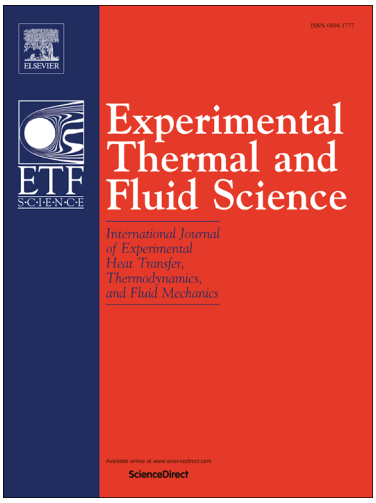

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Experimental study of flow boiling in an inclined mini-channel: effect of inclination on flow pattern transitions and pressure drops

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Abstract

An experimental study of R245fa two-phase flow in a 1.6 mm inner diameter circular channel is presented in both adiabatic and diabatic conditions. The test section is composed of a sapphire tube coated with ITO, which enables a total transparency of the evaporator. The effect of inclination on the flow patterns and the pressure drops is presented and discussed for various vapour qualities and mass velocities and a saturation temperature of 81°C, corresponding to a Bond number of 4.2. For each experimental conditions, the pressure drops are measured and the flow is visualised under eleven configurations of inclination from the vertical downward flow (-90°) to the vertical upward flow (+90°). The flow pattern transitions are compared with two flow pattern maps available in the literature. The effect of the heat flux on the flow patterns is analysed and shows the disappearance of the stratified flow for the downward flows in the case of low-inertia flows. A study of the effect of the inclination on the total and frictional pressure gradients is also led. The observations are compared with several models of the literature. These models show a good agreement to predict the pressure gradient for upward flows. Finally, the effect of the heat flux on the pressure drop variations with inclination is analysed. It shows a general increase of the pressure drops due to gravity and frictional forces with the heat flux for low vapour qualities, whatever the considered inclination. This offset decreases with the vapour quality.

Keywords: flow boiling, mini-channel, inclination angle, flow pattern, pressure drops

Nomenclature

Roman Letters

d	diameter (m)
G	mass velocity (kg.m^{-2}.s^{-1})
L	length (m)
P	pressure (Pa)
s	symmetry (-)
T	temperature (K)
u	velocity (m.s^{-1})
x	vapour quality (-)
z	abscissa (m)

Greek Letters

β	inclination angle (rad)

Dimensionless numbers

Bd	Bond

Subscripts

bottom	bottom
frict	frictional
grav	gravitational
h	homogeneous
in	inlet
liq	liquid
lines	lines
meas	measured
mom	momentum