4.0 EXPERIMENTAL

4.1 Equipment

A schematic of the experimental equipment is shown in Figure 1. The 1 ft. O.D. by 25 ft. Lucite column (Figure 2) is comprised of six flanged sections. These include two, six-foot and two, five-foot sections, which constitute the main body of the column, and two conical ends (45 and 60 degrees with the horizontal), which are interchangeable. Although never used, space was provided for a distributor plate at the bottom. Pressure taps are located 48 inches apart except for the two highest which are 36 inches apart. Sampling taps are located in each flange. Two taps (1 in. and 1/2 in.) were located on the bottom conical end for the solids withdrawal studies.

Six differential pressure gauges were used to obtain variations in static head along the length of the column due to gas holdup. Air was passed through the gauges and bled into the column at a slow rate while the gauges indicated the backpressure.

Slurry was prepared and stored in a 400 gal. aluminum feed tank equipped with a Lightnin agitator and transported via a Warren Rupp Model SA3-A or SB1 1/2-A diaphragm pump. Both pumps were equipped with tranquilizers to smooth the flow. Liquid or slurry flow rate was controlled via a Brooks Mag 7000 flow meter, Moore Model 55 Nullmatic controller, and a 3-in. Foxboro control valve. All piping was 3 in. or 1-1/2 in. PVC pipe with appropriate elbows and fittings. Chemtrol Model B ball valves were used to

regulate flow. The flow rate of compressed air from an Ingersoll-Rand SSR-2000 screw compressor was injected into the 3 in. feed line about 4 ft. from the column inlet. Overflow slurry and air from the column were recycled back to the feed tank where the air was vented.

4.2 Procedures

The range of superficial velocities studied was chosen to include those most likely to be encountered in operation of the dissolver in the SRC-II process. The same velocities were used in all tests for ease of comparison.

4.2.1 Gas Holdup

Gas holdup was measured by a technique similar to that of bed expansion. Slurry and gas were introduced into the column and their flow rates adjusted to the desired values. Approximately ten minutes were allowed for any disturbances associated with the initial startup or adjustment of flow rates to dampen out. Flow of slurry and gas was then simultaneously shut off and the final height of slurry was measured. The difference between the full column height and the height of slurry after shut off of flow represented the average gas holdup for that set of conditions. Gas superficial velocities varied from 0.475 to 10.5 cm/sec, while slurry superficial velocities ranged from 0.69 to 4.43 cm/sec.

Three types of solids were used in the three-phase studies. These include 400 mesh (37 micron) silica flour, 100-180 mesh (149-84 micron) sand, and 70-140 mesh (210-105 micron) glass beads. Experiments using 30 mesh (595 micron) sand failed when the particles could not be held in suspension in the feed tank. Slurries were mixed to the desired concentration in the feed tank and continuously agitated to insure uniformity. During solids withdrawal experiments the slurry withdrawn from the bottom of the column was recycled back to the feed tank.

Moneteric-LF 100, a commercial surfactant, was used to study the effect of surface tension variations on gas holdup. The surfactant was added to the agitated feed tank with water and permitted to stand 12 hours or more to insure that equilibrium had been established.

4.2.2 Solids Accumulation

The two larger particle size range (149-84, 210-105 micron) solids mentioned above were used to investigate the nature of solids accumulation in three-phase bubble columns. Slurry and gas were introduced into the column at superficial velocities such that solids accumulated at the bottom of the vessel. Approximately 20-30 minutes were allowed for the solid concentration gradient to form and stabilize. Samples were then withdrawn through the five sampling taps and labeled accordingly. Laboratory analyses were then performed to determine the solids concentration in milligrams/liter. The solids concentration gradient was examined as a function of slurry and gas superficial velocity only. An attempt to examine the effect of surface tension variations failed when the slurry/surfactant/gas system foamed extensively.

4.2.3 Backmixing

Several qualitative tests were run to investigate the mixing characteristics of the two-phase (air-water) system. In the absence of liquid flow, the gas superficial velocity was set to the desired value and steady state was established. A concentrated solution of methyl-orange was then injected into the column at the desired point through the nearest sampling tap. The dispersion of the dye was photographed at set time intervals in an attempt to gain insight into the mechanism involved with backmixing. Additional tests to quantify these observations are planned for the subsequent phase of the project.