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Numerical Simulation Of Steam Bubble Condensation Using Thermal Phase Change Model

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Abstract **-** Evaporation and condensation phenomena play a significant role in many of the nuclear, biochemical, and thermal processes in industrial applications. It is a complicated phenomenon as it undergoes both heat and mass transfer processes along with the complexities involved in the interfacial regions of vapor and liquid phases. Several experimental works have been carried out in the recent past to understand the condensation process in detail. However, understanding the phenomenon using computational technique is more advantageous as the interfacial mass transfer between gas and liquid can be modelled accurately. In the present work, condensation of a saturated vapor bubble in the sub-cooled liquid is studied, and various factors that influence the bubble shape change and the bubble lifetime, are evaluated. The analysis is carried out using the 'Multi-Fluid Volume of Fluid' (VOF) and 'Thermal Phase Change' (TPC) models implemented in ANSYS Fluent commercial CFD solver. A detailed study is performed to obtain the best approach for calculating interfacial area density using a 'user-defined function' (UDF), and the advantage of the node-based gradient calculation method is exhibited. The numerical results obtained for the history of bubble shape and bubble lifetime are validated against the experiment and previously published works with good accuracy. The paper also elaborates on how the initial bubble diameter, the subcooling temperature, and the system pressure affects the shape and lifetime of the bubble during the condensation process.

Keywords**:** Bubble Condensation, Thermal Phase Change, Interfacial Area Density Modelling, Multi-fluid VOF