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EVAPORATION OF A THIN LIQUID FILM IN A HEATED CAPILLARY TUBE: EXPERIMENTAL RESULTS AND DISCUSSION ON THE RELATED PHYSICAL PHENOMENA

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Abstract

The aim of this study is to analyze, by means of experimental infrared thermography, the heat transfer involved in the motion of a semi-infinite slug flow (one liquid slug followed by one single vapour bubble) in a heated capillary copper tube. The deposited liquid thin film is responsible for intense heat transfer at the wall by evaporation, leading to a very significant decrease of the external wall temperature. Post-processing of this temperature field allows identifying the equivalent heat transfer coefficient of the fluid inside the tube, in transient conditions, between the liquid slug and the dry vapour bubble. In this paper, the experimental methodology and tests results will be presented for water and N-pentane as working fluids, together with a description of the main physical phenomena that occur during this process. In particular, a study of the vapour flow, in the long pipe linking a tank at saturation state to the test section, will be held by modeling approach (using mass and momentum balances in transient conditions), reproducing the experimental operative conditions. The purpose is to check if the local vapour pressure downstream the meniscus remains almost constant, not changing the saturation conditions at the evaporation interface (case of N-pentane), or if its increase, due to the emergence of vapour from evaporation, is momentary not compensated by the big volume of the back tube (case of water). If this happens, the evaporation process will be delayed, and then the transfer shall be modified and influenced by this phenomenon. The results obtained allow better understanding of the physical phenomena involved in the experimental study.