Computational Fluid Dynamics Modeling of Flow Properties Fluctuations in Slug-Churn Flow through Pipe Elbow

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Abstract : Prediction of multiphase flow induced forces, void fraction and pressure is crucial at both design and operating stages of practical energy and process pipe systems. In this study, transient numerical simulations of upward slug-churn flow through a vertical 90-degree elbow have been conducted. The volume of fluid (VOF) method was used to model the two-phase flows while the K-epsilon Reynolds-Averaged Navier-Stokes (RANS) equations were used to model turbulence in the flows. The simulation results were validated using experimental results. Void fraction signal, peak frequency and maximum magnitude of void fraction fluctuation of the slug-churn flow validation case studies compared well with experimental results. The x and y direction force fluctuation signals at the elbow control volume were obtained by carrying out force balance calculations using the directly extracted time domain signals of flow properties through the control volume in the numerical simulation. The computed force signal compared well with experiment for the slug and churn flow validation case studies. Hence, the present numerical simulation technique was able to predict the behaviours of the one-way flow induced forces and void fraction fluctuations.
Keywords : computational fluid dynamics, flow induced vibration, slug-churn flow, void fraction and force fluctuation
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