K20 Fundamental Aspects of Pool Boling and Relation to Enhancement

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Abstract

Pool boiling research is currently pursued by a large number of researchers due to its importance as an industrial process, where large amounts of heat can be transferred with small temperature differences and due to its challenging complexity arising from the phase-change transition and solid-fluid interactions. In addition, fundamental knowledge of the pool boiling processes constitutes the starting point in any study of flow boiling. Heat transfer enhancement and in particular two-phase heat transfer enhanced through surface modification has also been actively pursued by the international research community. However, a lot of the proposed designs and surface modifications were not based on proper evaluation of heterogeneous nucleation and bubble dynamics in a pool boiling situation. A critical analysis is now required in order to move forward with enhanced surface designs, based on proper criteria.

The current on-going research on boiling fundamentals including bubble generation, growth and bubble dynamics and heat transfer mechanisms, will first be discussed in the lecture. In this context, the fluid-surface interaction is critical and the presentation will include the factors and parameters affecting the above, starting with the criteria for gas/vapour entrapment and nucleation site stability. The models predicting the incipience superheat and bubble growth and departure models will be critically described plus an appraisal of the current pool boiling heat transfer models. Three fluids, i.e. FC-72, HFE7100 and water are used through the discussion, as examples, to represent low and high surface tension fluids and help the understanding of surface-fluid interactions and relation to possible heat transfer enhancement.

In the second part of the presentation the different proposed surface modifications will be classified and discussed. The achieved enhancement in the average heat transfer coefficients and the critical heat flux will be presented. Finally, the different possibilities of the proposed designs will be compared and recommendations made.