BOILING HEAT TRANSFER EXPERIMENTAL RESEARCH AT MIT: ACCOMPLISHMENTS, OPEN QUESTIONS, AND FUTURE DIRECTIONS

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ABSTRACT

In every field of science, the possibility of discovering and understanding new phenomena, or testing new hypotheses, is strongly related to and limited by the capability of observation.
Here, we will discuss recent advances in experimental boiling heat transfer research made possible by unique experimental facilities and non-intrusive high-resolution optical diagnostics, e.g., high-speed infrared thermometry and phase detection techniques.
We will analyze these techniques' capabilities and limitations in supporting the understanding of fundamental two-phase heat transfer problems. Examples are the growth and departure of bubbles from a heated surface, the distribution of the dry area fraction, the partitioning of heat flux, and the boiling crisis. Notably, we will discuss experiments conducted in prototypical LWR conditions, presenting first-of-a-kind observations of the boiling process and the boiling crisis.
The use of these diagnostics has been instrumental in providing an answer to some long-standing fundamental physical questions. However, access to these techniques is not sufficient. Nowadays, new understanding is hindered by our capability to analyze data, i.e., we can produce much more data than we can possibly analyze. This issue is critical for highly non-linear phenomena, e.g., boiling heat transfer, whose complexity is hidden beyond what a human eye can hardly see or a human brain can timely analyze. We will discuss how artificial intelligence can alleviate this issue and, possibly, enable the development of autonomous, self-learning testing capabilities.

Keywords: Boiling Heat Transfer, LWRs, High-Resolution Diagnostics, Artificial Intelligence.