National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Phase-split of Liquid-liquid Two-phase Flow in T-junction: Numerical, Experimental, and Computational Investigation
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Venue	: Seminar Hall, Department of Mechanical Engineering
Date and Time	: 28 Jun 2024 (05:00 PM)

Abstract

: Split dynamics of the liquid-liquid two-phase mixture (LLTPM) through horizontal T-junction is numerically investigated. 3D steady-state numerical solutions are achieved by adopting a Finite Volume-based Eulerian Multi-Fluid VOF model. To simulate the turbulence SST *k-w* model is used. Before producing the results, the adopted numerical methodology is successfully validated with the results available in the literature. Extensive studies are made by varying the inlet-volume-fraction, inlet-mixture-velocity, liquid-pair of LLTPM, and the conduit-diameter of T-junction in a wide range and the role of each of these parameters on the said phase split phenomena are elaborately explored. Inertia imbalance is found to be the most vital factor in influencing the dynamics of phase split. More split is obtained for the mixture with high density-difference between the component liquids. Depending on the conduit diameter, liquid-pair, and inlet-mixture-velocity, a critical inlet-volume-fraction (> 0.5) is found where no split occurs, and the phenomenon of phase split is reversed at the critical inlet-volume-fraction.

Experimental attempts are made to study the phase-separation of co-current liquid-liquid two-phase mixtures (LLTPM) flowing through horizontal and vertical T-junction considering five different liquid pairs of five different fluid property pairs. For each liquid pair, rigorous experimentations are conducted by varying the superficial velocities of the constituent phases. An experimental attempt is also made to investigate the phase-separations of LLTPM flow in T-junctions with a 45° branch angle placed in three different inclined planes using a single liquid pair. The phase-splits of the liquid-liquid two-phase flows in the T-junction under different working situations or flow situations are identified, measured, and analyzed by espousing multiple schemes. The effects of the fluid properties and the constituent phases&rsquo superficial velocity combination on the phase-separation are studied, and the main influencing fluid properties are identified. An attempt is also made to inspect the influence of the branch angle and inclination angle of the T-junction&rsquos plane. After measuring and collecting the experimental outcomes, extensive analyses are made by adopting multiple strategies to quantify, parameterize, and represent the phase-split or phase-separation. The said phase-separation/split is perfectly quantified and parametrized using the concept of phase-split capacity defined by the fractional diversions of heavier and lighter liquids through the branch arm (D_{hb} and D_{lb}), as introduced here. The experimental observations are embedded in some experimental data points. The phase-separation for a particular combination of the liquid pair and the constituent phases&rsquo superficial velocities is perfectly reflected by the position of the corresponding experimental data point in the proposed D_{hb} versus D_{lb} plot. The proposed plots between the phase-split capacity and fractional volume take-off, as defined here, represent the phase-split performance with respect to the total fractional diversion of the LLTPM through the T-junction&rsquos branch arm. Biologically inspired computational intelligence (CI) based hybrid forecasters have been indigenously developed using the &lsquoC&rsquo programming language by employing the experimental data points. For the inlined T-junction, an attempt is also made to develop CI-based forecasters using objective descriptions of the two-phase flow. The proposed forecasters successfully capture the highly complex and nonlinear relationship between the liquid-liquid phase-split performance in the T-juction and the input situations and perfectly forecast the phase-split performance with high accuracy against different working conditions.