National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Phase-split of Liquid-liquid Two-phase Flow in T-junction: Numerical, Experimental, and Computational Intelligence-Based Investigations
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Venue	: Seminar Hall of Mechanical Engineering Department (Room No: ME001) (https://meet.google.com/mcy-hcrr-iej)
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Abstract

: At first, the split dynamics of uniform homogeneous liquid-liquid two-phase mixtures (LLTPM) entering through the inlet section of a horizontal T-junction is numerically investigated. 3D steady-state numerical solutions are achieved by adopting a Finite Volume-based Eulerian Multi-Fluid VOF model. The SST k-ω model is used to simulate the turbulence. 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 (LP) 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 is elaborately explored. Experimental and computational intelligence (CI)-based investigations on the phase-separation of nonhomogeneous LLTPFs entering at the inlet section of horizontal and vertical T-junctions are separately made considering 5 different LPs of 5 different fluid property pairs and varying the constituent (heavier and lighter) phases' superficial velocities (Vsh, Vsl) for each LP. The experimentally generated results are extensively analyzed using multiple strategies to identify, measure, quantify, parameterize, and represent the said LLTPF-split under different flow situations for each type of T-junction. The role of the constituent phases' superficial velocities is extensively investigated. The influences of fluid properties are elaborately studied, and the main influencing fluid properties are marked. Important intermediate parameters, namely fractional diversions of the heavier and lighter liquids through the branch arm (Dhb & Dlb), are defined and introduced to quantify the phase-split. The phase-split performance is quantified and parametrized by introducing the term phase-split capacity (ξ), which is defined as the absolute difference between the Dhb and Dlb. The phase-split performance of the horizontal T-junction is evaluated in another way also to incorporate some diversity in the process of its evaluation by introducing phase-split capability (ε), defined as the absolute difference between the lighter liquid's volume fractions at the inlet section and branch outlet (VFli & VFlb). The experimental outcomes against different combinations of the LP, Vsh, and Vsl, are embedded in some experimental data points. The position of an experimental data point in the proposed 2D coordinate system for Dhb versus Dlb plot or VFlb versus VFli plot perfectly reflects the phase-split intensity against that experimental data. The position of an experimental data point in the ξ versus fractional volume take-off (φv) plots or ε versus φv plots, as proposed here, represents the phase-split performance with respect to the total fractional diversion of the mixture via the branch arm. For each of the two cases (for horizontal and vertical T-junctions), the highly complex and nonlinear relationship between phase-split performance and the input flow situations is successfully modeled by indigenously developed biologically inspired CI-based hybrid methodologies that are able to predict the phase-split performance with high accuracy by knowing the working conditions (against diverse combinations of LP, Vsl, & Vsh). The phase-separation of nonhomogeneous kerosene-water LLTPF entering through the inlet section of a T-junction with a 45° branch angle is investigated through experimental and CI-based studies by placing the T-junction's plane (the plane passing through the axes of the three arms) at three different inclined (0°, 30°, & 60°) positions. Extensive investigations are conducted by varying Vsk and Vsw at each inclination of the T-junction plane (θ). The effects of the Vsk, Vsw, and θ on ξ are explored, and the main influencing factors are identified. The experimental data points' positions in the Dwb versus Dkb plots perfectly represent the respective phase-split intensity. The positions of the experimental data points in the proposed ξ versus φv plots represent the phase-split performance with respect to the total fractional flow diversion via the branch arm. The relationship between ξ and input flow situations is successfully caught by an indigenously developed CI-based hybrid methodology that can predict ξ by knowing the input combination of θ, Vsk, and Vsw. The said phase-split is characterized and identified using LLTPF's objective descriptions by employing objective sensors, like differential pressure transmitters and in-house fabricated conductivity probes, to avoid possible confusion arising from subjective descriptions. The relationship of ξ with the non-parametric probability distribution and statistical parameters extracted from the objective signatures is fruitfully captured using an indigenously developed CI-based hybrid scheme that can forecast ξ with high accuracy by knowing the objective signatures' statistical features under different flow situations.