Abstract

The role of droplets in vertical upwards annular flow is investigated, focusing on the droplet size distributions, dynamics and deposition phenomena. An experimental program was performed based on a new laser optical technique developed in these laboratories and implemented here for annular flow. This permitted the simultaneous measurement of droplet size, axial and radial velocity.

The dependence of droplet size distributions on flow conditions is analyzed. The Upper-Log Normal function proves to be a good model for the size distribution. The mechanism controlling the maximum stable drop size was found to result from the interaction of the pressure fluctuations of the turbulent flow of the gas core with the droplet.

The average axial droplet velocity showed a weak dependence on gas rates. This can be explained once the droplet size distribution and droplet size-velocity relationship are analyzed simultaneously. The surprising result from the droplet conditional analysis is that larger droplet travel faster than smaller ones. This dependence cannot be explained if the drag curves used do not take into account the high levels of turbulence present in the gas core in annular flow. If these are considered, then interesting new situations of multiplicity and stability of droplet terminal velocities are encountered. Also, the observed size-velocity relationship can be explained.

A droplet deposition is formulated based on the particle inertia control. This permitted the calculation of rates of drop deposition directly from the droplet size and velocities data. With the rates of deposition and droplet velocities known, the momentum balance equations now can be written to include the droplet exchange terms. It is shown that droplet entrainment can be responsible for a significant part of the total measured pressure drop. The interfacial friction factors calculated from these results are essentially independent of liquid film Reynolds number.