UNIVERSITI TEKNOLOGI MARA

EXPERIMENTAL INVESTIGATIONS ON BUBBLE GROWTH AND HEAT TRANSFER MECHANISMS DURING NUCLEATE POOL BOILING OF SiO_2/HFE-7000 NANOREFRIGERANT

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of the requirements for the degree of
Master of Science
(Mechanical Engineering)

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Nucleate boiling heat transfer is known as one of the best heat transfer mechanism in heat transfer studies due to the high heat transfer rate that can be achieved despite low-temperature differences. Numerous fundamental studies i.e. bubble dynamics, heat transfer mechanisms have been conducted for pure fluids such as water and refrigerants. However, such studies for nanofluids that are known for better thermal conduction are found to be still lacking in the works of literature. Most previous experimental studies found that during nucleate boiling of nanofluid, the nanoparticle has sedimented over the cavity causing bubble nucleation to not occur. Because of that, this research developed a stable SiCh/HFE-7000 nanorefrigerant using two-step method with nanoparticles concentrations 0.02, 0.01, and 0.005 vol%. The investigation of thermo-physical properties of the nanorefrigerant shows that the thermal conductivity enhanced up to 27%. The viscosity is increased about 23%, although their presence is still low since the base fluids are considered as inviscid fluids. The main study is to investigate characterizations of SiCh/HFE-7000 nanorefrigerant for application of nucleate pool boiling system. This study has been carried out by an experimental work of single bubble growth dynamics in nanofluids nucleate pool boiling. In the nucleate pool boiling experiment, the parameters that have been investigated are bubble frequency, bubble growth, waiting time, and bubble departure diameter for different volume concentrations of nanofluids. The bubble images were captured using a high-speed video camera during nucleate pool boiling. Image processing in Matlab has been used to process the images and identify the parameters that describe growth and departure. The relationship between bubble waiting time and increasing wall superheat is found to be exponentially decreasing. With inclination wall superheat, the bubble growth time also decreases significantly. The size of the bubble right before the process of departure determines the rate of frequency of bubbles. The temperature of wall superheat, which is one division of regulating the bubble growth rate, is the primary cause of this circumstance. The departure volume is maintained by wall superheat, which is normal for quasi-static bubble growth. The bubble growth curves revealed to compress into a single curve that is independent of wall superheat and follows the empirical growth rules quite well, $V^* = t^{*\prime}$. With the enhancement of thermo-physical properties and fluids behaviour studied, innovation nanorefrigerant is greatly suitable for application pool boiling heat transfer system. It can be concluded that, boiling heat transfer applications of nanorefrigerant have great potential to be implemented in cooling technologies such as in electronics cooling.

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