CHAPTER-5

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Video were recorded at 120 and 400 fps. These were analysed using image processing algorithms to measure gas holdup, expanded bed height, bubble size distribution, Sauter-mean bubble diameter, aspect ratio and specific interfacial area of bubbles. From pixel density as a function of height above the distributor plate, expanded bed height, foam layer thickness and thickness of entry region were measured. Autocorrelation function of the upper layer of air-water dispersion exhibited a periodic variation with time period of about 0.8 s.

The foam layer width, f_w, was estimated from pixel density as a function of H_s and average value over 60 frames were taken. The foam layer width increases with increasing U_g upto a value of $U_g = 0.1$ ms^{-1} above which it starts decreasing at all values of H_s. The effect became less prominent as the value of H_s increased. It is in contradiction to the findings of Yamashita (1995) who observed that the foam layer thickness increases monotonically with increasing gas velocity. The maximum foam width decreased with increasing value of H_s. At large values of U_g bubble coalescence takes place forming large bubbles which move at large velocity. As a result the foam layer decreases.

The width of entry region increases with increasing settled bed height. It increases upto $U_g = 0.084$ ms^{-1}. Above this value at low values of H_s, the width of entry region becomes constant.

Gas holdup increases with increasing U_g.. For air-water system, no effect of H_s on gas holdup is observed upto U_g =0.04 ms^{-1}. For U_g > 0.04 ms^{-1} large difference in has hold without any definite trend was observed. It may be attributed to flow regime transition from homogeneous glow regime to churn-turbulent design and was confirmed with drift flux diagram. Phase transition for CMC solution was observed at U_g =0.03 ms^{-1}. No significant effect of CMC Conc. on gas holdup is observed for $U_g \leq 0.03$ ms^{-1}.

Number of bubbles decreases smoothly with increasing d_b. BSD is independent of U_g. The number of small bubbles seems to increase slightly with increasing H_s in case of air-water system. In case of CMC solution, number of bubbles decreases with increasing bubble diameter. BSD in all cases were single modal with a few large bubbles. Number of small bubbles increased with increasing concentration of CMC.

The values of d_{32} increased with increasing U_g. The increase was more in the churn turbulent regime. The value of d_{32} is independent of H_s. Present data are lower than the data of Cents et al. (2005), Al-Masry et al. (2006) and Pohoreck et al. (2001). CMC concentration has little effect on the values of d_{32} in the uniformly bubbling regime but showed considerable effect on d_{32}, though, no definite trend was observed.

A wide variation in aspect ratio was observed. The trend is Besagni et al. (2016) also used image processing technique to determine the aspect ratio and observed somewhat similar results. It was thought to be due to distortion of the bubbles. It may also be due to overlapping of small bubbles. In case of large deviation in aspect ration the mean aspect ratio does not have any meaning and were not determined. Similar results were also observed for CMC solution of all concentrations.

Value of a_i increases with increasing value of U_g and decreasing value of H_s. Present values of a_i are in close agreement to the data of Cents et al (2005) upto U_g =0.02 m s^{-1}. Above this value of U_g, present values of a_i are lower than their values.

Present data of a_i are about 50 % higher than that predicted by correlation of Pohiorech et al (1999). Value of a_i increases with increasing value of U_g. Upto $U_g < 0.017$ m s^{-1} there is large variation in values of a_i. The value of a_i increases with increasing CMC concentration. The value of a_i for 3.0% CMC is about 140% higher than that for 0.5% CMC solution. For $U_g \geq 0.017$ m s^{-1}, value of a_i for 3.0% CMC is about 70% higher than that for 0.5% CMC solution. The change in the nature of the dependence of a_i on CMC concentration at about $U_g = 0.017$ m s^{-1} may be attributed to change in the flow regime.

A simple model based on Higbie's, surface renewal model was used to estimate volumetric mass-transfer coefficient, ($k_L.a_i$). Swarm velocity was estimated using equation given by Krishna et al. (1999). Time taken by fluid element to travel from upper tip of the bubble along the surface to mid-point of equivalent diameter was taken as the critical time. The estimated values of k_L compared well with the equation proposed by Akita and Yoshida (1974).The value of k_L is independent of U_g. Hence, a constant value of k_L may be chosen.

A simple model for the estimation of shear rate and apparent viscosity of non-Newtonian fluids in bubble columns is proposed. The apparent viscosity is given by Equations 4.29 and 4.30. The model requires bubble velocity, U_b, and average inter-bubble distance, L_b.