Chapter III

EXPERIMENTAL EQUIPMENT

3.1 The Experimental System

The experimental system consisted of several units of equipment combined together as shown in Figure 3-1. These units were the air compressor, the condenser, the rotameter, the electric heater, and the fluidized bed column. All those units of equipment were connected by metal pipes of 1.5-inch diameter. Figures 3-2 and 3-3 show the schematic drawings of the experimental system for batch and continuous type operations, respectively. The details of some units were described as follows.

3.1.1 Condenser

It was a shell and tube heat exchanger, installed vertically. It was used to condense water vapor from the compressed air by passing countercurrent cooling water.

3.1.2 Rotameter

The rotameter (Brooks Instrument B.V., Nederland) was used to control and measure inlet air flow rate, ranging from 0-100% reading. The calibration curve of this rotameter is shown in Appendix A.

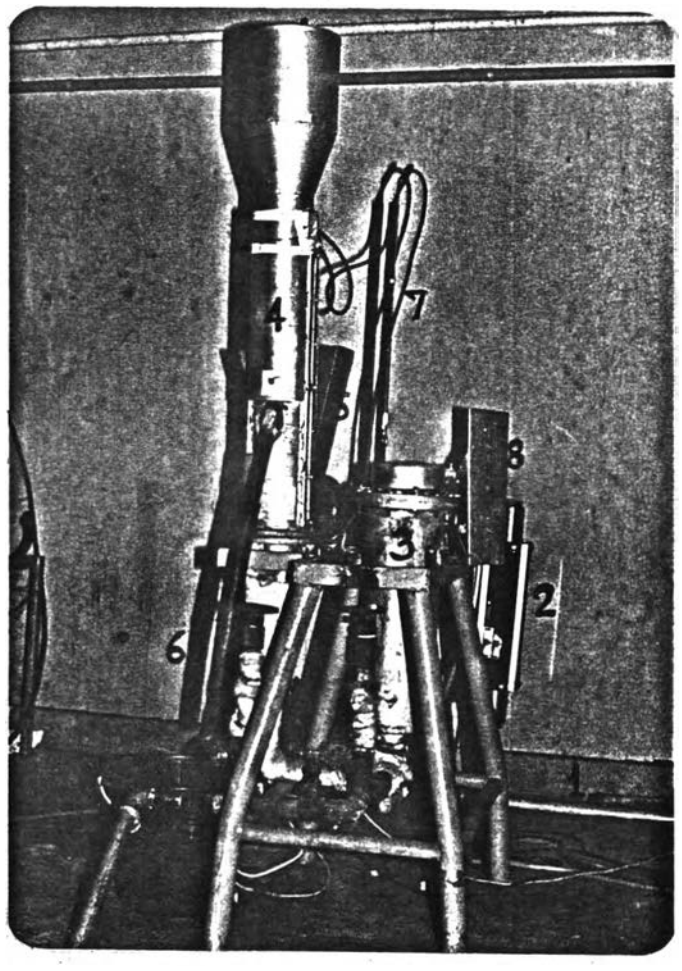


Figure 3-1 The Experiment System

1. Pipe line from air compressor
2. Rotameter
3. Electric heater
4. Fluidized bed column
5. Screw feeder (for continuous drying)
6. Product outlet (for continuous drying)
7. Manometer
8. Switch board

1. Air compressor
2. Condenser
3. Rotameter
4. Electric heater
5. Fluidized bed column
6. Manometer

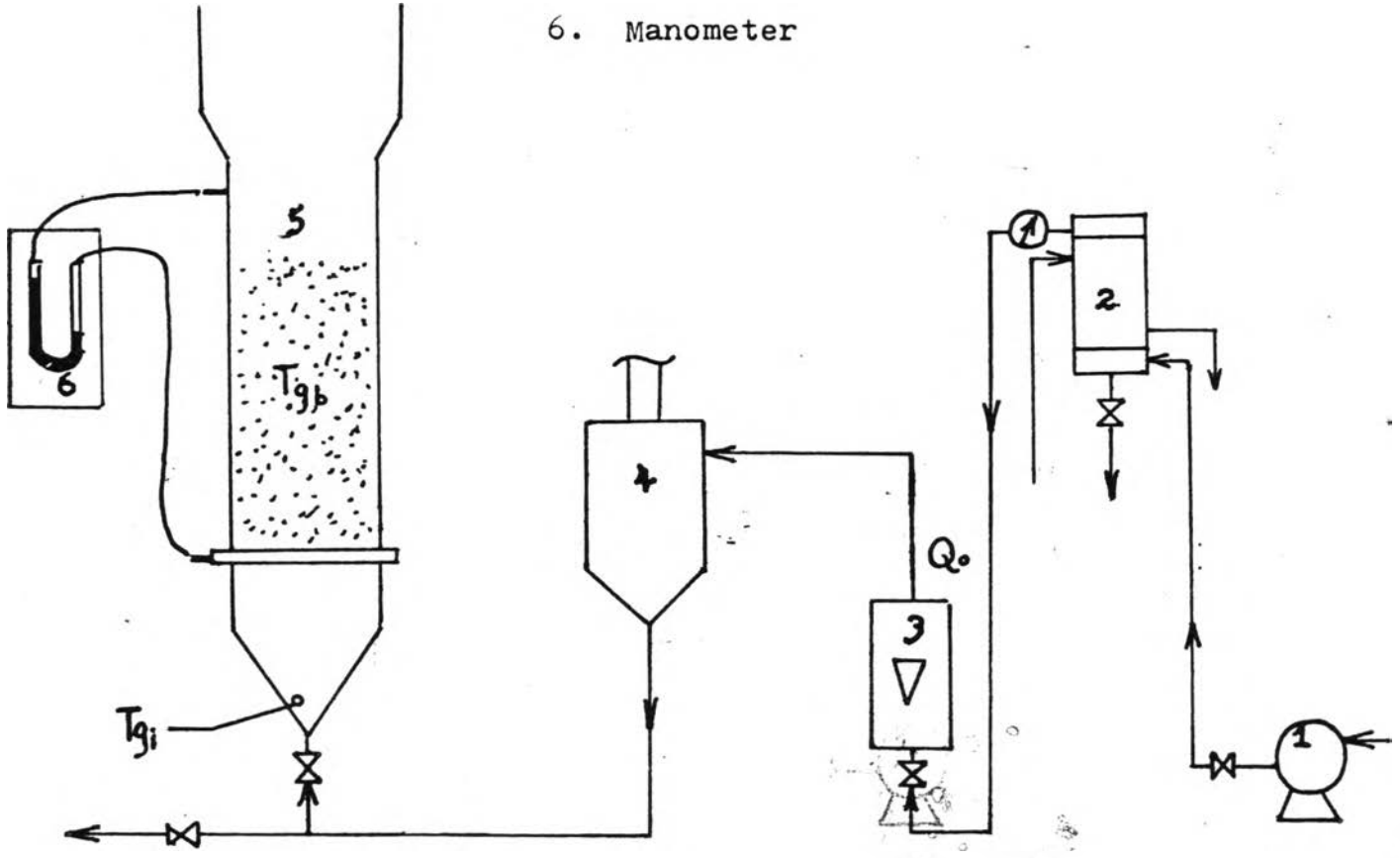


Figure 3-2 Schematic drawing of the experimental system (BATCH DRYING)

1. Air compressor
2. Condenser
3. Rotameter
4. Electric heater
5. Fluidized bed column
6. Manometer
7. Screw feeder
8. Product outlet pipe

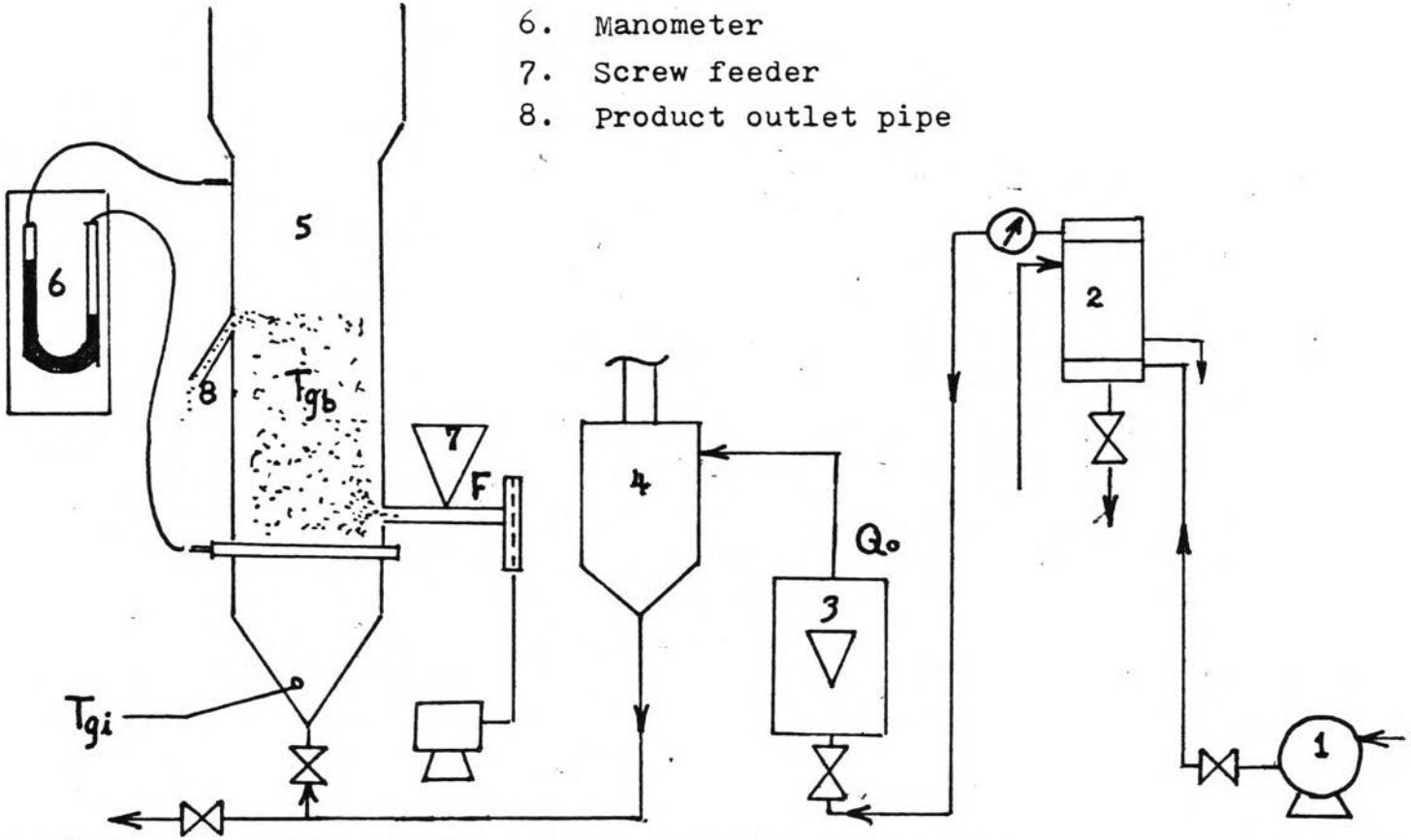


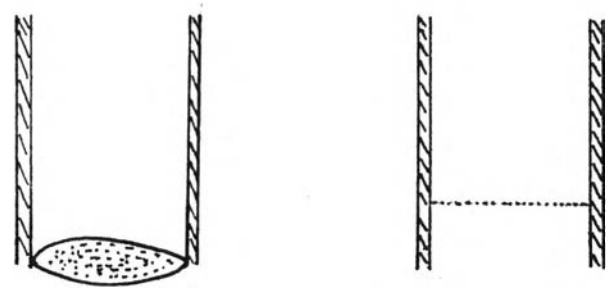
Figure 3-3 Schematic drawing of the experimental system
(CONTINUOUS DRYING)

3.1.3 Electric Heater

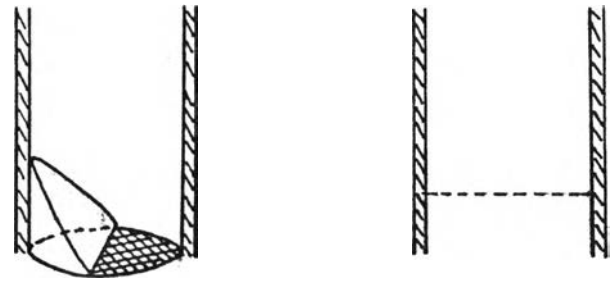
It had a cylindrical shape with 20-cm diameter and 48-cm high. It consisted of three electric heating units, each of which had a power of 1.5 kw. The first unit was controlled by switch (on-off) directly, the second one was connected to the variac for controlling the voltage of heater, and the third one was controlled by the temperature controller.

3.1.4 Fluidized-Bed Column

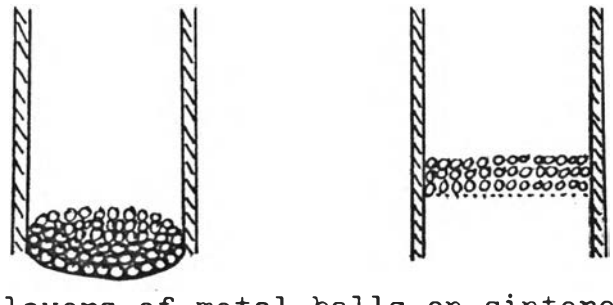
For batch and continuous operations, the same column was used. The fluidized-bed column was a metal column of 10-cm diameter and 105-cm high with 30° conical base and an air inlet of 2.5-cm diameter. The distributor was three layers of small metal balls (0.5-cm diameter) placed on a round sieve plate (12-cm diameter). This type of distributor was the best one from selection of four good types of distributor: (1) sintered plate, (2) wooden cone on sieve plate, (3) metal balls on sieve plate, and (4) metal balls on sintered plate; see Figure 3-4. The reasons were; it developed lower pressure drop, gave good distribution (more homogeneous bed), could be scaled up, and had lower cost[43]. A glass window of 2.5-cm wide and 60-cm high made observation of the behavior of the bed possible. At one side of column, two small holes were made and welded with tiny tubes for connection with manometer to measure the pressure drop across the bed. Another two small holes were drilled



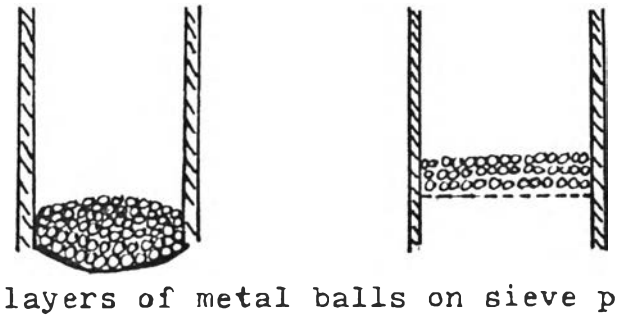
1. Sintered plate



2. Wooden cone on sieve plate



3. Three layers of metal balls on sintered plate



4. Three layers of metal balls on sieve plate

Figure 3-4 Types of distributor

at the middle of column for inserting thermometer to measure temperature in bed, and at the entrance of hot air for inserting two thermocouples connected with the temperature controller and temperature recorder to control and measure the temperature of air inlet. The schematic drawing of the column is shown in Figure 3-5. In case of continuous operation; the column was perforated two points to connect with a screw feeder, and a 2.5-cm pipe for product outlet as shown in Figure 3-3.

3.1.5 Screw Feeder

It consisted of a metal hopper of 23.5-cm by 13-cm and 32-cm high with 40° conical base, and screw feeder at the bottom with 3.5-cm diameter and 1.5-cm pitch width. The screw feeder was connected with a small motor. The picture of this equipment is shown in Figure 3-6.

3.2 Steaming Tank

It was a stainless steel tank of 40-cm diameter and 75-cm high; had a pressure gauge at the top outside, and a sieve plate at the bottom inside. It could be used for both soaking and steaming. This equipment is shown in Figure 3-7.

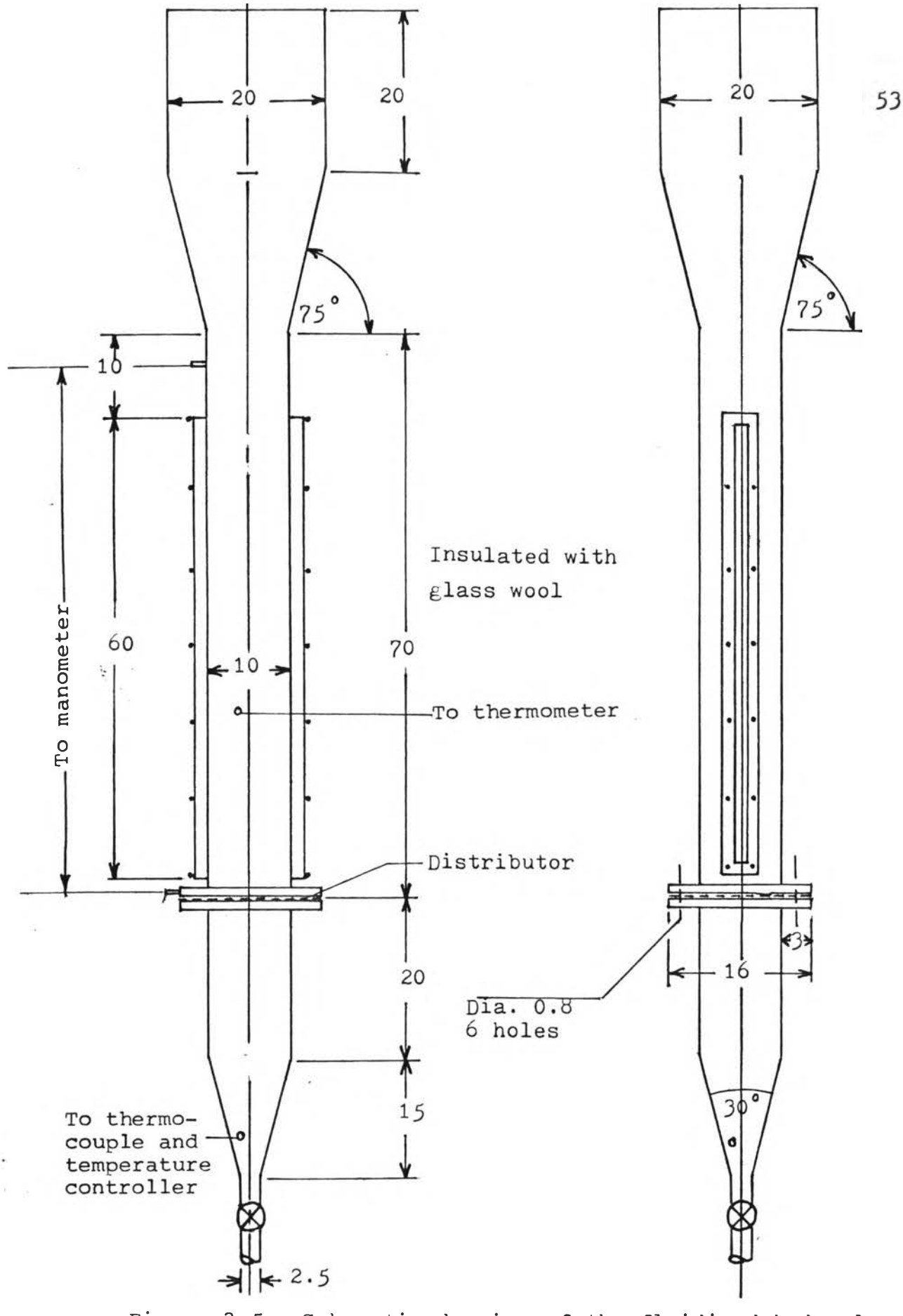


Figure 3-5 Schematic drawing of the fluidized bed column

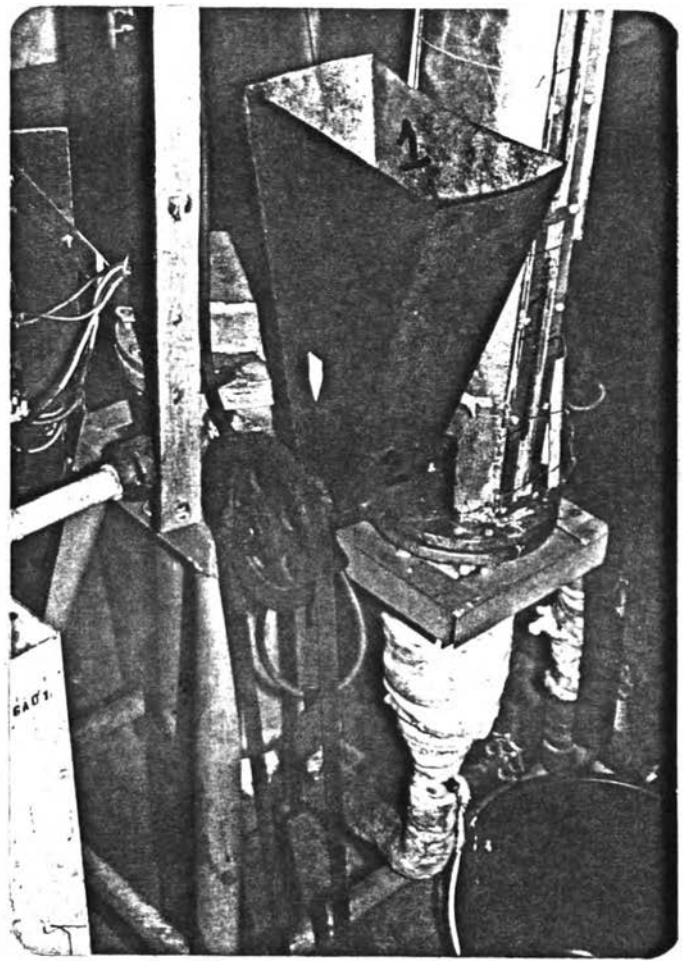


Figure 3-6 Screw Feeder

1. Hopper
2. Screw Feeder

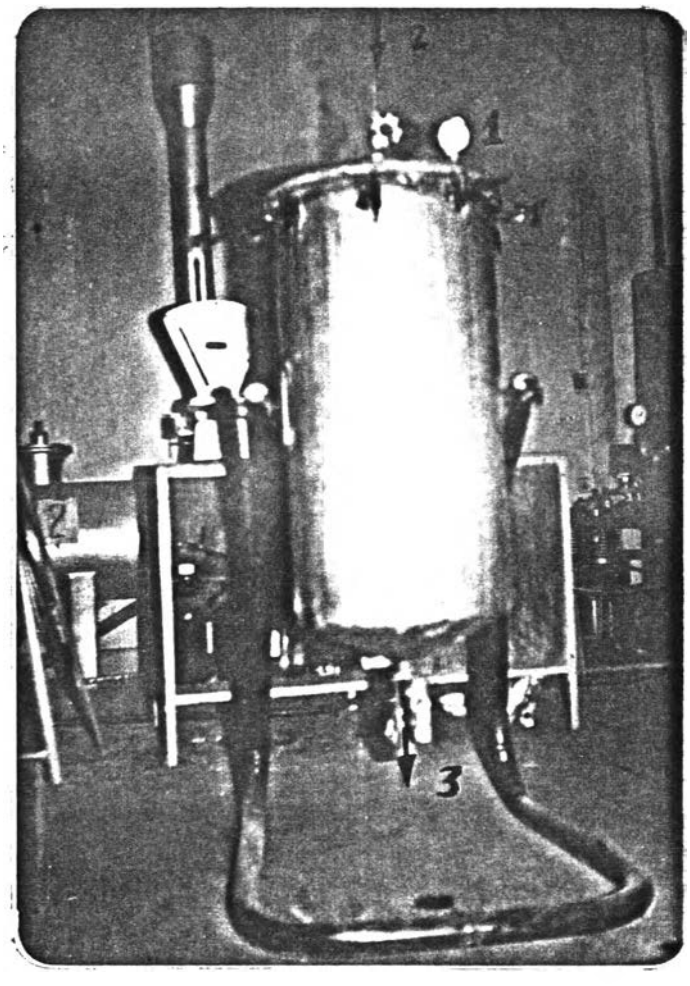


Figure 3-7 Steaming tank

1. Pressure gauge
2. Steam or water inlet
3. Water outlet