heat removing to keep them running for the long-haul and to reduce maintenance and system failures. Pool boiling is one of the most effective and efficient modes of heat transfer, which occurs in a variety of engineering applications. There are numerous investigations in the past decades, in order to study the enhancement of boiling heat transfer [1–5].

In recent past years nanofluids which are new kind of heat transfer fluid and refer to solid nanoparticles suspended in base fluid have been studied by some researchers [6–8]. Most of researches about pool boiling characteristics of nanofluids are related to Al_2O_3 nanofluids. For example, Yang and Maa [9] performed pool boiling experiments with alumina–water solid particle suspensions. They used Al_2O_3 particles of sizes 50 nm, 300 nm and 1 μm. They found that pool boiling performance is greatly improved for low particle concentrations of 0.1–0.5% in nucleate pool boiling regime. Das et al. [10] investigated the nucleate pool boiling heat transfer of Al_2O_3/water nanofluids. They reported deterioration of boiling performance and the degradation enhancement with increasing nanoparticles concentration. In contrast to Das et al. interpretation, Bang and Chang [11] studied boiling of Al_2O_3/water nanofluids at high heat fluxes and observed that the surface roughness after boiling increased with nanoparticles concentration and the increased roughness caused a fouling effect with poor thermal conductivity. You et al. [12] studied pool boiling behavior of silica/water and Al_2O_3/water nanofluids. They found little effect of the presence of nanoparticles on the nucleate boiling heat transfer but about 200% enhancement of CHF was observed. Vassallo et al. [13] investigated silica/water nanofluids boiling on a 0.4 mm diameter horizontal NiCr wire at the atmospheric pressure. They found no obvious heat transfer enhancement at low and medium heat flux operating conditions. Wen and Ding [14] investigated pool boiling heat transfer of aqueous based alumina nanofluids. They observed significant enhancement of boiling heat transfer of nanofluids. Prakash et al. [15] investigated the boiling heat transfer behavior of Al_2O_3/water nanofluid. They found that when the average particle size is of the order of the surface roughness, the number of nucleation sites is greatly decreased. Kedzierski [16] studied effect of Al_2O_3 nano-lubricant on R134a pool boiling heat transfer on an indirectly heated surface. He observed heat transfer enhancement up to 155% in the region of heat fluxes less than 40 kW m^{-2} for 0.2% mass fraction of Al_2O_3 nanoparticles in R134a/polyolester. Zhou [17] investigated experimentally the heat transfer characteristics of Cu/acetone nanofluids with and without acoustic cavitations. Results showed that the copper nanoparticles and acoustic cavitations had significant influence on heat transfer in the fluid. Rahimi et al. [18] proved that, it will be possible to increase the average thermal performance of thermosyphon by making the evaporator section more hydrophilic. Soltani et al. [19] investigated the pool boiling heat transfer of Al_2O_3/CMC non-Newtonian nanofluids. Results show that the pool boiling heat transfer coefficient of CMC solutions is lower than water. Adding nanoparticles to CMC non-Newtonian solutions results in an improved boiling heat transfer performance. Naphon et al. [20] showed that the nanoparticles have a significant effect on the enhancement of thermal efficiency of heat pipe. Ahn et al. [21] through the experimental investigation showed that the nanofluid flow boiling CHF was distinctly enhanced under the forced convective flow conditions compared to that in pure water. The effect of surfactant additives on nucleate pool boiling heat transfer of refrigerant-based

☆ Communicated by W.J. Minkowycz.
E-mail address: zeinali@ferdowsi.um.ac.ir.

0735-1933/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.icheatmasstransfer.2011.08.004