Chapter III

EXPERIMENTAL WORKS

3.1 General

The purpose of the experimental work described here was to study the mass transfer with chemical reaction in fluidized bed. Experimental data were obtained from dissolution of benzoic acid particles of uniform diameter in dilute NaOH solutions. Attention has been focused on the influence of hydrodynamical conditions and experiments have been performed at room temperature.

The mass transfer coefficient and, thus, the Sherwood numbers of the solutions were varied by varying NaOH concentrations. Data were taken at different Sherwood numbers and a wide range of Reynolds numbers in the dense phase region using a perforated plate distributor.

3.2 Experimental Apparatus

The experimental apparatus used is as shown in Fig.3.1. NaOH solution was prepared in a set of storage tanks, and pumped to a constant head tank. The solution was pumped from the constant head tank to a fluidization column. Flowrates were measured by a calibrated orifice meter and controlled with a globe value. The fluidization unit consisted of two main parts: a fluidization column and a homogenisation section.

3.2.1 Fluidization Column

A cylindrical column was made of Plexiglass with a

diameter of 94 mm and a height of 650 mm. The base of the column was fixed with a homogenisation section. The overflow section was on the top of the column. It consisted of two coaxial cylinders; the inner had the same diameter as that of the main column, the outer being connected to a drainnage pipe had a diameter of 200 mm and a height of 150 mm.

3.2.2 Homogenisation Section

Liquid solution entered the bottom of the fluidization column through the homogenisation section which controlled the liquid velocity profile over the cross section of the column and thereby eliminated channelling. This method of preventing channelling was proposed by Couderc[6]. It was made up of a Plexiglass cylinder having the same diameter as that the fluidization column with 200 mm in height. Inside of this section was packed with spherical glass beads of 2 mm diameter. The top and the base of the section were enclosed with two stainless steel perforated plates having 60 mesh and 16 mesh respectively.

Surrounding the homogenisation section, there was a container for collecting the benzoic acid particles after each run. This was intended to reduce the percentage error of the mass dissolution and the operating time during the unfluidizing period. This method of collecting the particles was proposed by VANADURONGWAN[7].

The benzoic acid particles used in this work had a modified ball shape, as shown in Fig.3.2.

The experiments were arranged according to the plan shown in Table 3.1.

3.3 Experimental Procedure

The evaluation of the mass transfer coefficient was carried out by calculating the amount of solid dissolved during fluidization over a period of time. The period of fluidization used in this work was fifteen minutes, after which the particles were dried by hot air and their weight loss calculated. With this information the mass transfer coefficient for the run was evaluated using Eq.(2.2) and Eq.(2.3). The inlet stream was free of benzoic acid ($C_1 = 0$). The concentration of benzoic acid in the bed was calculated from the weight loss of solid during the run, the flow-rate of liquid, and the period of dissolution.

The physical properties of the system to be used in the calculations are tabulated in Appendix A. These properties are for example, diffusivity of benzoic acid in water, saturated concentration of benzoic acid in water, viscosity of NaOH solutions, density of NaOH solutions, density of benzoic acid particles. The calibration of orifice meter is as shown in Appendix B.

Table 3.1 Plan of the Experiment

Expt.No.	$dp \times 10^2$	C_{A1}	Re	ϵ	T
1	0.5850	0	172-319	0.513 - 0.691	30.0-30.1
2	0.5594	0.011	158-180	0.526 - 0.684	30.0-30.1
3	0.4012	0.026	102-182	0.556 - 0.738	29.6-29.7
4	0.5196	0.049	109-294	0.463 - 0.716	29.7-29.8
5	0.3596	0.075	102-156	0.641 - 0.787	30.0-30.1
6	0.4567	0.099	132-280	0.544 - 0.742	30.7-30.8

d_p = Average diameter of benzoic acid particles, m

C_{A1} = Initial concentration of NaOH solution, %

Re = Reynolds number

T = Temperature in the bed, ^oC

ϵ = Bed voidage

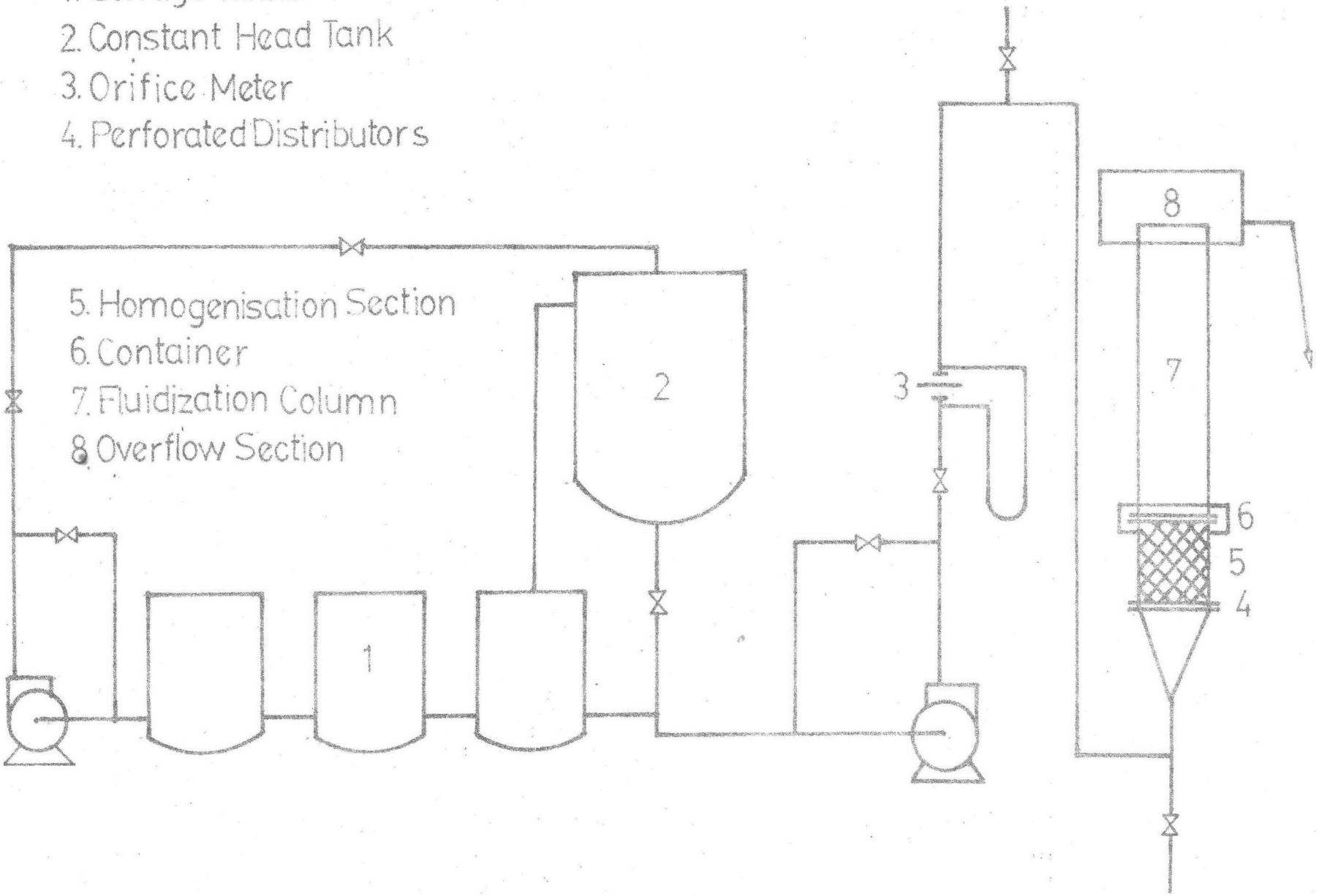

Fig.3.1 Schematic Diagram of Experimental Apparatus

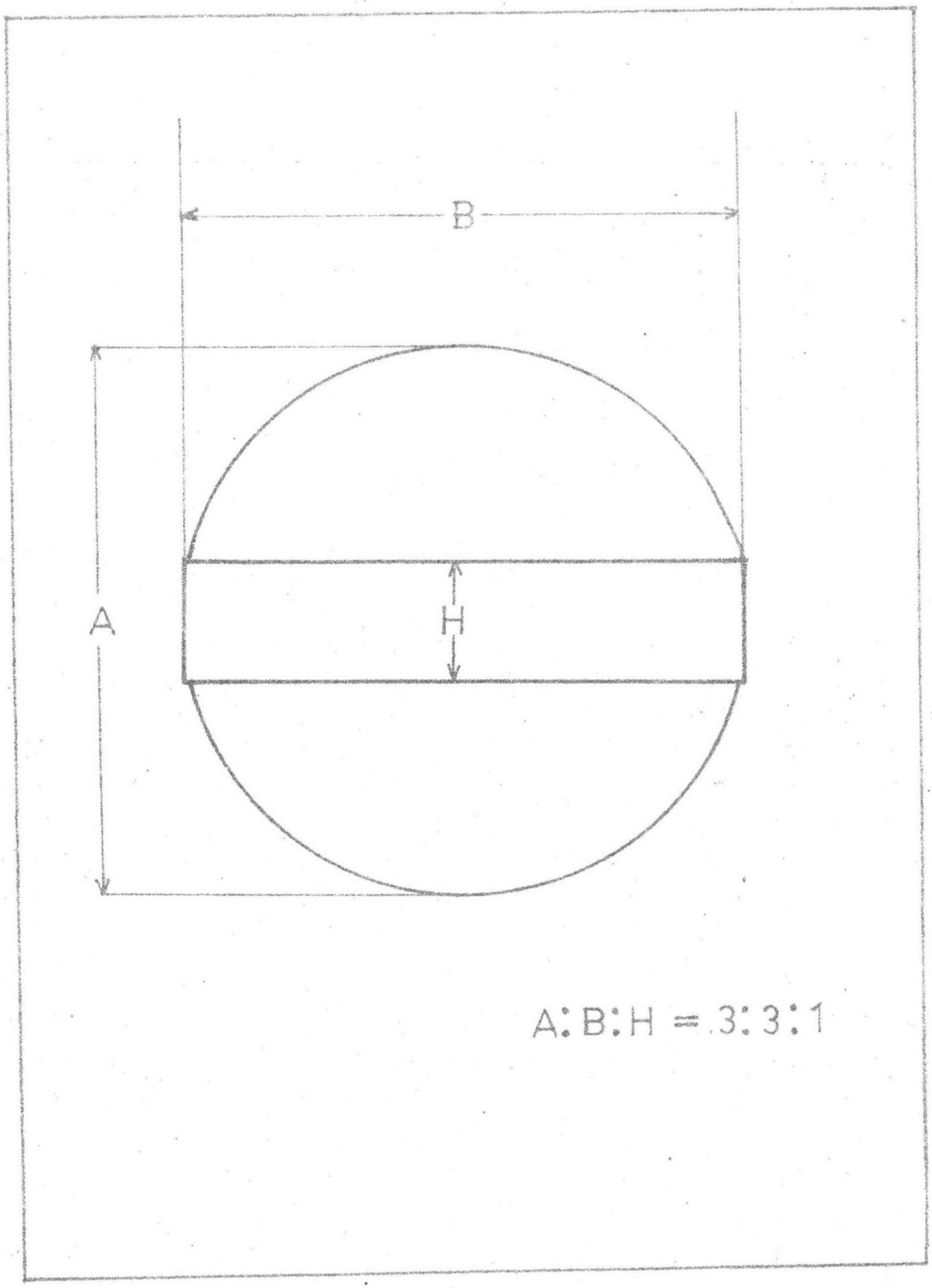

Fig.3.2 Shape of Benzoic Acid Particle