ON THE SLUG-ANNULAR TRANSITION OF TWO-PHASE GAS-LIQUID FLOWS AT MICROGRAVITY

J. F. ZHAO, W. R. HU

National Microgravity Laboratory/CAS; Institute of Mechanics, Chinese Academy of Sciences (CAS). 15, Beisihuan Xilu, Beijing 100080, China

In accordance with observations, it is proposed that two mechanisms control the slug-annular transition of two-phase gas-liquid flows at microgravity conditions. The first one is the instability of annular liquid film. In this case, increase of the amplitude of perturbation waves leads to formation of a "liquid-bridge" that separates continue gas core into isolate bubbles, and then two-phase annular flow will transit to slug or bubble flow. The conditions of this transition will be determined by the linear stability analyses of core-annular flow configuration (Carron & Best, 1994, 1996). The other mechanism is the rupture of "liquid-bridges" due to the reason that the gas inertial impetus overcomes the surface tension force. The transition from slug to annular flow will occur when "liquid-bridges" rupture, resulting in a continuous gas core. Based on this idea, a semi-theoretical Weber number model is proposed by Zhao & Hu (2000). In principle, the two kinds of transitions don't have to overlap. Comparisons between the two models mentioned above, however, show that their predictions are consistent with each other despite some disagreements for the case of less liquid flow rate. The reason underlining the above fact is discussed. The void fraction matched model (Dukler et al., 1988; Bousman, 1995) is also discussed. This model is based on the assumption that the void fraction must be a continuous function of flow rates. Thus the transitional void fraction is determined by equaling those calculated from the correlations for both slug flow and annular flow. Analyses show that there exist some severe problems in the void fraction matched model, which arise from both its basic assumption and the empirical correlation for annular flow.

J. F. ZHAO, National Microgravity Laboratory/CAS; Institute of Mechanics, Chinese Academy of Sciences. 15, Beisihuan Xilu, Beijing 100080, China. Tel: 86-10-62615542. Fax: 86-10-62615524. E-mail: jfzhao@imech.ac.cn