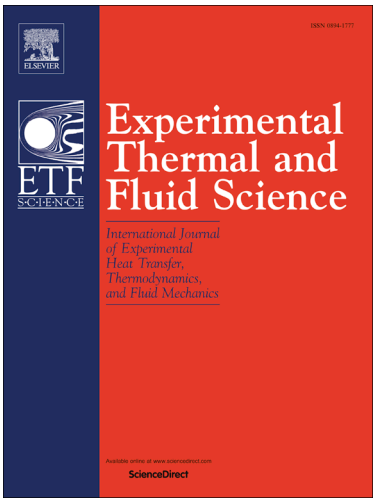

Experimental study on flow boiling characteristics in a high aspect ratio vertical rectangular mini-channel under low heat and mass flux

Jiayao Liu, Jinping Liu, Rixin Li, Xiongwen Xu

PII: S0894-1777(18)30846-X
DOI: https://doi.org/10.1016/j.expthermflusci.2018.05.019
Reference: ETF 9484

To appear in: *Experimental Thermal and Fluid Science*

Received Date: 4 January 2018
Revised Date: 12 May 2018
Accepted Date: 18 May 2018

Please cite this article as: J. Liu, J. Liu, R. Li, X. Xu, Experimental study on flow boiling characteristics in a high aspect ratio vertical rectangular mini-channel under low heat and mass flux, *Experimental Thermal and Fluid Science* (2018), doi: https://doi.org/10.1016/j.expthermflusci.2018.05.019

Experimental study on flow boiling characteristics in a high aspect ratio vertical rectangular mini-channel under low heat and mass flux

Jiayao Liu[a], Jinping Liu[a,b,c], Rixin Li[a], Xiongwen Xu[a,b*]

[a]School of Electric Power, South China University of Technology, Guangzhou 510640, China

[b]Guangdong Province Key Laboratory of Efficient and Clean Energy Utilization, Guangzhou 510640, China

[c]State Key Laboratory of Subtropical Building Science, South China University of Technology, Guangzhou 510640, China

[*] Corresponding author at: School of Electric Power, South China University of Technology, Guangzhou 510640, China. Tel:+86-020-87110213; Fax:+86-020-87110613; E-mail address: epxwxu@scut.edu.cn

Abstract

This study investigates the flow patterns and flow boiling characteristics of R600a, R227ea and R245fa in a visualized vertical rectangular mini-channel, with a moderate-high aspect ratio (width/height=6.25), cross-section area of 1.6 mm × 10 mm and length of 520 mm. The experimental results are obtained at saturation temperatures of 27.5, 36.6 and 45.5℃, with relatively low heat and mass flux ranging from 3.60 to 10.50 kW/m^2 and 32.20 to 116.8 kg/m^2 s, respectively. Five flow types are identified and a flow pattern map is plotted. Front waves are observed and minimized bubbles are detected, generated from the slug to the churn-annular liquid film. The effects of heat flux, mass flux, vapor quality and saturation pressure on flow boiling are investigated and analysed. For all three tested refrigerants, the heat flux and saturation pressure are found to have a significant influence on the heat transfer coefficient, while the effects of the mass flux and vapor quality are negligible. Eleven existing correlations are comparatively evaluated based on the experimental data. The dimension groups correlation exhibits superior predicting performance, and a new correlation is developed for low heat and fluxes flow boiling in vertical minichannel.

Keywords

Vertical rectangular mini-channel; Flow boiling; Heat transfer mechanism; Low heat and mass flux

1. Introduction

Facing the energy crisis worldwide, improving the utilization efficiency and thermal management of traditional energy systems has been an effective method for energy conservation. In recent years, there has been great interest in utilizing small sized channels to achieve high efficiency and compact results. For common used compact heat exchangers, such as parallel flow heat exchangers and plate-fin heat exchangers, the passages are separated into narrow rectangular minichannels by straight fins. However, published data relating to flow boiling in mini-channel is mainly focusing on heat dissipating for electrical devices, which aims to achieve as maximum heat flux as possible. While the flow boiling conditions in plate-fin heat exchangers are quite different from the heat dissipating conditions. Firstly, to avoid the excessive two phase flow pressure drop, the mass flow rate are relatively low. Secondly, to reduce the exergy loss, the temperature difference between the hot and cold flow is designed to be small, which leads to low heat flux.