Comparison of a Mechanistic Model for Nucleate Boiling with Experimental Spatio-Temporal Data

I Golobic, E Pavlovic, J von Hardenberg, M Berry, RA Nelson, DBR Kenning & LA Smith

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Abstract

Mechanistic numerical simulations have been developed for pool nucleate boiling involving large groups of nucleation sites that are non-uniformly distributed spatially and have different activation superheats. The simulations model the temperature field in the heated wall accurately and use approximations for events in the liquid–vapour space. This paper describes the first attempt to compare the numerical simulations with spatio-temporal experimental data at a similar level of detail. The experimental data were obtained during pool boiling of water at atmospheric pressure on a horizontal, electrically heated stainless steel plate 0.13 mm thick. They consist of wall temperature fields measured on the back of the plate by liquid crystal thermography at a sampling rate of 200 Hz over a period of 30 s. Methods of image analysis have been developed to deduce the time, position, nucleation superheat and size of the cooled area for every bubble nucleation event during this period. The paper discusses the methodology of using some of the experimental data as input for the simulations and the remainder for validation. Because of the high-dimensional dynamics and possibly chaotic nature of nucleate boiling, the validation must be based on statistical properties over a large area and a long period. This preliminary study is restricted to a single heat flux.