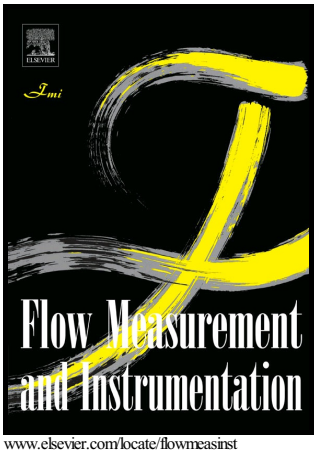

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Modeling of Multiphase Flow through Chokes

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Abstract

The accurate measurement of mass flow rate is of vital importance with respect to production control in gas or oil fields equipped with chokes. A theoretical model to predict the flow regime and mass flow rate of multiphase flow through chokes was developed and derived on the basis of Perkins and Al-safran models. In the present model, the assumption of adiabatic condition between gas and liquid was adopted alternatively when fluids flow through the throat of chokes, which is different from the existing models. The slippage phenomena between gas and liquid have also been taken into consideration in this model. After analyzing, the Schuller slip model was found to be the most appropriate one, which is consistent with the work of Al-safran. Furthermore，the effect of the discharge coefficient C_d on the model calculation accuracy was discussed. The way to calibrate irreversible loss using the optimal discharge coefficient was recommended instead of a constant coefficient, which means that experiment should be carried out for a particular choke before use. Meanwhile, the present model was validated and compared with the models currently used in fields against both subcritical and critical experimental data. The model evaluation demonstrated that the present model was more reliable in predicting the critical pressure ratio y_c, especially in large *GLR* condition. Meanwhile, the statistical error analysis of calculated mass flow rate showed that the average percent error (E_1), absolute average error (E_2) and standard deviation (E_3) were 0.117%, 8.754% and 0.729% for the present model, respectively. Compared to other models, the present model prediction outperforms their predictions a lot. It indicated that the present model was more reasonable and reliable in predicting the mass flow rate of multiphase flow through chokes.

Keywords: mass flow rate; critical pressure ratio; multiphase flow; choke

1. Introduction

It is a common practice that the mixture of gas/water or gas/water/oil flow through chokes in the gas or oil fields. Chokes are important devices that installing at gas transmission pipeline or wellhead to protect the equipment from unusual pressure fluctuations, to prevent water coning or sand production and to control flow rates [1-4]. The purposes of installing chokes may be various. However, the flow regime through the choke is similar. There are two kinds of flow regimes in the flow, which are the critical and subcritical flows according to flow rate, respectively [5]. If the flow rate of choke throat is less than the local sound speed, the flow is subcritical. Furthermore, the critical flow occurs once the flow rate is equal to the local sound speed [6-8]. The pressure ratio of downstream to upstream is often used to distinguish between subcritical flow and critical flow due to the difficulty in estimating the local sound speed in the field. [9-10]. The critical pressure ratio for single gas flow is almost equal to 0.55, which means that the flow regime will change from subcritical flow to critical flow once the pressure ratio is less than 0.55. For