Measurement of both gas and liquid velocity profiles for bubble-induced turbulent flow

H. Takiguchi1*, M. Furuya1, T. Arai1, T. Kanai1
1: Central Research Institute of Electric Power Industry (CRIEPI)
* Correspondent author: t-hiro@criepi.denken.or.jp

Keywords: Laser Doppler velocimetry, Wire mesh sensor, Bubbly flow, Velocity, Gas density dependence

HIGHLIGHTS

• A combined measurement technique using laser Doppler velocimetry (LDV) and wire mesh sensor (WMS) was developed to simultaneously measure gas and liquid phase velocity profiles in two-phase flow.
• In order to reveal gas density effect on the velocity field due to bubble deformation, which is undefined in a drift flux model, gas velocity, void fraction and liquid velocity, including its fluctuation, were measured.
• From the negative trends of drift velocity relative to gas density and the mismatching with the drift flux model, it was suggested that the deformation of bubbles provides the possibility of gas density effect on the velocity field.

ABSTRACT

In order to understand forces acting on bubbles generated around interfaces into two-phase flow under high pressure and high temperature, we developed a combined measurement method applicable to gas phase velocity, void fraction, liquid-phase velocity and its fluctuation in a turbulent field using LDV and WMS. Gas density dependence of these values as referred to above was compared using four types of gases (helium, air, nitrogen and argon) to test the reliability of this compensated method.

The trends of the experiment indicated that [1] gas drift velocity was shifted closer to liquid phase velocity with increasing gas density in Fig. (a), [2] gas density affected the liquid and gas velocity field that the trend of liquid velocity worked in a positive direction and that of gas velocity worked in a negative direction, and [3] void fraction dependence of drift velocities was not in accordance with a drift flux model using water and air in Fig. (b).

From the results, it can be considered that the deformation of bubbles shown in Fig. (c) affects bubbles to mass change according to change of relative frictional force, in other words, density change. This hypothesis suggests that gas density has a considerable effect on forces acting on bubbles under liquid and gas velocity field.

![Graphs](image1.png)

(a) Liquid velocity vs. gas velocity  (b) Void fraction vs. gas drift velocity  (c) A snap shot of bubble deformation

**Fig 1** Results of gas density dependence on gas and liquid velocity field caused by bubble deformation.