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MICRO-SENSORS FOR BOILING HEAT TRANSFER STUDIES

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Abstract

Despite of the enormous number of studies on boiling heat transfer we still have far more empirical results than knowledge on the physical mechanisms. Empirical correlations required for design purposes in practice still govern the field. But it is now accepted that further progress requires emphasis on studies focused on the physics of this very complex process. This trend is on one hand supported by new experiments - which are doubtless unavoidable in this field - taking advantage of the growing capacities in data processing by computers in connection with miniaturized sensors and high speed cinematography and other opto-electronic facilities, and on the other by better and new mathematical tools which have been developed in recent years.

The objective of the present report is to present a summary of results found in our laboratories during the past years. Most of these results have already been published elsewhere (e.g. [1-11]) The philosophy of our research follows the lines mentioned above.

In the first and second part a novel experimental technique is presented which enables a precise and systematic measurement of entire boiling curves under steady-state and transient conditions. This technique has been applied, in the first step, to find out whether boiling curves exhibit a hysteresis in the transition region under steady-state conditions. There are still controversial opinions about this aspect. To find an answer, steady-state experiments were carried out with well wetting fluids and fluids with a larger contact angle (FC-72, isopropanol, water). Moreover, boiling curves under transient heating and cooling conditions have been determined with FC-72. Here, the heating and cooling rate could be varied systematically.

A precise technique to determine entire boiling curves is a necessary prerequisite to study the boiling mechanisms in the different boiling regimes by means of micro-sensors. Results of this kind are presented in the third part of our report. A micro-optical probe was applied to study the two-phase behaviour above the heating surface in the different boiling regions. Microthermocouples beneath the surface were used to measure temperature fluctuations due to the action of the two-phase system above the surface. All the obtained results lead to some interesting conclusions on the physics of boiling in the different boiling regime.

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