CHAPTER III

EXPERIMENTATION

3.1 The Apparatus

The experimental apparatus as shown in figure 3.1 consists of a disk and ring column mounted on a support equipped with a pulsing device. A conductimeter and a recorder are used to record conductivity of the solution.

3.1.1 The Disk and Ring Column System

The disk and ring columns used are of three different sizes as follows

	Material	Size
large column	Plexiglass	10.00 cm I.D.
large disks	stainless steel	8.72 cm O.D.
large rings	stainless steel	10.00 cm O.D.
		4.90 cm I.D.
middle column	glass	7.50 cm I.D.
middle disks	stainless steel	6.54 cm O.D.
middle rings	stainless steel	7.50 cm O.D.
		3.67 cm I.D.
small column	glass	4.50 cm I.D.
small disks	stainless steel	3.92 cm O.D.
small rings	stainless steel	4.50 cm O.D.
		2.20 cm I.D.

The disks and rings are supported by stainless steel rods

and tubes to control the spacing between disk and ring at 2.50 cm, 3.75 cm and 6.25 cm. Both disks and rings were designed to allow a 24 percent free area.

The column assembly was equipped with a pulsing system consisting of a pipe connecting the column support with a system of solenoid valves in series connected to an air compressor. The frequency of the pulse can then be regulated by a timer that controls the electromagnetic valves and the amplitude of the pulse can be regulated by varying air pressure at the compressor outlet. Using that system allowed the velocity of pulsation (Axf) to vary between 0.47cm/s to 2.92cm/s. For the large column between 0.47cm/s to 0.59cm/s, for the medium sized column between 0.87cm/s to 1.05cm/s and for the small column between 2.42cm/s to 2.91cm/s.

On figures 3.2-3.4 are pictures of the apparatus.

3.1.2 Auxiliary Equipment

Conductimeter : a Swiss made METROHM HERISAU conductimeter type E518 was used to measure solution conductivity using a stainless steel electrode made up of two short pieces of stainless tubes protected with DELTA, an ethoxylene welding process material, but with a protruding end of 1 mm in length and 3.2 mm in diameter and separated by 1 cm for the two largest columns and 0.5 cm for the smallest column.

Recorder : the recorder used was a US made Quantachrome recorder of model No. SR-4, equipped with recording paper.

Air compressor : a single stage air compressor with an automatic unloader that could supply compressed air at a maximum pressure of 150 psig was used. The necessary 4 psig pressure was set with an attached pressure regulator.

3.1.3 Materials Used

The tracer used was analytical grade nitric acid diluted to 1 percent by volume. The water used was de-ionized water. For experiments involving the presence of solid particles 0.9-1.4 mm polystyrene beads of the expandable type were used. The beads were heated to allow for a slight expansion in the bead volume to attain a proper density in order to have good suspension of the solid particles in water.

3.2 The Procedure Used

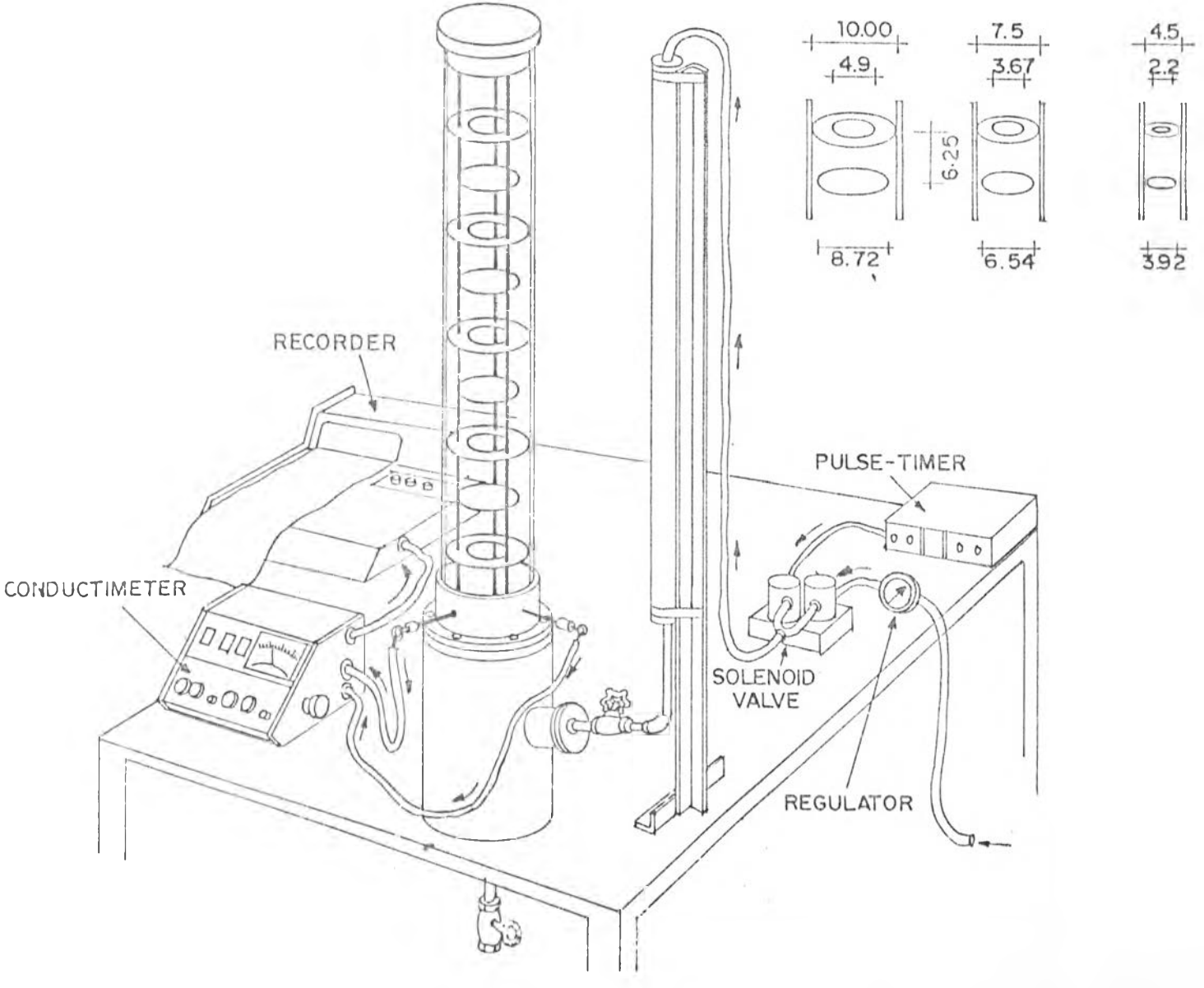
The object of the experiments conducted was to obtain tracer response curves at the bottom of the column sections and then compare experimental tracer responses with derived theoretical response curves.

The procedure may be summarized as follows. The column is fixed on to the support and filled with de-ionized water to a height of 45-50 cm above the electrodes which are located at the bottom of the column. The pulse timer is adjusted and the air compressor outlet is set at 4 psig and the pulser system allowed to operate at the desired amplitude and frequency. 50 ml of 0.1% by volume of HNO_3 used as tracer is prepared in a volumetric cylinder. The conductimeter and recorder are both turned on. When a steady base line recording is obtained the tracer is poured

into the column from the top and a time zero mark is noted on the recording paper. The time dependence of the tracer response curve is then obtained.

In order to test the influence of the presence of solid particles polystyrene beads were added to the water and their densities adjusted so that the beads remain in suspension. This is done by selecting polystyrene which contains pentane and which are used to make polystyrene foams. The beads are then placed in hot water to allow them to expand just slightly so that they reach a density of one and remain suspended in water.

Each tracer response curve obtained is then normalized prior to further computations. Normalization involves the determination of the highest average concentration of the response curve and the division of all the data points by that value so that the tracer response curve varies from zero to one and can be compared meaningfully with theoretical response curve. It is to be noted that if the recording is allowed to continue for a very long time the tracer response maximum concentration will decrease slightly due to volume effect of the support zone.


10.00
4.9
7.5
3.67
4.5
2.2
6.25
8.72
6.54
3.92
RECORDER
PULSE-TIMER
CONDUCTIMETER
SOLENOID
VALVE
REGULATOR

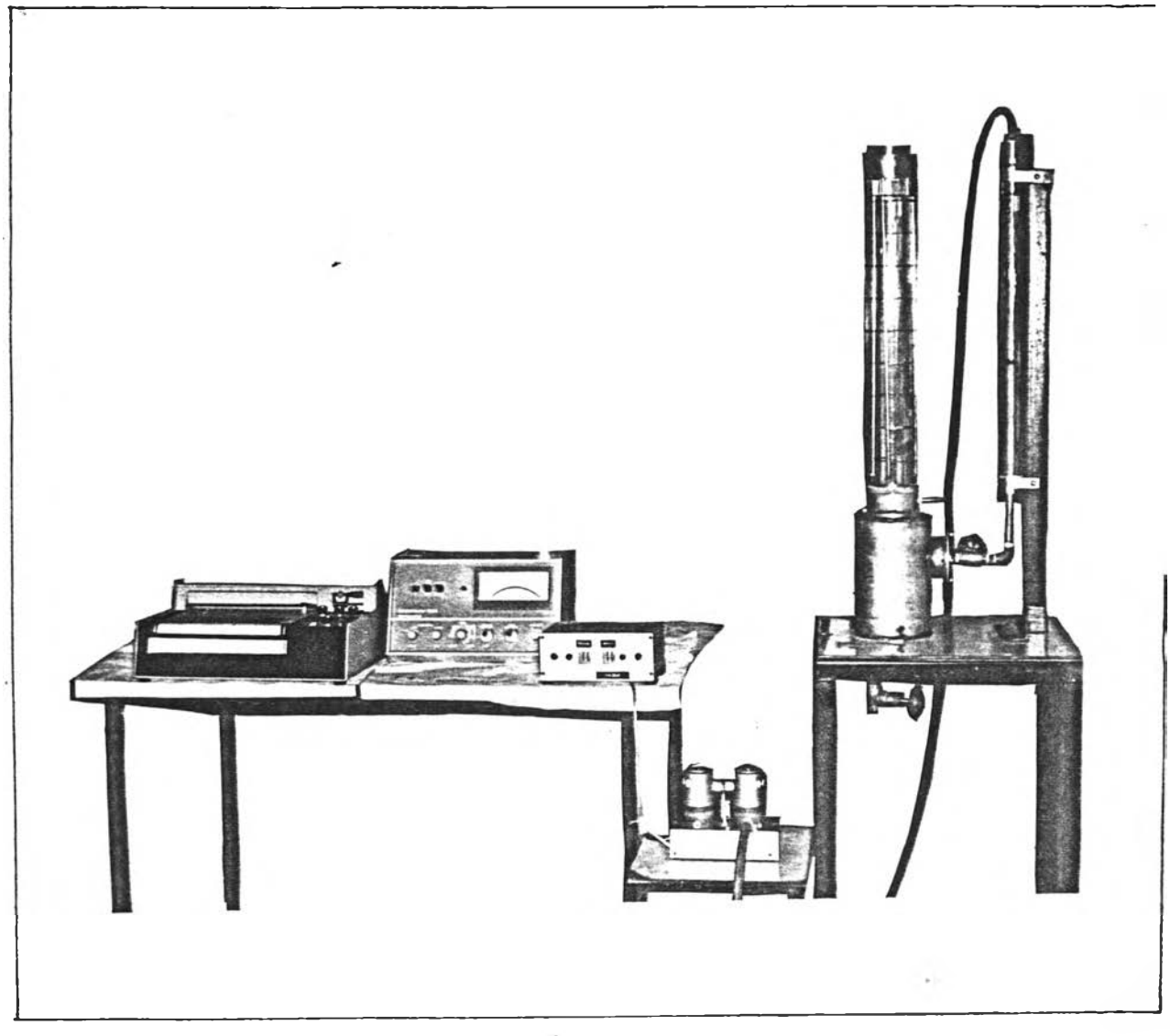


Figure 3.2 The apparatus

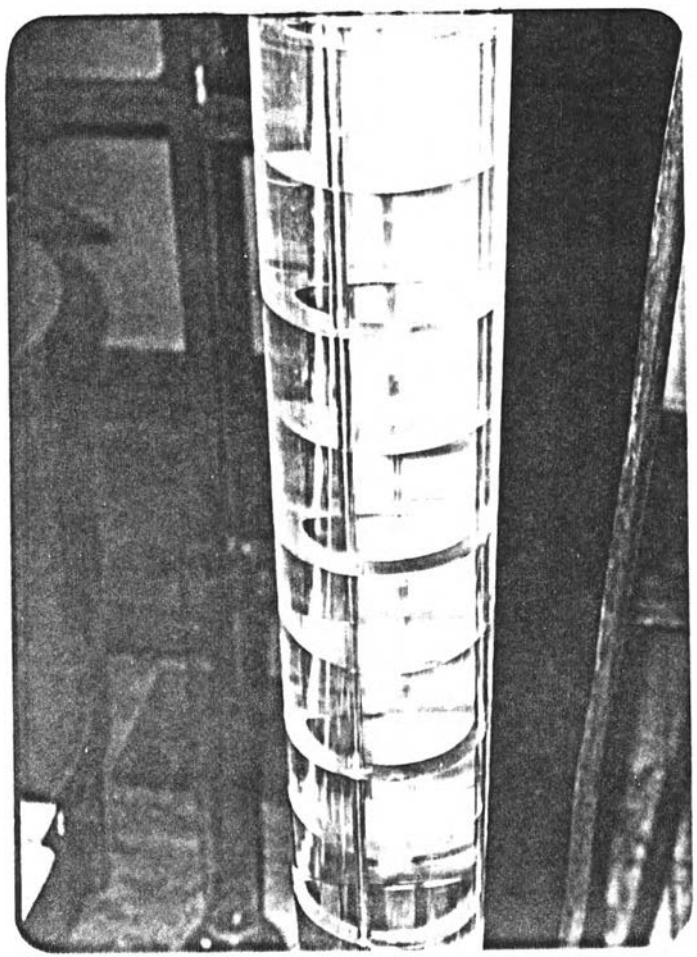


Figure 3.3 Large column with disks and rings

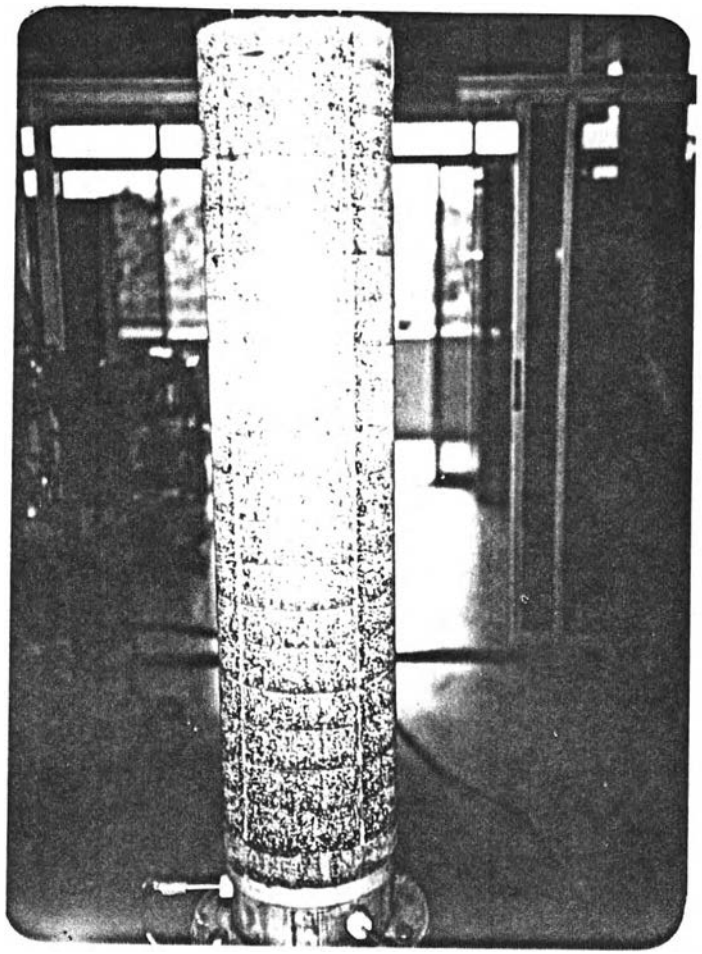


Figure 3.4 Column with plastic beads (2.5 % holdup)