LIQUID PHASE VELOCITY IN TURBULENT FLOW OF A WATER/DISPERSED BUBBLE MIXTURE IN LARGE DIAMETER HORIZONTAL PIPES

A. A. Lakis* and N.D.Trinh
Department of Mechanical Engineering, École Polytechnique de Montréal. C.P. 6079, Succ. Centre-Ville, Montréal, Québec, **CANADA** H3C 3A7.
*Corresponding author: aouni.lakis@polymtl.ca

ABSTRACT

Methods for the measurement of impact pressure in two-phase bubble flow are discussed, leading to the design of a liquid phase isolator. This simple device, equipped with a miniature pressure transducer, makes it possible to measure the impact pressure of the liquid phase in a flowing gas-liquid mixture. The liquid velocity can then be predicted, provided that the local void fraction is known. Using a measured void fraction it is possible to predict the pressure drop, mixture and phase velocities, and liquid phase distribution by either finding new correlations or using a newly-developed numerical model. Experiments were performed in 8.6-in (218.44 mm) diameter horizontal pipes with 0.30 maximum flow volumetric qualities. In high turbulence conditions ($R_e = 2 \times 10^6$), we observed that the liquid velocity profile behaves like single-phase liquid flow; the symmetry of the profile changes when flow volumetric quality varies from about 12 % to its maximum value. It was determined that, in fully-developed dispersed bubble flow the void fraction is uniform, giving rise to a uniform vertical pressure distribution. This strongly influences the vertical phase distribution. The liquid velocity distribution was found to be uniform in the vertical plane. The presence of a large concentration of bubbles in the upper part of the pipe causes the velocity of the liquid there to be generally lower than in the liquid phase; the liquid velocity decreases in the transversal plane because of the drag effect of local displaced bubbles. Liquid velocity is therefore distributed non-uniformly in the transversal plane. The effects of gravity (assuming it to be stabilized in steady fully developed flow), interfacial forces and the turbulence structure of the continuous phase appear to have a great influence on the liquid phase velocity distribution in a large horizontal pipe. In this study, the liquid phase velocity of turbulent flow of a water/dispersed bubble mixture in large diameter pipes is predicted. The first step is development of a measuring technique for the liquid phase velocity of dispersed bubble flow. Subsequently, the relationship between the phase distribution mechanism and the turbulence structure in the continuous phase is expressed in terms of linear liquid velocities (in single- phase and two-phase flows). Finally, velocity distributions determined using experimental data are compared with those predicted numerically.

Keyword: Two-phase bubble flow, liquid phase velocity and large diameter horizontal pipe flow.