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Gas-liquid two-phase upward flow through a vertical pipe: Influence of pressure drop on the measurement of fluid flow rate (Article) (Open Access)

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Abstract

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The accurate estimation of pressure drop during multiphase fluid flow in vertical pipes has been widely recognized as a critical problem in oil wells completion design. The flow of fluids through the vertical tubing strings causes great losses of energy through friction, where the value of this loss depends on fluid flow viscosity and the size of the conduit. A number of friction factor correlations, which have acceptably accurate results in large diameter pipes, are significantly in error when applied to smaller diameter pipes. Normally, the pressure loss occurs due to friction between the fluid flow and the pipe walls. The estimation of the pressure gradients during the multiphase flow of fluids is very complex due to the variation of many fluid parameters along the vertical pipe. Other complications relate to the numerous flow regimes and the variabilities of the fluid interfaces involved. Accordingly, knowledge about pressure drops and friction factors is required to determine the fluid flow rate of the oil wells. This paper describes the influences of the pressure drop on the measurement of the fluid flow by estimating the friction factor using different empirical friction correlations. Field experimental work was performed at the well site to predict the fluid flow rate of 48 electrical submersible pump (ESP) oil wells, using the newly developed mathematical model. Using Darcy and Colebrook friction factor correlations, the results show high average relative errors, exceeding ±18.0%, in predicted liquid flow rate (oil and water). In gas rate, more than 77% of the data exceeded ±10.0% relative error to the predicted gas rate. For the Blasius correlation, the results showed the predicted liquid flow rate was in agreement with measured values, where the average relative error was less than ±18.0%, and for the gas rate, 68% of the data showed more than ±10% relative error.

Author keywords

Flow rate | Flow regime | Friction factor | Multiphase flow | Pressure drop | Pressure loss

Indexed keywords

Engineering controlled terms: Drops | Errors | Estimation | Friction | Liquids | Multiphase flow | Oil well completion | Pressure drop | Submersible pumps

Engineering uncontrolled terms: Average relative error | Electrical submersible pumps | Flow regimes | Friction correlations | Friction factor correlation | Friction factors | Multi-phase fluid flow | Pressure loss

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