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Characterization of Flow Dynamics and Reduced-Order Description of Experimental Two-Phase Pipe Flow BIANCA VIGGIANO, Portland State University, USA, OLAF SKJRAASEN, MURAT TUTKUN, Institute for Energy Technology, Norway, RAUL BAYOAN CAL, Portland State University, USA
— Multiphase pipe flow is investigated using proper orthogonal decomposition for tomographic X-ray data, where holdup, cross sectional phase distributions and phase interface characteristics are obtained. Instantaneous phase fractions of dispersed flow and slug flow are analyzed and a reduced order dynamical description is generated. The dispersed flow displays coherent structures in the first few modes near the horizontal center of the pipe, representing the liquid-liquid interface location while the slug flow case shows coherent structures that correspond to the cyclical formation and breakup of the slug in the first 10 modes. The reconstruction of the fields indicate that main features are observed in the low order dynamical descriptions utilizing less than 1% of the full order model. POD temporal coefficients a_1, a_2 and a_3 show interdependence for the slug flow case. The coefficients also describe the phase fraction holdup as a function of time for both dispersed and slug flow. These flows are highly applicable to petroleum transport pipelines, hydroelectric power and heat exchanger tubes to name a few. The mathematical representations obtained via proper orthogonal decomposition will deepen the understanding of fundamental multiphase flow characteristics.

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