World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:9, No:05, 2015

Effect of Hydraulic Diameter on Flow Boiling Instability in a Single Microtube with Vertical Upward Flow

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Abstract : An experiment is conducted to fundamentally investigate flow oscillation characteristics in different sizes of single microtubes in vertical upward flow direction. Three microtubes have 0.889 mm, 0.533 mm, and 0.305 mm hydraulic diameters with 100 mm identical heated length. The mass flux of the working fluid FC-72 varies from 700 kg/m2•s to 1400 kg/m2•s, and the heat flux is uniformly applied on the tube surface up to 9.4 W/cm2. The subcooled inlet temperature is maintained around 24°C during the experiment. The effect of hydraulic diameter and mass flux are studied. The results showed that they have interactions on the flow oscillations occurrence and behaviors. The onset of flow instability (OFI), which is a threshold of unstable flow, usually appears in large microtube with diversified and sustained flow oscillations, while the transient point, which is the point when the flow turns from one stable state to another suddenly, is more observed in small microtube without characterized flow oscillations due to the bubble confinement. The OFI/transient point occurs early as hydraulic diameter reduces at a given mass flux. The increased mass flux can delay the OFI/transient point occurrence in large hydraulic diameter, but no significant effect in small size. Although the only transient point is observed in the smallest tube, it appears at small heat flux and is not sensitive to mass flux; hence, the smallest microtube is not recommended since increasing heat flux may cause local dryout.

Keywords : flow boiling instability, hydraulic diameter effect, a single microtube, vertical upward flow
Conference Title : ICSREE 2015 : International Conference on Sustainable and Renewable Energy Engineering
Conference Location : Montreal, Canada
Conference Dates : May 11-12, 2015