EXPERIMENTAL INVESTIGATION WITH DIGITAL PARTICLE IMAGE VELOCIMETRY FOR TURBULENT FLOW OF SLENDER PARTICLES IN A STIRRED TANK

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Stirred vessels are one of the oldest and most commonly encountered industrial devices. It is frequently used in chemical process industry where gas dispersion in liquids, liquid-liquid blending and solid suspensions in liquids are involved. The design of stirred tanks requires the knowledge of flow field and understanding of the effects of various system parameters on mixing efficiency.

However the experimental data acquisitions for design purposes with solid-liquid two-phase flows in a stirred tank are difficult. Solid-liquid two-phase flow is very common and of considerable interest for multiphase flow in stirred tanks. Intrusive probe techniques introduce an undesirable physical disturbance to the flow and can result in either inaccuracies in the measurements or even permanent impairment of the probes. A number of non-intrusive methods for the measurement of particle velocities have been developed in the last decade. Among these new methods, Digital Particle Image Velocimetry (DPIV) is a very appropriate choice. DPIV is a technique that combines the accuracy of Laser Dynamic Velocimetry (LDV) with the qualitative information from flow visualization.

In the case of solid-liquid two-phase flow, solid phase is often taken as spherical particles. Non-spherical particles are rarely involved. Slender particles are important in many industrial processes. In recent years, the problems related to slender particles have gained increasing attention in process engineering. Different from spherical particles, slender particles are orientation dependent. Orientation, as shown in the schematic diagram of Figure 1, is significant to the application of slender particles. For example, Herzhaft and Guazzelli *et al.* (1) (2) experimented on the sedimentation of fibers in a Newtonian fluid. By using a charged coupled device video camera connected to an image processing and acquisition board located in a computer, they obtained the mean sedimentation velocity, the orientation distribution of fibers in the bulk of the settling suspensions.

In this paper, we carried out experiments with slender particles in turbulent solid-liquid two-phase flow field using DPIV. The present work is aimed at the measurement of orientations and velocities of slender particles in a stirred tank under different conditions. The turbulent velocity field is obtained. The influences of impeller speed, aspect ratio and solid concentration of slender particles on velocity field are discussed. Figure 2 shows one of the many results. Besides these, the velocity profiles of solid-liquid two-phase flow with spherical particles are also measured.

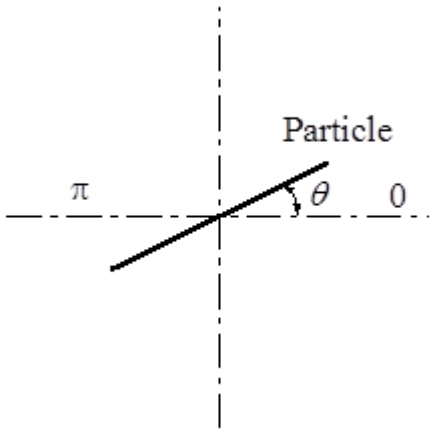

Figure 1. Schematic diagram of orientation of a slender particle (radian from 0 to π)

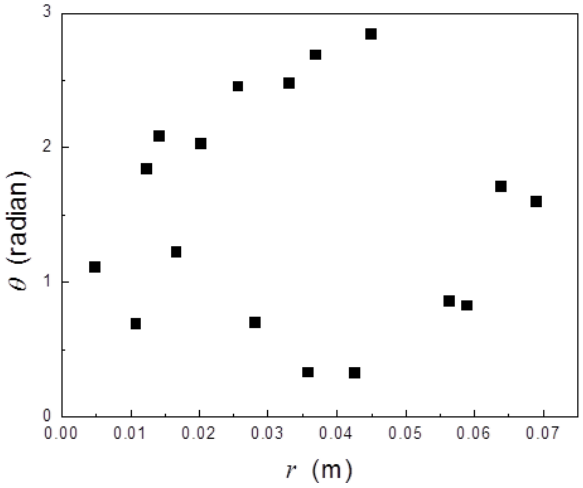

Figure 2. Experimental orientation of a slender particle at the top of the vessel (r, radial coordinate; θ, the angle between the particle and the plane normal to velocity)

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