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Two Phase Flow and Thermal Physics of Nanofluids: Understanding the Fundamentals, Mechanisms and Challenges

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This keynote lecture presents a comprehensive review and analysis of the state-of-the-art research on two phase flow and thermal physics covering nucleate pool boiling heat transfer, flow boiling heat transfer and critical heat flux (CHF) phenomena of nanofluids and the challenges for understanding the mechanisms and their engineering applications. First, analysis of the available experimental studies on the relevant topics is presented. In particular, our new experimental results of understanding the fundamentals and mechanisms of nucleate boiling heat transfer of nanofluids in a confined space are presented and compared to those in the literature. Then, flow boiling heat transfer and two phase flow phenomena in macroscale and microscale channels are discussed. Next, boiling heat transfer and critical heat flux results and mechanisms are discussed. Finally, future research needs have been identified through this review. The physical properties of nanofluids have a significant effect on the boiling heat transfer and CHF characteristics but the lack of the accurate knowledge of the physical properties has significantly limited the understanding and application of these interdisciplinary research topics. Furthermore, fundamentals of boiling heat transfer and CHF phenomena of Nanofluids have not yet been well understood. Flow regimes are very important in understanding the boiling and CHF phenomena but less investigated so far. Therefore, effort should be made to contribute to the physical property database of nanofluids as a first priority. Secondly, systematic accurate experiments and flow regime observations on boiling, flow regimes and CHF phenomena with various types of nanofluids under a wide range of test conditions should be emphasized, Finally, physical mechanisms, theory and prediction methods for boiling heat transfer and CHF characteristics should be targeted at and applied research of nanofluids in engineering practice should also be focused on in the future.

Keywords: Nanofluid, nucleate boiling, flow boiling, two phase flow, critical heat flux, heat transfer, analysis, mechanisms, prediction methods and applications