Investigation of Slug Flow Induced Forces on Pipe Bends Applying STAR-OLGA Coupling

Gas-liquid slug flow can exert cyclic forces on pipe bends. A knowledge of the time-varying force and its distribution on the bends is highly desirable in designing the piping and piping support systems. A numerical study has been carried out to obtain an understanding of the slug flow induced forces and develop simulation models for engineering applications. The STAR-OLGA coupling has been applied to achieve a co-simulation of 3-D CFD (Computational Fluid Dynamics) and 1-D pipeline models. In the coupling model a horizontally oriented 90° bend with a diameter of 70 mm is modelled using 3-D CFD code STAR-CCM+ and the pipeline upstream of the bend is modelled using 1-D code OLGA. The predictions of the coupling model have been compared with experimental data where available. The time dependent forces and force components acting on the bend wall have been analysed together with the liquid holdup time traces in the bend. Significantly large forces appear when the highly turbulent slug front arrives at the bend centre hitting the bend in the wall and the slug body is travelling in the bend. The distribution of the force on the bend wall and gas/liquid phases in the bend has been exhibited. The force distribution contour plots illustrate that the large force acts on a certain area of the bend wall, which is the most vulnerable part to mechanical damage. It has been demonstrated that the STAR-OLGA coupling model can provide reasonable predictions of the slug flow induced forces on the bend.

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