CHAPTER III
EXPERIMENTAL

3.1 Materials

3.1.1 Sodium Dodecyl Sulfate

Sodium Dodecyl Sulfate ($C_{12}H_{25}OSO_3Na$ or SDS) obtained from Sigma Chemical Co. was used as the anionic surfactant without further purification. SDS used in this study was 99% purity. It appeared as white solid. The molecular weight of SDS is 288.4 g/mol. The structure of SDS is shown in Figure 3.1.

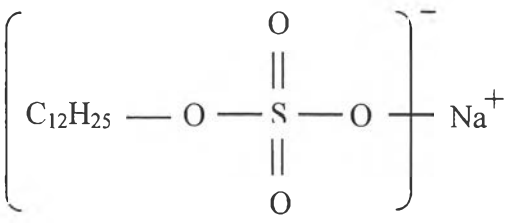

Figure 3.1 The chemical structure of SDS.

3.1.2 Deionized Distilled Water

Deionized distilled water was used as the pure solvent without further filtering or purification.

3.1.3 Capillary Tubes

The capillary tubes used in this work were precision bore borosilicate glass capillaries obtained from Sigma-Aldrich with uniform internal radius 0.17 mm.

3.2 Equipment

3.2.1 Cathetometer

The cathetometer, model TC-II, from Titan Tool Supply Inc., is a precision optical instrument used for measuring vertical displacement with the accuracy of 0.0001 inch per foot. It is a micro-telescope, which has a simple cross

hair reticle mounted in the eyepiece and is attached to the digimatic height gauge, Model 192-631, obtained from Mitutoyo with accuracy ±0.002 inch.

3.2.2 Du-Nauy Ring Tensiometer

Du-Nauy Ring Tensiometer, Model K101, from Kruss was used to obtain the equilibrium surface tension of deionized distilled water and SDS solutions.

3.3 Experimental Conditions

The experimental conditions were carried out at room temperature (25±1°C) and atmospheric pressure (1 atm.)

3.4 Methodology

3.4.1 Glassware Cleaning

All glasswares and capillary tubes were cleaned with cleaning solution then thoroughly rinsed with distilled deionized water and allowed to drain until dry. The cleaning solution was prepared by dissolving 50 g of potassium dichromate in 100 cm^3 of deionized distilled water, then carefully adding 500 cm^3 of 96% concentration of sulfuric acid.

3.4.2 Surface Tension Measurements

3.4.2.1 Deionized Distilled Water

The Du-Nauy ring tensiometer and the capillary tube technique were used to measure surface tension of deionized distilled water. For the capillary tube technique, the experiment started by putting the capillary tube in contact and normal to the bulk deionized distilled water in a beaker. Then, the height of liquid inside the tube was observed by cathetometer until a constant height was obtained for a period of time, approximately 5 hours. The values of surface tension was then calculated from equation (2.1).

3.4.2.2 *SDS Solutions*

Surface tension of SDS solutions was measured by the Du-Nauy ring tensiometer and the capillary tube technique. The SDS concentration was varied from 1, 2, 3, 4, 5, 8, 8.2, 8.5, 12 and 16 mM. For the capillary tube technique, the capillary tube was placed contact and normal to the SDS solution in the bulk beaker. The liquid height inside the tube was monitored by using the cathetometer. In order to obtain the Gibbs plot of SDS, the surface tension of SDS solution were calculated from equation (2.1) and plotted with their concentration.

3.4.3 Mathematical Model Development

The mathematical model was developed by using the theory of the capillary force, Gibbs plot (surface tension versus concentration) and mass transport of the surfactant in the tube. Details are provided in the next chapter.

3.4.4 Transient Capillary Rise Measurements

The experiment for the transient capillary rise started by filling SDS solution in a glass beaker, stirred the solution by a magnetic stirrer. Three pieces of stirring rod were putted to prevent vortex formation. The capillary tube was put in contact and normal to the SDS solution. Once the level of the liquid inside the tube was constant, the solution was flushed out by deionized distilled water from an overhead tank at the flow rate 1,500 ml/min for 1 min. With the flow rate and time of the flushing, the SDS concentration in the beaker was reduced more than 99% of this started concentration. After that the deionized distilled water was constantly flushed at a flow rate 15 ml/min in order to maintain the level of the bulk liquid in the beaker.

The cathetometer was used to monitor the level of liquid in a capillary rise as a function of time. The concentration of SDS solution was varies from 1, 2, 3, 4, 5, 12 and 16 mM. The schematic diagram of the experimental set-up was shown in Figure 3.2.

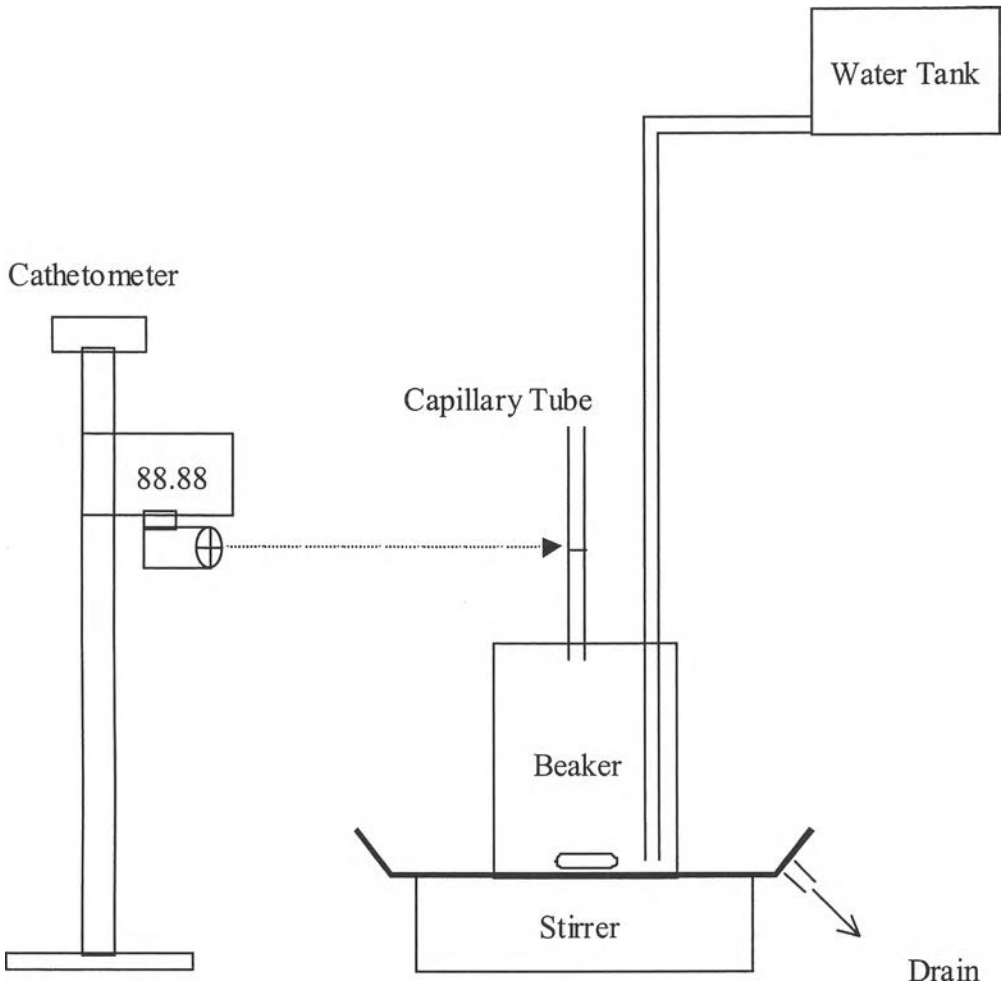

Figure 3.2 The schematic diagram of the experimental set-up for the transient capillary method.

With the experimental data, the mathematical model was used to obtain the SDS diffusivity.