CHAPTER III

EXPERIMENTAL

3.1 Raw Material

The field corn used in this investigation was purchased from Field Crop Division, Agricultural Department where it was stored in an air-conditioned room. The corn was of flint type and of the variety of Bogor #2 grown in the area of Phrabuddhabaht, Saraburi. It was already shelled, dried, mixed proportionally with the powder of fungicide and insecticide. It was packed in a plastic bag and then wrapped with three paper bags to prevent the atmospheric moisture. Each bag contained 30 kg of shelled corn.

3.2 Apparatus

3.2.1 The Dryer. The dryer consisted of several units of equipment combined together (Fig. 3.1). These units were the air compressors, the heat exchanger, the rotameter, the air preheater, and the heater. All these units of equipment were connected with metal pipes of 2-inch diameter. Fig. 3.2 shows the schematic drawing of the dryer. Each unit was described as follows.

3.2.1.1 Air Compressors. Two air compressors were used together in the study : one was the reciprocating compressor (Broom Wade, England), the other was the straight lobe type rotary compressor (Roots, U.S.A.).

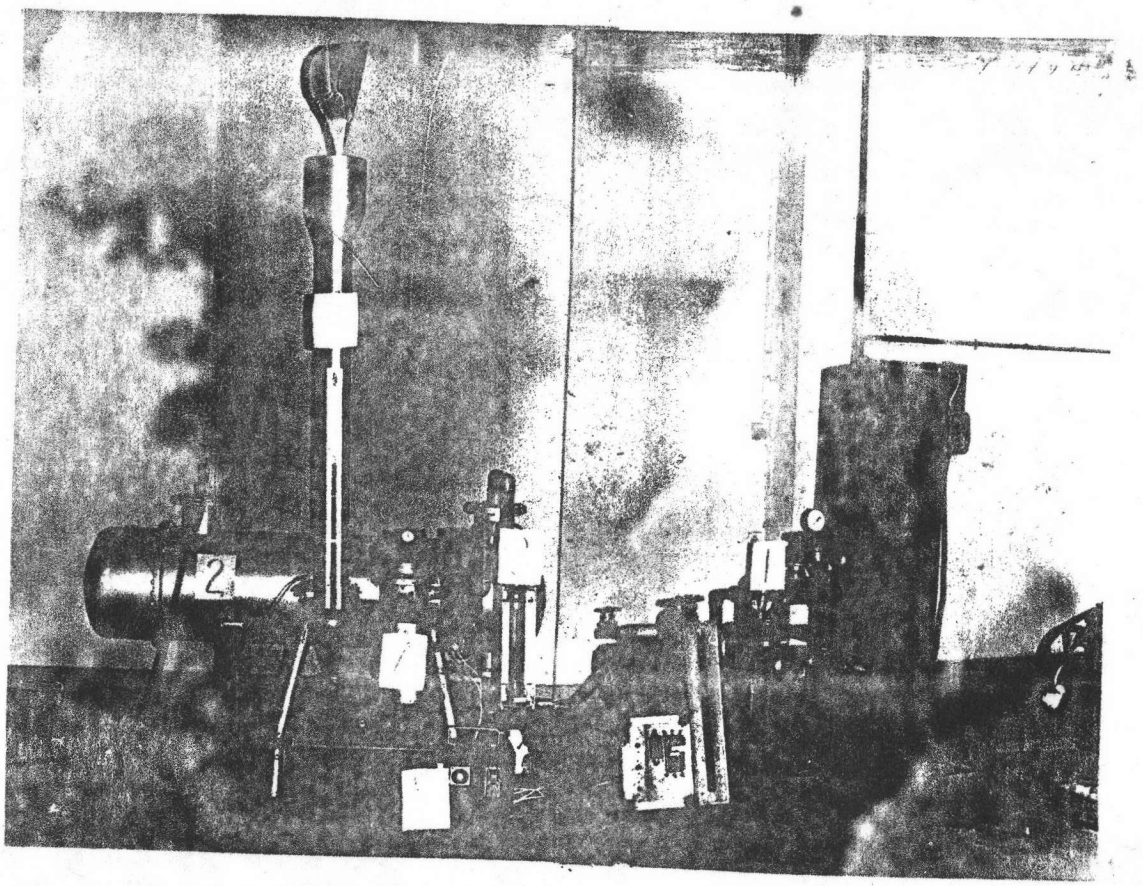

Fig.3.1 The dryer

1 = Air compressor
2 = Heat exchanger
3 = Rotameter
4 = Air preheater
5 = Temperature Controller
6 = The Spouted-Bed Heater

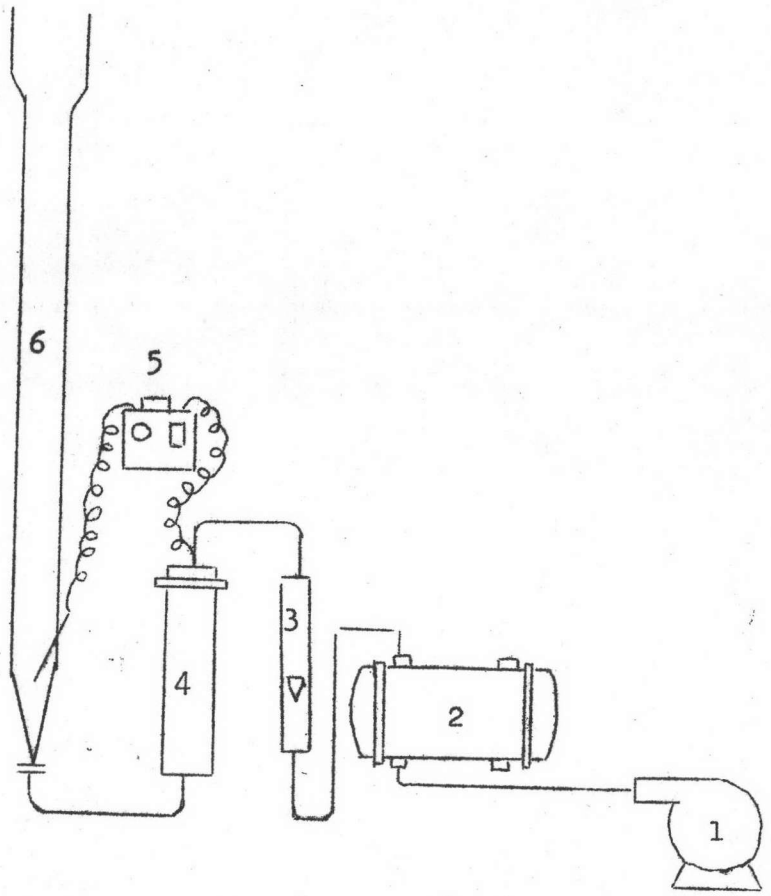

Fig. 3.2 Schematic drawing of the apparatus

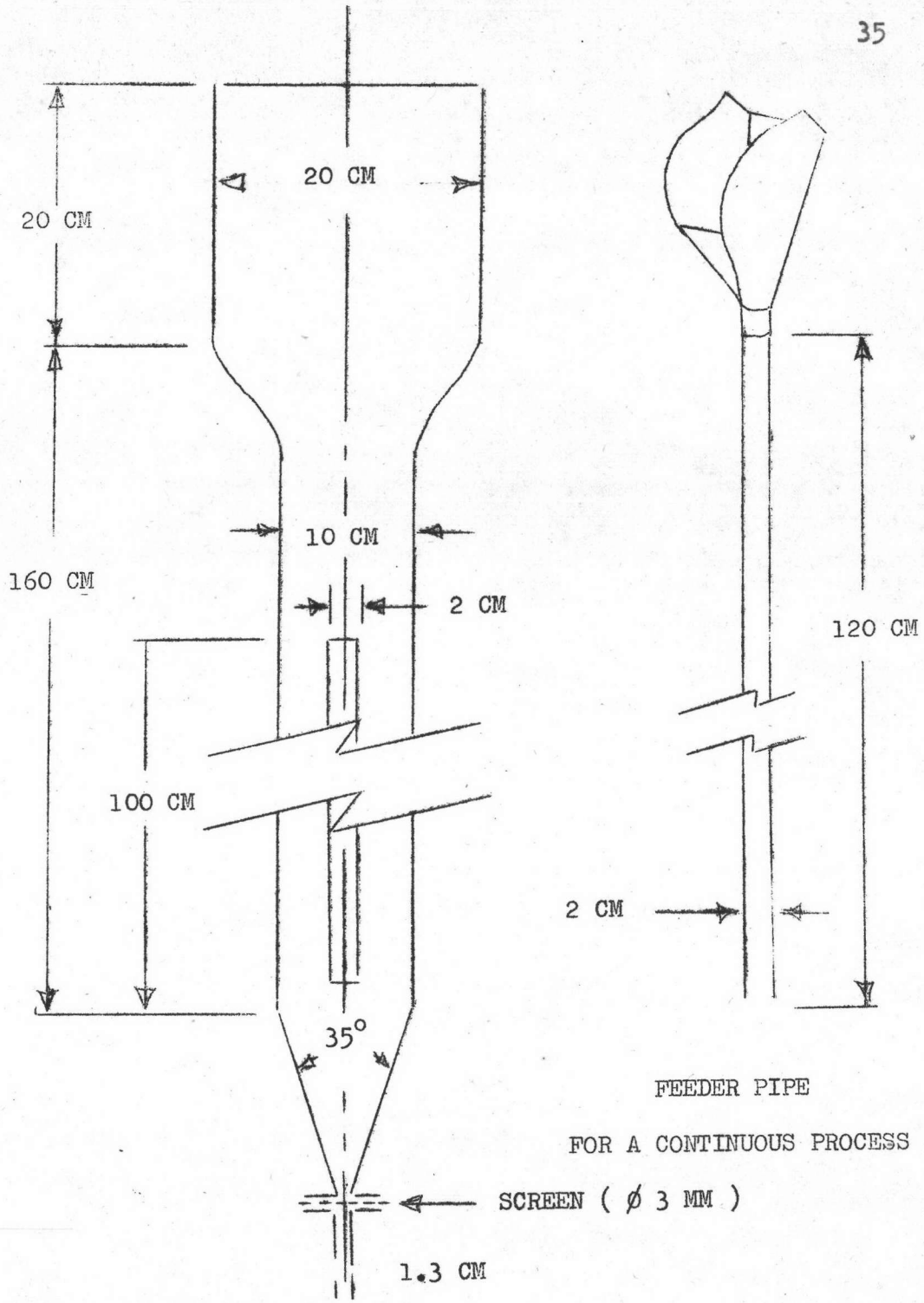

Fig. 3.3 Drawing of the spouting column

The compressed-air storage tank was of the dimensions of 50-cm diameter by 150-cm high.

3.2.1.2 Heat Exchanger. The heat exchanger was of shell and tube, used to remove the heat evolved by air compression.

3.2.1.3 Rotameter. The rotameter (GEC-Elliott, Instruments Ltd., England) was used to measure air flow rate ranging up to 26 cm-reading or 3500 litres per minute (see Appendix D). The float was of stainless steel weighing 603.0 gm.

3.2.1.4 Air Preheater. The air preheater was designed by Dr. Pol Sakethong. It consisted of three electric heating units, each of which had a power of 1.4 kw.

3.2.1.5 Heater. The spouted-bed heater or the heater was designed and constructed for the present study. It was a metal column of 10 cm diameter by 180 cm high with a 35° conical base and an air inlet of 1.3-cm diameter. A glass window of 2.0 cm wide by 100 cm high made observation of the behavior of the bed possible. The height of the column was sufficient to permit the study of the bed of 40 cm. deep. The feeder pipe of 2-cm pipe diameter was also provided in case of continuous feed. The drawing of the spouting column as well as the feeder pipe is shown in Fig. 3.3.

3.2.2 Temperature Controller. This equipment was designed and constructed by the laboratory of Chemical Technology Department. Its thermocouple was made of the alloys of chromium and aluminium, called

Chromel Alumel. The desired temperature was controlled by magnetic system. It could be used at a temperature up to 600°C. This unit can be seen from No. 5 in Fig 3.1.

3.2.3 Thermo-Hydrograph. The thermo-hydrograph manufactured by Thies, Germany, it was used to measure the humidities and room temperatures. The measurements were recorded graphically so that the changes could be followed. This equipment is shown in Fig. 3.4.

3.2.4 Sampling Tool. The sampling tool was designed and constructed for the present study. It was simply a small glass bottle of capacity about 15 gm of shelled corn. The tool is shown in Fig. 3.5. The string must be long enough to take sample at the bottom of the column.

3.2.5 Oven. The hot air oven used for the determination of moisture content was manufactured by Baird & Tatlock (London) Limited, England. It was additionally equipped with a thermostat made by Rika Kogyo Co., Ltd., Japan.

3.2.6 Balances. Two types of balance were used in the experiment. One was made by Mettler, Switzerland, which provided a weight of four decimal points used for moisture determination. The other was manufactured by Berkel, Belgium, whose maximum weighing capacity was 25 kg., used to weigh corn prior to drying.

3.2.7 Moisture Tester. The equipment was manufactured by the Dole Valve Company, U.S.A. (Model 300), and shown in Fig. 3.6. It was used to measure approximately the feed moisture contents of conditioned shelled corn.

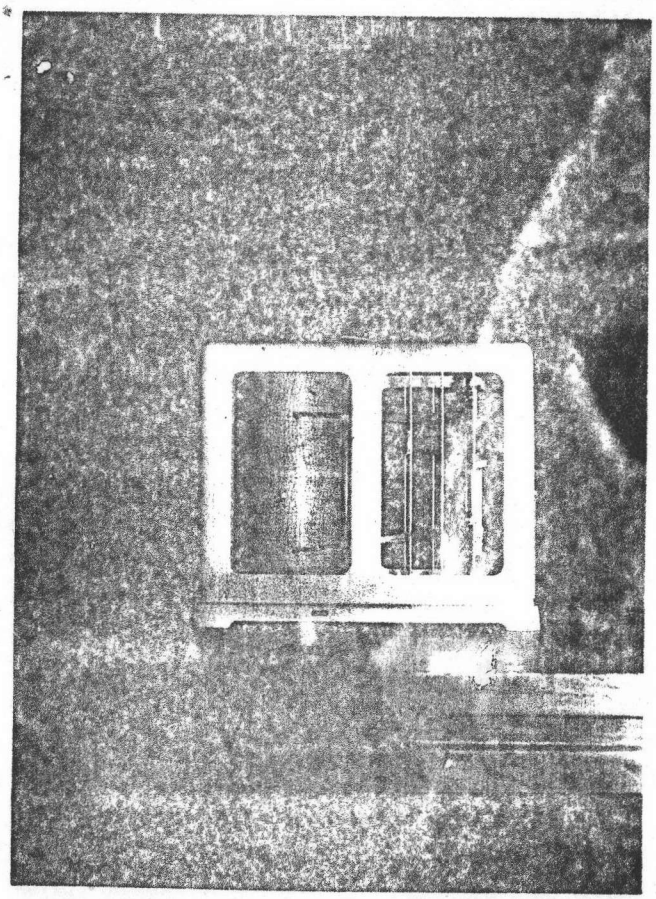

Fig.3.4 Thermo-hydrograph

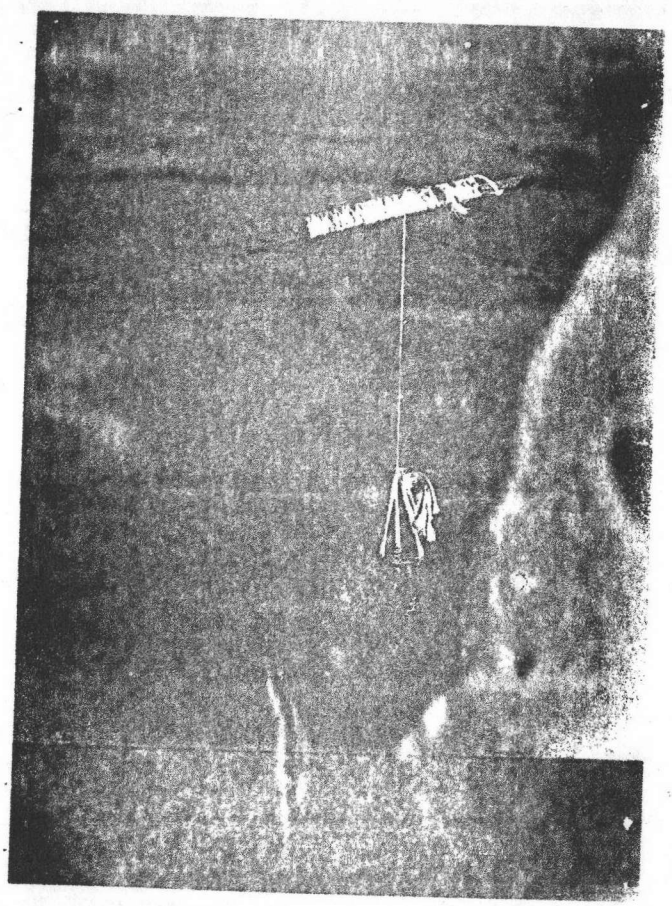

Fig.3.5 Sampling tool

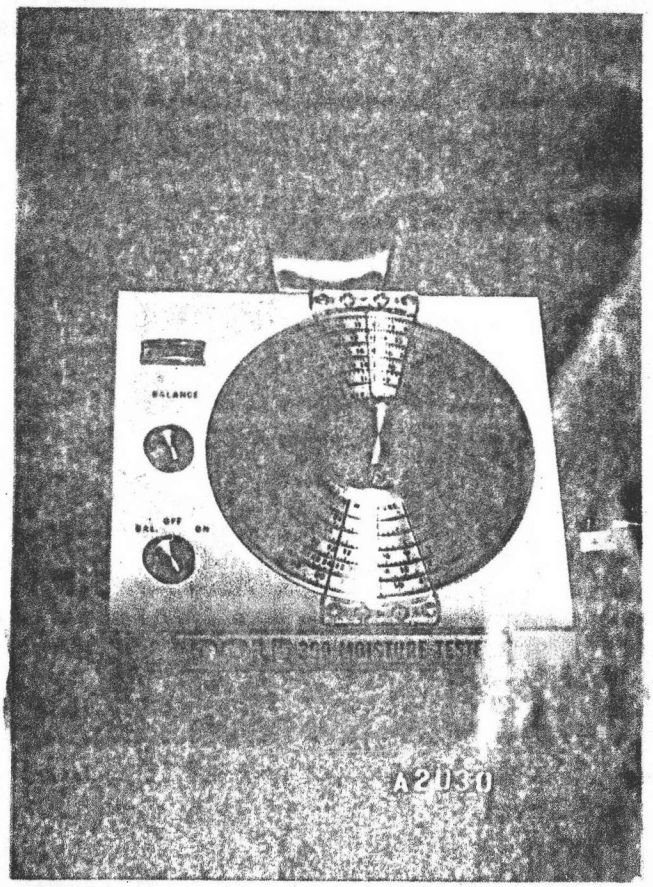

Fig. 3.6 Electric Moisture Tester

3.3 Physical Methods of Analysis

3.3.1 Sieve Analysis. The procedure was in accordance with standard method of test for particle size of plastic materials.

The sieves (seetable 3.1) covering the expected range of particle size were selected and nested together in order of diminishing openings with the coarsest sieve on top and the pan on the bottom. The weighed amount of shelled corn was transferred to the top sieve of the stack. The stack was covered and placed in the mechanical sieve shaker. The device was started and the sample was shaken for 15 min. After shaking, the stack of sieves was carefully separated, begining at the top, and the quantity of sample retained on each sieve and that contained in the pan were weighed to the nearest o.1 gm.

Tale 3.1[12]

U.S. Sieve Series No.	Sieve Opening (in.)	(cm.)
4	0.187	0.475
$\frac{1}{4}$ in.	0.250	0.635
$\frac{5}{16}$ in.	0.312	0.792
$\frac{3}{8}$ in.	0.375	0.952

3.3.2 Moisture Determination. The moisture content of shelled corn was determined by using the hot air oven.[10] The samples were held at temperature of 100°C for a period of 72-80 hr. The petri dishes were closed before they were removed from the oven, and then placed in a glass desiccator charged with silica gel, where they cooled to room

temperature. The petri dishes were then weighed and the moisture contents were calculated to the closest 0.01 %

3.4 Experimental Procedures

3.4.1 Start-Up Procedure. The temperature controller was connected to the circuit of the air preheater and its thermocouple was inserted into the middle of the bed. The desired operating temperature was set by the controller. The air compressors were started; tap water was run through the heat exchanger; the air preheater was switched on; the air flow rate was controlled and determined by the rotameter. The steady state desired temperature was observed when the temperature controller showed "on" and "off" signals alternately and periodically.

3.4.2 Experimentation. The experimental work was carried out according to the scheme illustrated in Fig. 3.7.

The shelled corn was first screened by the mechanical shaker to remove the powder of fungicide and insecticide. It was then soaked in water at room temperature for a period of 24 hr. which was found adequate for absorption and uniform distribution of the soaking water. The corn was dewatered and rolled in cheesecloth to remove loose water adhering to the surface without removing capillary moisture and to prevent loss during drying by dripping. The corn was then conditioned to the different feed moisture contents: m_{o1}, m_{o2}, m_{o3}, and m_{o4}, by natural air drying. At this step, the feed moisture content was tested by the moisture tester and the accurare value was determined by the oven methed. Up to this step, the moisture contents of the shelled corn was raised ranging from 15% to 30% dry basis.

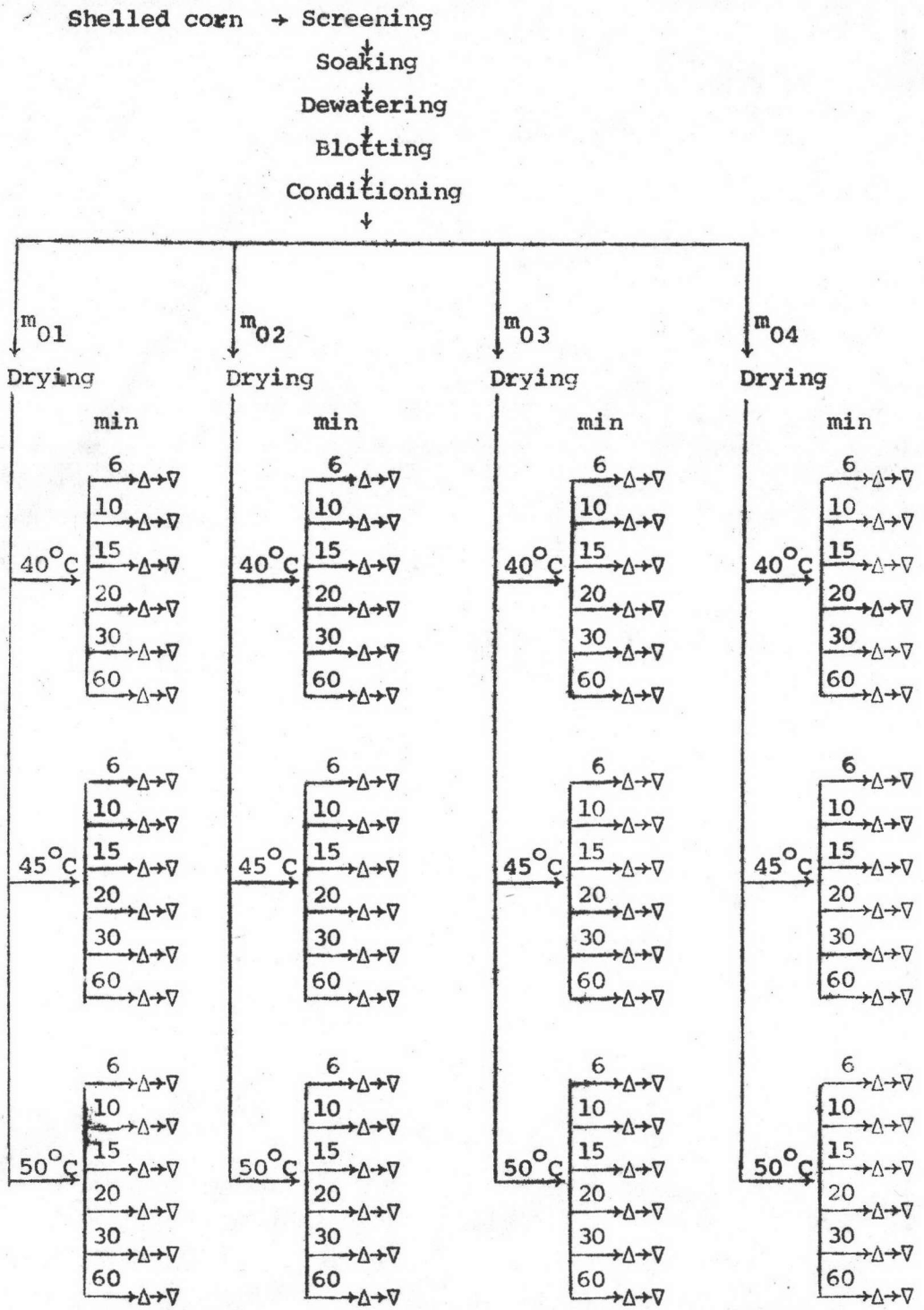

Fig. 3.7 Experimental Scheme

For each feed moisture content, the corn was taken to be dried in the spouted-bed heater. 800 gm. of corn was weighed out. After the steady state desired temperature was reached, the corn was poured into the column from the top. The drying time was counted from that moment. At each interval of 6, 10, 15, 20, 30, and 60 minutes, a sample was taken with the sampling tool. To take a sample, the empty bottle of the sampling tool was lowered down from the top of the column and above the bed. As soon as the specified drying time was reached, the bottle was dropped into the bed and the corn simultaneously flowed into it. The filled bottle was quickly lifted up by rolling the string of the sampling tool and the dried corn was transferred into a potri dish which had already been weighed and kept in a desiccator. The petri dish with dried corn was allowed to cool in the desiccator and then weighed. After that it was placed in the oven to determine the moisture content as described in 3.3.2.

It should be noted that the drying temperatures were fixed at 40, 45, and 50°C; however, the feed moisture content, either m_{o1}, or m_{o2} m_{o3}, or m_{o4}, might be different at these drying temperatures.