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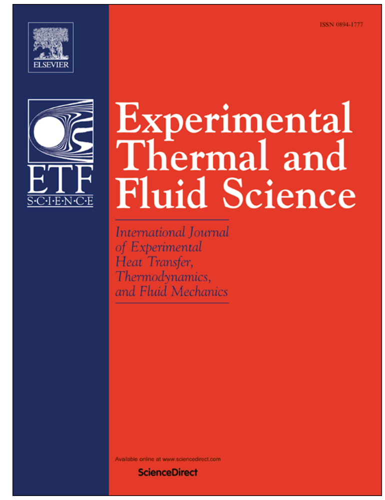

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A new model for volume fraction measurements of horizontal high-pressure wet gas flow using gamma-based techniques

Yanzhi Pan[1,2], Yugao Ma[3], Shanfang Huang[3,2], Pengman Niu[1], Dong Wang[1], Jianhua Xie[2]

1. *State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, PR China*
2. *Haimo Technologies Group Corp., Lanzhou 730050, China*
3. *Department of Engineering Physics, Tsinghua University, Beijing 100084, China*

Abstract

The accurate predictions of void fraction and gas volume fraction are important in characterizing wet gas flow, as they are the basic input for determining other key flow parameters, such as flow velocity and flow rate of each phase. In previous studies, empirical relationships were used to predict void fraction and gas volume fraction, which have limited applicability due to the lack of detailed structural and dynamic information involved in two-phase flow. Hence, in this work, attempts are being made to develop a model based on a simplified two-phase interfacial structure. A slip ratio based equal-diameter double-circle model is proposed to predict the void fraction and gas volume fraction using gamma ray attenuation method for high-pressure wet gas conditions. Model predictions were verified against experiments in a 172.0 mm inner diameter horizontal pipe. Nitrogen and kerosene were used as the test fluids with gas volume fractions ranging from 92% to 100%. The relative errors in the line-averaged void fraction predicted by the slip ratio based model were within $\pm 2\%$. In addition, this model can be used to explain the relationship between the key flow parameters and further to predict the optimal measuring angle of the gamma rays. The line-averaged void fraction measured by the gamma ray attenuation method at a proper angle predicted by the model is equal to the gas volume fraction for these high-pressure wet gas conditions, with an average relative error of 0.2%.

Key words: high-pressure wet gas flow; slip ratio; equal-diameter double-circle model; gamma ray attenuation method; gas volume fraction