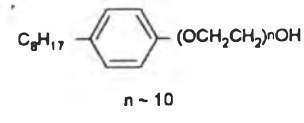
CHAPTER III
EXPERIMENTAL

3.1 Materials

In this study, two surfactants were used: Cetylpyridinium chloride (CPC) and Polyethylene glycol tert-octylphenyl ($OPEO_{10}$). Cetylpyridinium chloride (CPC) as a cationic surfactant was supplied by Zealand Chemical (Steinheim, Germany) with above 99% purity. $OPEO_{10}$ known as Triton X-100 obtained from Fluka (Switzerland) having higher than 98% in purity represented a nonionic surfactant. Distilled water was used in all experiments. Chemical properties of the studied surfactants provided by the suppliers are listed in Table 3.1.

Table 3.1 Chemical properties of the studied surfactants

Type	Chemical formula	Molecular weight	Purity
1.Cetylpyridinium chloride (CPC)	$n\text{-}C_{16}H_{33}N(CH{=}CH)_2CHCl$	358.01	> 99% pure
2. Polyethylene glycoltert-octylphenyl ($OPEO_{10}$)		625	>98% pure

3.2 Apparatus

The multi-stage foam fractionation apparatus used in this study is shown in Figure 3.1. The column did not have water jacket because previous work showed that temperature did not have much effect for the separation. The column was built by using acrylic with tray spacing equal to 15 cm. The inner and outer diameters of the column were 18 and 18.03 cm, respectively. The unit had several stages and could be built of up to 5 stages. Each tray had 22 bubble caps which were made

from stainless steel with 2 cm of diameter and 6 cm of height. Figure 3.2 illustrates the dimensions of bubble-caps. The dimensions of the multi-stages foam fractionator are given in Table 3.2.

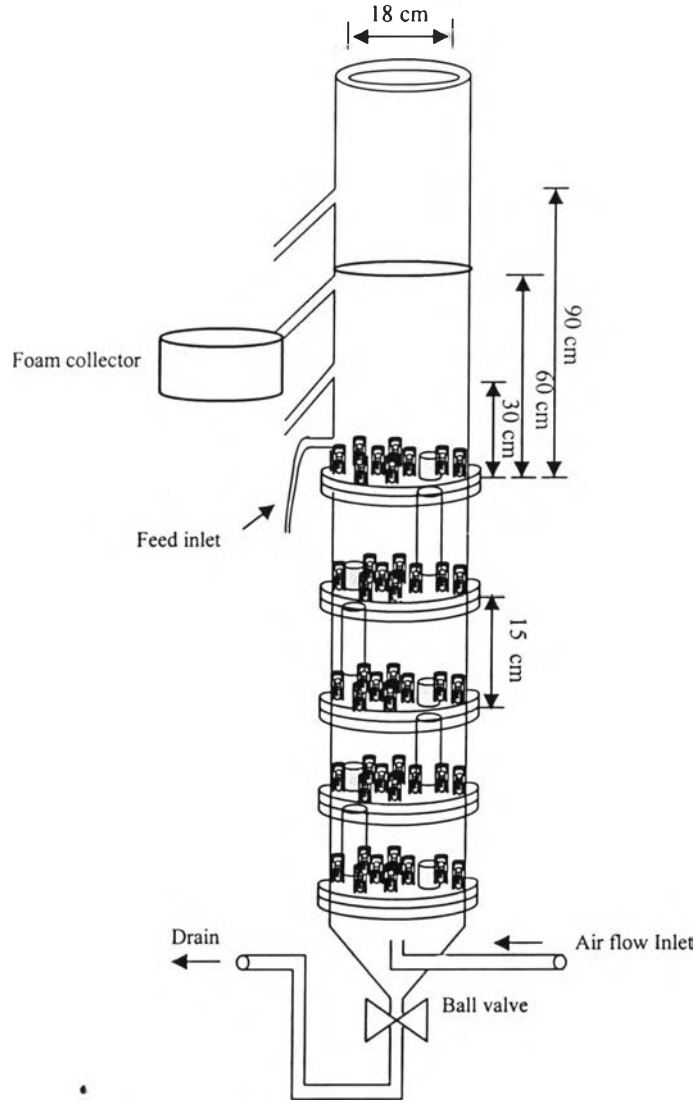


Figure 3.1 Schematic of multistage foam fractionation column.

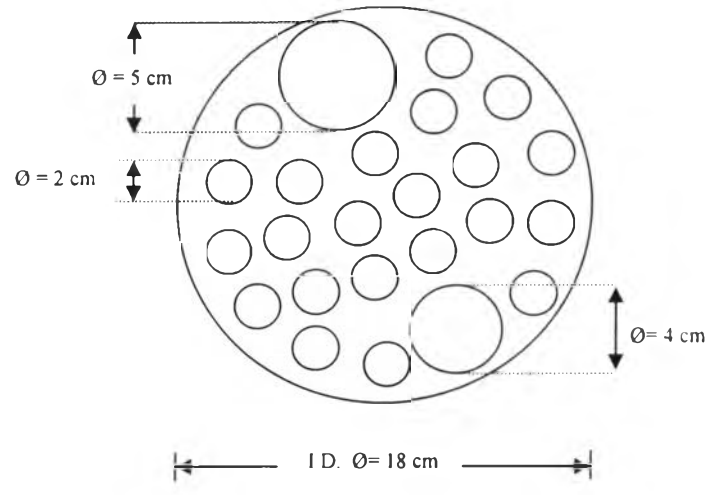


Figure 3.2 Schematic of tray (Top view).

Table 3.2 Dimensions of the multi-stage foam fractionation column

Tray spacing	15 cm
Column diameter - Inner - Outer	 18 cm 18.03 cm
Weir of bubble cap - Diameter - Height	 2 cm 6 cm
Number of bubble caps per tray	22

3.3 Methodology

The foam fractionation was operated in continuous flow mode with aqueous solution containing surfactant. The surfactant solution was continuously fed into the top of the column at a constant flow rate by using a peristaltic pump. The compressed air was introduced to the column at the bottom tray. The foam was collected at three variable positions of 30, 60 and 90 cm from the surface of the top tray. Then, the foam collected was frozen, thawed and then weighted to get the collapsed foamate volume.

The foam fractionation system was studied under steady state conditions. Steady state was insured when all measured parameters were invariant with time. The surfactant concentration in the feed solution was kept constant at 0.225 mM. The ranges of number of trays and foam height were 1-5 trays and 30-90 cm, respectively. Table 3.3 illustrates the ranges of operating parameters. In each experiment, foam wetness (grams of foam solution/liter of foam), the surfactant concentration (mM) in the collapsed foam solution, and the surfactant concentration (mM) in the inlet and outlet stream were measured. The concentrations of CPC and $OPEO_{10}$ were measured by an UV visible spectrophotometer (Shimadzu, BARA WINDSOR Co., Ltd.) at wavelength of 260 nm and 275 nm, respectively.

The critical micelle concentrations (CMC) of each surfactant and the mixtures were calculated at the concentrations where the plots of the surface tension versus surfactant concentration showed abrupt changes in slope. The measurement of surface tension of surfactant solutions was carried out by using Contact Angle Instrument (DSA 10, Kruss).

In this research, a glass column having an internal diameter of 5 cm and a height of 100 cm was used to investigate the foam ability and foam stability of all surfactant solutions. A certain amount of 250 ml of surfactant solution was poured into the column and then sparged by a constant flow rate of air of 0.1 L/min. The foam height was measured as a function of time to indicate the foam ability of the system. When the foam reached the highest level at which it was stable, the air flow

was suppressed and then the time that it took for collapse to the half of maximum point was measured as a foam stability.

Table 3.3 Operating parameters

Feed inlet - Type - Total concentration - Flow rate	 CPC and/or $OPEO_{10}$ 0.225 mM 25-100 ml/min
Air inlet - Flow rate	 40-100 l/min
Number of trays	1-5
Foam height	30-90 cm