Intermittent – Annular Flow Transition Analysis of R410a Based on Capacitance Signal Clustering

Hugo Canière [C, S], Christophe T'Joen and Michel De Paepe
Department of Flow, Heat and Combustion Mechanics, Ghent University - UGent, Gent, Belgium

To study the objectivity in flow pattern mapping of horizontal two-phase flow in macroscale tubes, a capacitance sensor is developed for use with refrigerants. Sensor signals are gathered with R410A in an 8mm I.D. smooth tube at a saturation temperature of 15°C in the mass velocity range of 200 to 500kg/m²s and vapour quality range from 0 to 1 in steps of 0.025. A visual classification based on high speed camera images is made for comparison reasons. The fuzzy c-means clustering algorithm is used to classify the sensor signals. This soft clustering algorithm perfectly predicts the slug/intermittent flow transition compared to our visual observations. The intermittent/annular flow transition is very gradual. A probability approach can therefore better describe this transition. The membership grades of the cluster algorithm can be interpreted as flow probabilities to quantify this transition.