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Numerical Investigation of Pressure Drop in Core Annular Horizontal Pipe Flow

Authors : John Abish, Bibin John

Abstract : Liquid-liquid flow in horizontal pipe is investigated in order to reveal the flow patterns arising from the co-existed flow of oil and water. The main focus of the study is to identify the feasibility of reducing the pumping power requirements of petroleum transportation lines by having an annular flow of water around the thick oil core. This idea makes oil transportation cheaper and easier. The present study uses computational fluid dynamics techniques to model oil-water flows with liquids of similar density and varying viscosity. The simulation of the flow is conducted using commercial package Ansys Fluent. Flow domain modeling and grid generation accomplished through ICEM CFD. The horizontal pipe is modeled with two different inlets and meshed with O-Grid mesh. The standard k-ε turbulence scheme along with the volume of fluid (VOF) multiphase modeling method is used to simulate the oil-water flow. Transient flow simulations carried out for a total period of 30s showed significant reduction in pressure drop while employing core annular flow concept. This study also reveals the effect of viscosity ratio, mass flow rates of individual fluids and ration of superficial velocities on the pressure drop across the pipe length. Contours of velocity and volume fractions are employed along with pressure predictions to assess the effectiveness of this proposed concept quantitatively as well as qualitatively. The outcome of the present study is found to be very relevant for the petrochemical industries.

Keywords : computational fluid dynamics, core-annular flows, frictional flow resistance, oil transportation, pressure drop
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