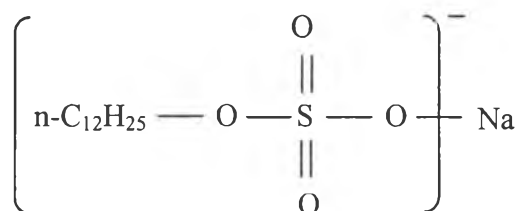




## CHAPTER III EXPERIMENTAL

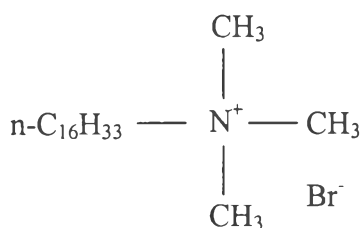
### 3.1 Materials and Equipment

Sodium Dodecyl Sulfate ( $C_{12}H_{25}OSO_3Na$  or SDS) obtained from Sigma Chemical Co. was used as an anionic surfactant without further purification. SDS used in this study was 99% purity. Its structure is shown below.



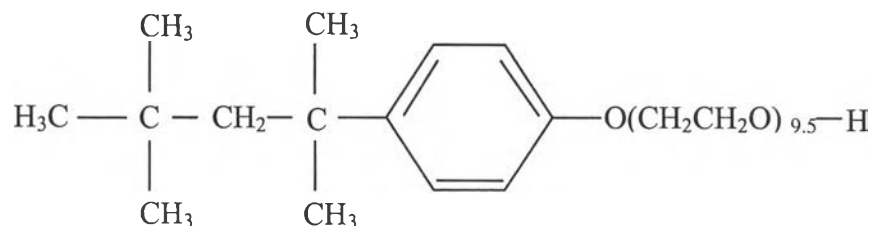
**Figure 3.1** Chemical structure of SDS.

Tetradecyl trimethyl ammonium bromide (CTAB) obtained from Fluka Chemical Co. was used as a cationic surfactant without further purification. CTAB used in this study was 98% purity with the molecular weight of 364.46 g/mol. Its structure is shown in Figure 3.2.



**Figure 3.2** Chemical structure of CTAB.

Octylphenol ethylene oxide condensate (Triton X-100) obtained from Union Carbide Co. was used as a nonionic surfactant without further purification. Triton X-100 used in this study has the molecular weight of 625 g/mol. Its structure is shown below.



**Figure 3.3** Chemical structure of Triton X-100.

Capillary tubes used in this work were obtained from Hirschmann Co. with 1.16 mm internal diameter, 1.5-1.6 mm external diameter, and 75 mm length; and from Sigma-Aldrich with a uniform internal radius of 0.17 mm.

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

A 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 in/ft. 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  $\pm 0.002$  inch.

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

### 3.2 Experimental Conditions

All experiments were carried out at room temperature ( $25 \pm 1^\circ\text{C}$ ) and atmospheric pressure (1 atm).

### 3.3 Methodology

#### 3.3.1 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<sup>3</sup> of deionized distilled water, then carefully adding 500 cm<sup>3</sup> of 96% concentration of sulfuric acid.

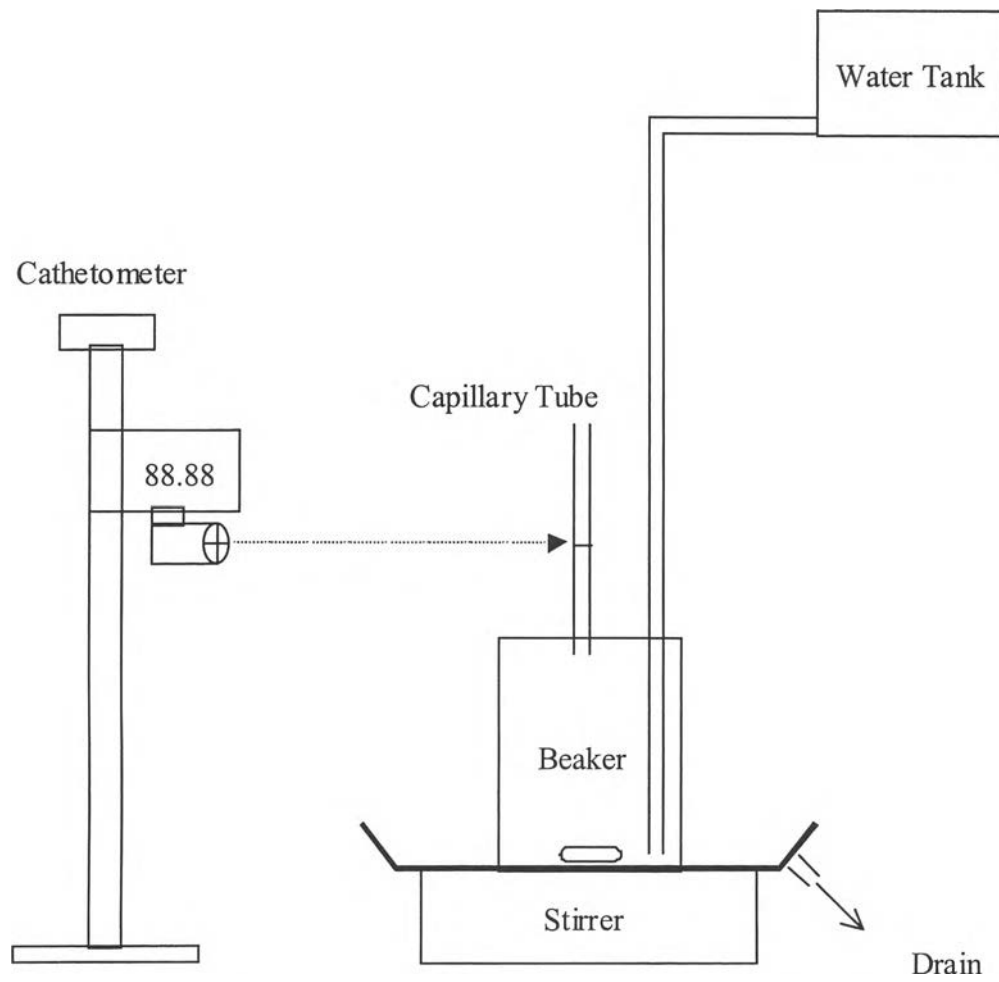
### 3.3.2 Mathematical Model Development

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 Transient Capillary Rise Measurement

Experiments for the transient capillary rise started by filling a surfactant solution in a glass beaker, stirred the solution by a magnetic stirrer for well mixing. Three stirring rods were putted to prevent vortex formation. The capillary tube was put in contact and normal to the surfactant solution with orifice at a depth of about 0.00 to 0.01 mm. 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 a flow rate of 1,500 ml/min for 1 min. With the flow rate and time of the flushing, the surfactant concentration in the beaker was reduced more than 99% of the start concentration in 1 min. After that, the deionized distilled water was constantly flushed at a flow rate of 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 the liquid in the capillary tube as a function of time. The concentration of surfactant solution was varied into 2 sets, below CMC and above CMC. The schematic diagram of the experimental set-up is shown in Figure 3.4.



**Figure 3.4** Schematic diagram of the experimental set-up for the transient capillary rise method.