CHAPTER VIII

SUMMARY AND RECOMMENDATIONS

8.1 Summery

From a high speed video of the experiments, we have observed that our fluidized bed was operating mostly in the coalesced bubble regime. Figure 8.1 shows an image of a bubble that was captured by the High Resolution Micro-Imaging/ Measuring system. The coalesced bubbles diameters were about 2 to 4 cm. This compares well with the bubble diameter (D_b) of 4.33 cm calculated using the correlation (Kim, et.al., 1977),

$$D_b = 0.142\ u_l^{0.052}\ u_g^{0.248}\ \mu_l^{0.008}\ \sigma^{0.034} \qquad (8.1)$$

in SI units. ($3 < D_b < 8$ cm).

Figure 8.2 shows that bubbles occurred mostly between 10 to 17 cm height above the distributors.

In this thesis, the three-phase concentration, the bed behavior, the bubbles frequency, the bubbles size, the bed viscosity, and the solids velocity were investigated. Also, the solids granular temperature was defined from two sources: measurement of the solids velocity, and measurement of the solids viscosity. There was fair agreement between these two methods. However, at lower solids concentration, the data do not match and this might be due to the fact that local solids concentration may differ from overall solids concentration in the bed.

A preliminary simulation of three-phase fluidized bed in asymmetric mode qualitatively predicts the bed behavior, such as bubble coalescence and flow circulation.

The computations in fluidized bed in symmetric mode incorrectly showed no bubble coalescence because of a downward velocity profile in the bed center which caused a gas deficiency in that region. The asymmetric behavior of three-phase fluidized beds differentiates its simulation from that of gas-solid fluidized beds where a conventional symmetric bed simulation was adequate to predict bed behavior. The asymmetric mode is set up by vorticities generated by gas flow circulation which produce a change in gas volume fraction inside the bed. Good agreement was obtained between measured and computed solids viscosities.

8.2 Future Work

1. The time-averaged volume fractions and porosity fluctuations measurements in a new three-phase fluidized bed with a central jet are needed in order to compare the bed behavior with that of three-phase fluidized beds with a uniform distributor.

2. The bubble frequency in gas-liquid two phase fluidization can be measured with a more sensitive detector than currently is available.

3. To completely analyze the velocity distribution in all three axes the measurements should be obtained by two CCD cameras with a smaller field of view.

4. In order to investigate the effect of solid concentration on the bed viscosity, the viscosity can be measured using a Brookfield viscometer and concentration can be measured using a CCD camera. Hence the data can be plotted for viscosity as a function of solid concentration.

5. The shear rate can be directly measured while the Brookfield viscometer is

conducting the viscosities value by using a High Resolution Micro-Imaging/ Measuring system technique.

6. The effect of particle sizes on the bed viscosity should be investigated. The particles of different size (for example, 0.08 mm) should be placed in the fluidized bed with a central jet so that measurements can be obtained.

7. Two different computer simulations using the predictive hydrodynamic model should be performed in three-phase fluidization in asymmetric mode: one using a measured bed viscosity and one using a predicted granular viscosity from the kinetic theory of granular solids. The computed results should be compared with the experimental results.

8. The computer simulation should be modified from two dimensions to three dimensions in order to resolve the loss of solid over a short period of time. This modification will also provide the effect of the wall in the third dimension.

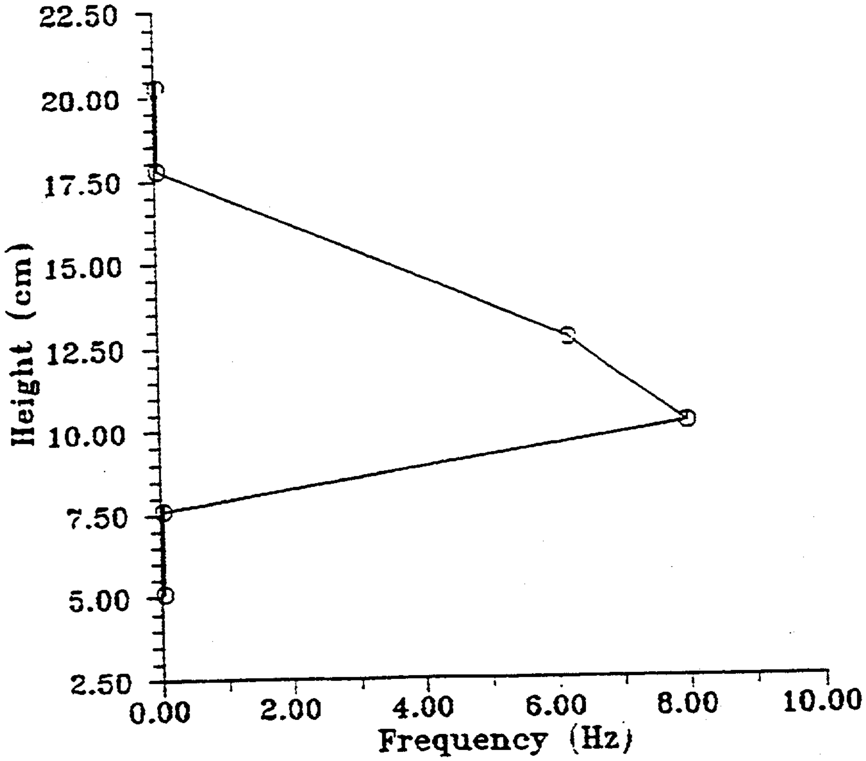

Figure 8.1. Bubble Frequency Vs. Height above the Distributer at X=12.7 cm

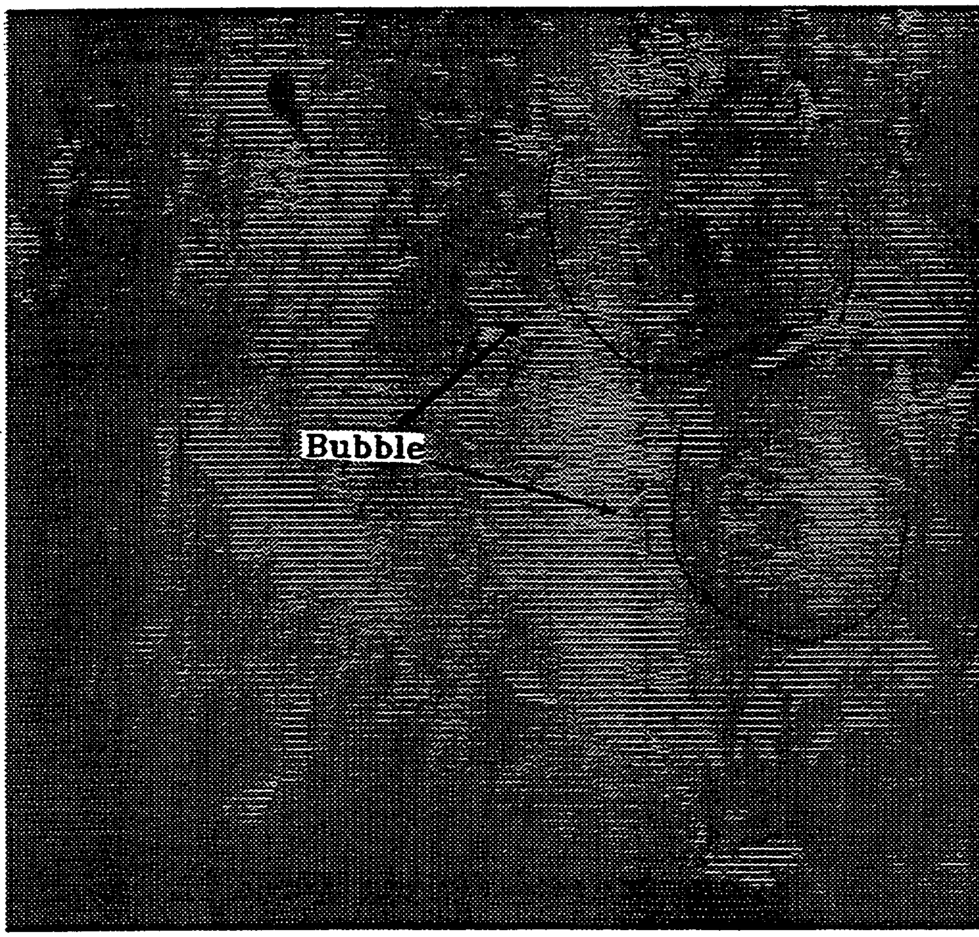

Figure 8.2. The Image of a Bubble That Was Captured by A Recording System