EVALUATION OF THE LIQUID HOLDUP IN A STRATIFIED GAS-LIQUID INCLINED PIPELINE ACCORDING TO THE HERSCHEL–BULKLEY FLUID MODEL

Lintong Hou[1,2] and Jingyu Xu[1,2]

[1]School of Engineering Sciences, University of Chinese Academy of Sciences, Beijing 100049, China
[2]Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China

ABSTRACT

The theoretical models of gas-liquid flow based on Newtonian fluid, power-rate fluid and Bingham fluid cannot be accurately applied to the unconventional petroleum field. To this end, based on the Herschel-Berkeley fluid constitutive, with the help of the two-fluid theory and flow control equations, a prediction model of liquid holdup in a two-phase stratified pipe flow is derived. The effects of non-Newtonian fluid rheological parameters, flow conditions and pipe angle on the gas-liquid stratified flow of the Herschel-Berkeley fluid are comprehensively considered. The results show that non-Newtonian rheological characteristics (such as power law index and yield stress) have a significant effect on the liquid holdup in two-phase flow. The specific performance is that the enhancement of liquid yield and shear thinning characteristics will lead to an increase in liquid holdup. Comparing the experimental data, the liquid holdup calculation model shows a good prediction effect. The main feature of this prediction model is that even if the liquid has complex rheology or contains solid particles, it can also describe the two-phase stratified flow through the gas/non-Newtonian fluid behaviour. This model provides new insights into the gas-liquid flow characteristics of complex fluids in inclined pipes.

Key words: Herschel-Bulkley fluid; Gas-liquid stratified flow; Liquid holdup; Prediction model