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Microlayer Evaporation during Steam Bubble Growth, And the Evidence It Provides Regarding the Evaporative Process Itself

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Abstract **-** During the formation of a steam bubble on a heated surface, it is commonly the case that a very thin layer of water is observed to be 'left behind' on the surface as the bubble grows. Heat is conducted from the heated surface through this 'microlayer', forming vapour at its upper surface. These microlayers perhaps start life at ~5 micron thick, and they evaporate to depletion. This talk presents a summary of recent advances in modelling of the evaporation of the microlayer, combining Computational Fluid Dynamics (CFD) simulation, theoretical developments and insight from measurements. Likely values, computed with interface capturing CFD simulation, of the liquid layer thickness as formed beneath a bubble are compared and found consistent with direct measurements. A model of microlayer evaporation based on a simple kinetic theory representation of the molecular fluxes impinging on and emitted from a liquid surface is studied. By analogy with convective heat transfer, the model can be formulated in terms of a relationship between the evaporative heat flux through the microlayer and the temperature difference between the upper microlayer surface (the liquid-vapour interface) and the saturated vapour in the interior of a bubble. Combined with measurements of microlayer depletion rates, the model analysed provides a good basis for the estimation of an effective 'evaporative heat transfer coefficient'. Values of the evaporative heat transfer coefficient so extracted, although reasonably consistent with estimates from other workers, are at odds with results of direct modelling of the interfacial evaporation process by means of molecular mechanics simulation, which suggest a much larger, perhaps of a factor of ~50, value of such an evaporation coefficient.

Keywords**:** boiling; evaporation; steam bubbles; thin film; CFD; molecular mechanics