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High Pressure Multiphase Flow Experiments: The Impact of Pressure on Flow Patterns Using an X-Ray Tomography Visualisation System

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Abstract : Multiphase flow structures of two-phase multicomponent fluids were experimentally investigated in a large diameter high-pressure pipeline up to 130 bar at TÜV SÜD's National Engineering Laboratory Advanced Multiphase Facility. One of the main objectives of the experimental test campaign was to evaluate the impact of pressure on multiphase flow patterns as much of the existing information is based on low-pressure measurements. The experiments were performed in a horizontal and vertical orientation in both 4-inch and 6-inch pipework using nitrogen, ExxsolTM D140 oil, and a 6% aqueous solution of NaCl at incremental pressures from 10 bar to 130 bar. To visualise the detailed structure of the flow of the entire cross-section of the pipe, a fast response X-ray tomography system was used. A wide range of superficial velocities from 0.6 m/s to 24.0 m/s for gas and 0.04 m/s and 6.48 m/s for liquid was examined to evaluate different flow regimes. The results illustrated the suppression of instabilities between the gas and the liquid at the measurement location and that intermittent or slug flow was observed less frequently as the pressure was increased. CFD modellings of low and high-pressure simulations were able to successfully predict the likelihood of intermittent flow; however, further tuning is necessary to predict the slugging frequency. The dataset generated is unique as limited datasets exist above 100 bar and is of considerable value to multiphase flow specialists and numerical modellers.

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