Chapter III

Experimental Apparatus and Procedures

The experimental works were designed to measure the water content which was retained at different depth in the columns filled with water saturated sand when the top of the column were exposed to air at three different temperatures and two different humidity levels. The entire system was operated isothermally. The measurement of sand moisture at different depth of the sand bed were made by sampling and direct weighing of each sample. As a result, the experimental apparatus included twelve identical sand columns that were removed at time intervals for sampling. As a result the experimental apparatus allowed the measurement of moisture content at six depth levels in the column over a period of time. The following is a description of the apparatus and the procedures.

The Apparatus

The experimental apparatus was shown in figure 3.1. It essentially consisted of three parts: a humidity control system for air in contact with the bed surface, the temperature control system for the entire system, and

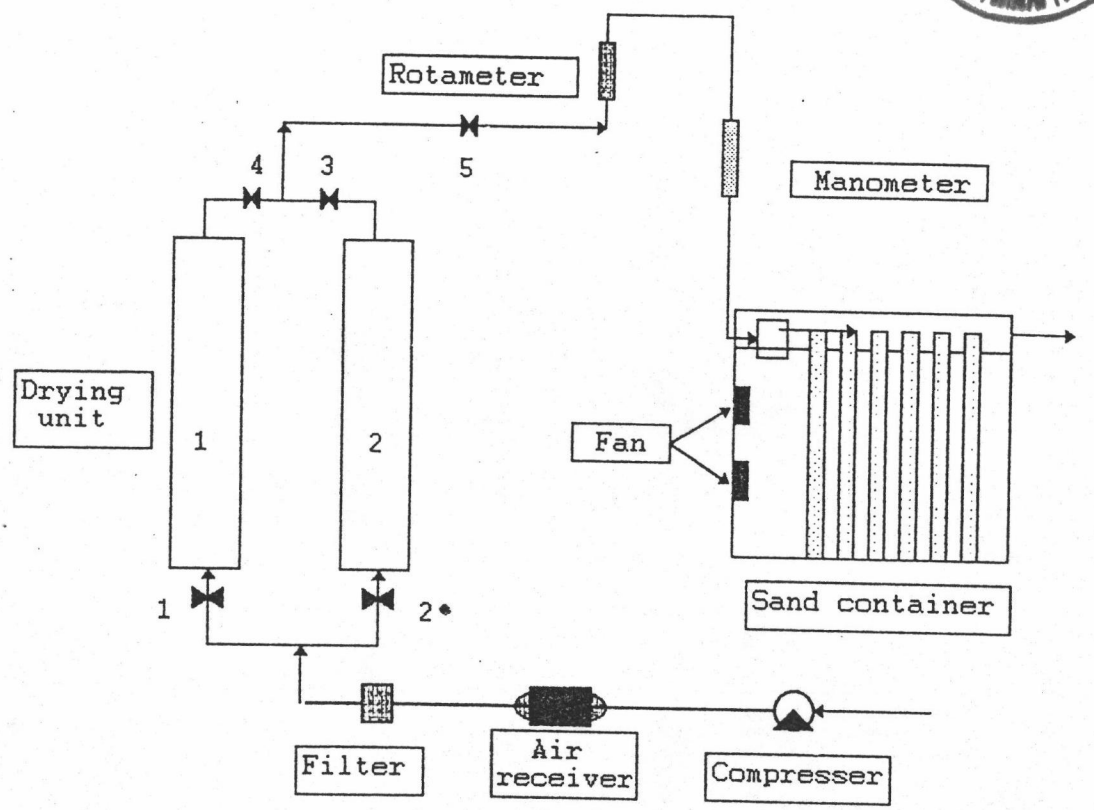

Figure 3.1 The Experimental Apparatus.

the chamber containing the twelve removable sand columns.

1.The Humidity control system

The humidity control system consisted of two identical silica gel water absorption columns connected in parallel. Each column was 15 cm. in diameter and 1 meter long.

The air in the laboratory was pumped by the compressor into the air receiver, was passed through the filter and then was passed through the silica gel columns. At the exit of the silica gel columns, air would be at 25% relative humidity. This air was sent directly into the column chamber for experiment at 25% RH condition. The flow rate of air was regulated by the rotameter.

To product air at 40% relative humidity, The saturated amonium chloride (NH_4Cl) solution was put into the column chamber. Air which passed through the silica gel columns and was in contact with saturated NH_4Cl solution, would be at 40% relative humidity. The humidity was continuously monitored by hygrometer.

This combined system allowed the air to contain either 25% and 40% relative humidity and maintain the humidity content at either of these values over extented periods of time. The deviations of a maximum of 4% occured after removel of each sand column for sampling but the set relative humidity was restored fairly

quickly. It is to be noted that the air used in the system was a one pass through flow of air with no recycling.

2.The Temperature control system

The temperature control system consisted of a wire heater, a temperature sensor (a platinum 100 probe, both of which were located inside the column chamber), and a temperature controller.

The air from the humidity control system were passed through the wire heater to increase the air temperature to the set temperature. The set temperatures used in this study were 30, 40, and 50 degree Celcius.

The accuracy of control of temperature control in the entire system was +/- 1 degree Celcius for most of the experimental time. However when a column was removed for sampling, the maximum temperature drop of 5 degree Celcius was recorded, but the set temperature was restored within 1 minute.

3.The chamber and the sand columns

The experimental chamber was a 15x60x60 cm. (WxDxH) box made of clear acrylic sheets. The chamber can hold 12 sand columns. Each sand column was 1 cm. internal diameter, 50 cm long, and made of acrylic tubes. Each column was fitted with 4 sampling ports. This allowed for

sampling at six points (on different depth) along the column including the top and bottom samples.

The chamber was divided into 2 parts with clear acrylic sheet. Most of the column length was located in the lower part of the chamber with only a few centimeters of the top of the column in the upper part.

The air stream with controlled temperature and relative humidity flowed into the upper part of the chamber to serve as the ambient air condition as required in the experiment. The air stream with controlled temperature only flow into the lower part of the chamber to maintain the columns at constant temperature. It was to note that the air temperature in both parts of the chamber were the same and were at the set temperatures as required by the experiments. Hence, the experiments were conducted isothermally.

The Materials used

The sands used in the experiment were obtained from the local construction company. The sand was passed through the 20 and 40 mesh sieves to remove large and small sand particles. The sand particles that passed through the 20 mesh sieve and was trapped on a 40 mesh sieve were used in the experiments.This process gave sands with the average diameter of 0.50-0.80 mm.

The water absorbing polymers used were a commercial grade sold to farmers for adding into tree

seedling soils. The name and chemical composition of the material are proprieting. The WAP used was manufactured in the U.K. and was reported to be biodegradable within two years. The sizes of the fresh WAP particles were fairly uniform and could be retained on a 20 mesh sieve (about 0.80 mm.).

Experimental Procedures.

The experimental procedures were as follows.

1.Preparation of the WAP Particles.

The WAP particles were weighted and soaked in excess water overnight. They were then mixed with wet sand particles in the required proportion and placed in each of the 12 columns.

2.Filling of the sand columns.

During each experiment the water soaked WAP was hand mixed with sand and the columns were filled to the brim. It is to be noted that all free space was filled with water for all experiments.

3.The Evaporation Procedure.

First the air compressor was switched on to the allow the room air to go through the humidity control system and in to the column chamber. Next, both wire heater were turn on and adjusted to the desired temperature via the temperature controller. The lower and the upper chamber fans were then turned on to circulate the air throughout the chamber. Lastly the twelve sand columns were now placed upright in the chamber to signal the start of the experiment.

At every sampling interval (either every one hour or three hours) one or more sand columns was removed from the chamber and six samples were taken using six different syringes, scaled then weighed for wet weight. Weighing of the samples was made using a four digit electronic balance using a sample size of 1.5-2.0 grams.

The sample would then be dried in an oven at 103 degree Celcius for 3 hours and weighed once again to obtain the dry weight.

The moisture content in the sample was then calculated as follows :

$$\text{moisture content} = \frac{\text{sample wet weight - sample dry weight}}{\text{sample dry weight}}$$

(% weight/dry weight)

The duration of each experiment was 12 hours. In the case of experiments with WAP, sampling would be done every three hours with 3 columns being removed every 3 hours.In the case of experiments with WAP-free sampling would be done every hour with one column being removed at every hour.