CHAPTER I
INTRODUCTION

The surfactant detergency development is driven by environmental concern with regard to eco-friendly products. The design of detergents to perform well in cold-water wash requires effective surfactant formulations of detergency not only making them effective but also highly solubilizing semi-solid fats of vegetable oil at low temperature. This is very challenging for many applications, including detergency and cleaning for saving energy.

Vegetable oil detergency cannot form microemulsion by a single conventional surfactant system as one of ingredients (Corswant, 1997; Tungsubutra T., 1994; Huang, 2004). Therefore, this surfactant system needs co-oil or alcohol for microemulsion formation. However, alcohol is a low vapor pressure and volatile substance, can act as a solvent which bleaches fabrics, and cause skin irritations (Acosta, 2005). The extended surfactant is compatible since it can form microemulsion without co-oil or alcohol due to its unique property such as low CMC, and CμC values which can achieve an ultralow interfacial tension (IFT<10^{-3} mN/m) and form a middle phase microemulsion (Rosen, 2012). Moreover, the branched tail structure of surfactant also reduces an IFT due to the disordered conformation of the branched alkyl group. As a result, the extended surfactant is considerable more efficient than that of a conventional surfactant. The use of vegetable oil in microemulsion formation is also very challenging because it mainly consists of triglycerides which is, ester of fatty acids with glycerol contributing to their complicated behavior. The long and bulky alkyl chains make triglycerides highly hydrophobic, while the ester region in the molecule causes high polarity. These affect to low solubilization of triglycerides by a surfactant. Although, the use of extended surfactant presents an ultralow IFT (Phan, 2011), vegetable oil is difficult to remove totally from surface. Consequently, the oil removal needs to be increased by improving interaction between oil and alkyl chain surfactant.

This work attempted to enhance vegetable oil (semi-solid fat) solubilization using mixed surfactant systems of extended anionic surfactant and nonionic surfactant. Palm olein was selected as hydrophobic oil in the microemulsion phase

behavior study by varying salinities, surfactant concentrations and mixed anionic nonionic surfactant molar ratios. The anionic extended surfactant [branched $C_{14-15}H_{29-31}$-$(PO)_8$-SO_4Na] having eight polypropylene oxide groups was selected because their intermediate polarity of PO groups would help to decrease interfacial tension (IFT) and increase amount of oil solubilization from surface. Furthermore, the developed surfactant formulation of the nonionic surfactant in anionic extended surfactant mixed system is expected to enhance oil removal and minimize the amount of extended surfactant uses. Two-series of renewable based nonionic surfactant were selected including, sorbitan and alcohol ethoxylated series. Sorbitan stearate (SS) and sorbitan oleate (SO) are different in saturation in the molecules in order to study the effect of alkyl chain length on the phase behavior. These linear alcohol ethoxylated surfactants [$(C_{12-14}H_{25-29}$-$(EO)_n$-$OH)$] with three different in polyethylene oxide (EO) groups (n=3, 5, and 9) in the surfactant molecules were selected in order to study the effects of EO groups on their phase behaviors. The dynamic IFT of the surfactant systems were evaluated with palm olein. The selected optimum formulations providing the lowest IFT (<<0.1 mN/m) were conducted to perform solubilization study with palm stearin (semi-solid fat) at 30 ± 1 °C. The solubilization of solid-semi fat, the palm stearin was selected as model oil which represents as solid stage at 30 ± 1 °C to perform solubilization study of semi-solid fat at below its melting point. The results of this study provided the insight information regarding to the vegetable oil based microemulsion for cold water detergency applications.

1.1 Objective

This research aimed to formulate middle phase microemulsion using mixed surfactants between anionic extended and nonionic surfactants with palm olein (liquid) for solubilization study with palm stearin (semi-solid fat) at low temperature (below its melting point).

1.2 Scope of Research

First of all, the synergism effect of mixed anionic and nonionic surfactants was observed through surface tension measurement. Following this, the effect of mixed anionic and nonionic surfactants on middle phase microemulsion formation and interfacial tension measurement were conducted with palm olein. Finally, the solubilization study of palm stearin was observed.