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SEDIMENTATION OF DILUTE SUSPENSION IN INTERMEDIATE REGION

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Abstract: *The present paper describes the results of experimental investigation of the continuous sedimentation of a dilute fine-grained suspension in the intermediate region of settlement. The effects of particle size (glass beads of average diameter 150 – 850* μm), concentration *and inclination of the vessel axis on particle local and mean fall velocities were evaluated.*

Keywords: ***sedimentation, intermediate settlement, particle size, concentration, vessel inclination.***

1. Introduction

The particle fall velocity is an integral parameter describing behavior of the particle in the solid-liquid mixture flow. The paper describes the experimental results of dilute suspension sedimentation in the intermediate region of sedimentation for particle Reynolds number Re_p varying from 3 to 140 in vertical and inclined sedimentation vessel.

The local fall velocity of a particle in suspension is generally determined by the particle diameter d, shape b, and density ρ_p, the volumetric concentration of the suspension C_v, the distance from the container wall y, and the density ρ_o and viscosity μ_o of the carrier liquid. It is also dependent on the dimension D of the horizontal cross-section and shape B of the container, and, as will be shown below, on the inclination of the container walls α.

To determine the local absolute particle velocity w_p of the individual particles and also the local velocity of displaced water, v_o, the LDA (Laser Doppler Anemometry) was used (Vlasak et al., 1991). The effects of the particle concentration of the suspension and the vessel inclination on the particle velocity and the internal structure of sedimentation were described. For higher particle concentrations the radiometric tracer method was used, and a method based on the increment of hydrostatic pressure due to the increase in suspension density was developed.

To measure the particle and water velocities equipment consisting of a sedimentation vessel (a glass tube of inner diameter D = 0.05 m and length L = 2.3 m), measuring devices, and a particle dosing device, which maintained a constant solid concentration of the measured suspension. Narrow sized glass beads of different mean diameters (mean particle diameter varied in range d_{50} = 150 – 850 μm) were used as model particles.

2. Results and discussion

The absolute local particle fall velocities and local water velocities were measured for different volumetric concentrations C_v of the suspension and three values of the sedimentation vessel axis inclination α = 0, 1% and 2%. The effects of concentration and vessel inclination on the particle fall velocity and particles distribution in the vessel cross-section were evaluated.

The absolute particle fall velocity profiles in a vertical vessel are relatively flat and symmetrical with curvature steeper near the vessel walls. The measured profiles of displaced water show very

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similar shapes to absolute particle fall velocity profiles, with the opposite direction, of course. The relative particle fall velocity $w_r = w_p - v_o$ values are nearly constant, independently of the position in the vessel. The difference in the absolute fall velocities is due to the different velocities of the displaced water. In the vertical sedimentation vessel, upward flow of the displaced water was observed near the wall, while downward flow of the displaced water was observed in the central area. The suspension divides into channels, in which so called co-current and counter-current regime of the particles and liquid occurs during continuous sedimentation.

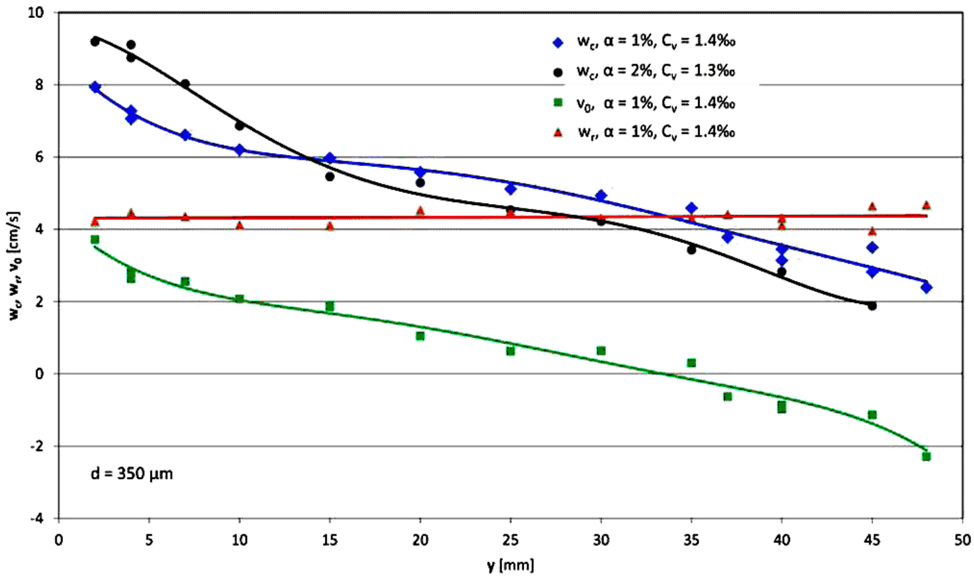

Fig. 1. Relative and absolute particle and water velocity profiles in the inclined sedimentation vessel.

The sedimentation process is highly sensitive to the inclination of the sedimentation vessel axis; even very small inclination causes a considerable change in the inner structure of the sedimentation process. If the axis of the sedimentation vessel is slightly inclined, the absolute particle velocity profiles become significantly asymmetric (see Fig. 1). Nevertheless, the relative particle-water velocity reached an almost constant value over the whole cross-section. An upward flow of the displaced water was conducted near the downward-facing surface of the vessel and more concentrated down ward flow was observed near the upward-facing wall. Higher particle fall velocities are attained near the upward-facing wall, which is located at co-ordinate $y = 0$. The transverse migration of the particles in the direction of the upward-facing wall, combined with an increase of the local concentration near the upward-facing wall, was observed.

It is generally known that the value of absolute particle fall velocity decreases with increasing concentration. Based on our experimental data obtained by the hydrostatic pressure method and the radiometric tracer method measurement (Vlasak et al., 1994, Vlasak & Chara, 1995), the relation $w/w_c = (1 + 4.92\, C_v)^{-1}$, was proposed.

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