Abstract

During flashing, a liquid is transformed into vapour very rapidly through a number of highly intertwined transport processes. Both experimental investigation and physical modelling of this complex process remain as challenges until today. Nevertheless, flashing plays an important role in diverse engineering systems.

In the first problem, the phenomenon of flashing front (FF) propagation has been studied experimentally through a shock tube experiment. Although flash evaporation in vertical channels has been investigated in past, the understanding is yet incomplete. In the present work, the details of FF hydrodynamics, formation and propagation of front, propagation speed, and time response of the FF have been studied through visualization as well as pressure and temperature measurements. The interesting phenomenon of jet formation (void formation) has also been investigated in sufficient detail. It is found that the front speed increases with the degree of superheat as well as the tube inclination towards the vertical.

The phenomenon of the FF propagation in the presence of the nucleation has been studied computationally, simulating in a one-dimensional shock tube domain. The governing equations, coupled non-conservative advection equation for volume fraction and Euler equations are solved with different relaxations (mechanical, thermal and chemical). In the shock tube, expansion waves are generated, which interact with interface leading to a change in the interface configuration, as well as pressure and velocity jump under the presence of nucleation site (NS). It is found that when the NS is at the end wall, reflection, and interaction with expansion wave, prominent to a rather complex flow field.

The effects of flashing of the flowing heated liquid in the adiabatic riser of a rectangular natural circulation loop have been studied analytically. The two-phase zone in the loop is addressed by simple averaging through the homogeneous equilibrium model and drift flux model. It is found that, due to flashing, the maximum mass flow rate reduces compared to without flashing in the same loop. In addition to this observation, a significant finding is that the static instability region also reduces when the flashing is considered. Continued to this, the effect of flashing in the dual risers over a range of operating conditions is also investigated and the findings are important, as significant changes are noted in loop performance in the presence of flashing.

This dissertation aims to contribute to the ongoing study of flash evaporation by (i) investigating the FF propagation experimentally, (ii) by simulating the same computationally and (iii) by analytically studying the performance of flashing driven natural circulation loops.

Keywords: Flashing, Flashing front, Expansion wave, Compressible two-phase flow, Natural circulation loop, Ledinegg instability, Homogenous equilibrium model, Drift flux model.