CHAPTER VII
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In this work, the microemulsion-based formulation for removal of motor oil in laundry detergency at low salinity was formed. The mixed surfactant system of 1.5% ADPODS, 5% AOT and 5% Span 80 (13 parts ADPODS, 43.5 parts AOT, and 43.5 parts Span 80 of the total actives) was found to form a middle phase microemulsion at a relatively low salinity (2.83%). Under using the microemulsion-based formulation in detergency experiment, up to 80% oil removal for all three types of fabric (pure cotton, 65/35 polyester/cotton blend, and pure polyester) was obtained at a relatively low total surfactant concentration (0.1%). The motor oil removal was found to increase with increasing hydrophilicity of the fabric. In this microemulsion-based formulation, a substantial fraction of oil removal occurred during the rinse step due to the ultralow oil/water interfacial tension, resulting in the spreading effect in the wash step and the oil removal in the rinse step is strongly correlated to the residual surfactants after the wash step. In addition, the detergency performance in term of oil removal was found to be optimized with a low rinse volume (one-third of washing solution) and two rinses.

To further reduce salinity, a new formulation of mixed surfactants of 0.5% ADPODS, 5% AOT and 3% Span 80 (6 parts ADPODS, 59 parts AOT, and 35 parts Span 80 or ADPODS:AOT:Span 80 ratio of 1:10:6) was found to exhibit Winsor Type III microemulsions with motor oil at a very low optimum salinity of 2%. The oil removal in the first rinse step was found to be higher than that in the wash step because a significant loss of the surfactants by the surfactant adsorption, leading to the reduction in the solubilization capacity in the wash step. The remaining oil on the fabric was further removed in the rinse step as well as desorption of residual surfactants from the fabric into the rinsing solution, leading to increasing in both the emulsification and the solubilization capacity. The amount of water used in the rinse step was found to affect the oil removal of each rinse step but did not affect the overall oil removal. Moreover, the higher the quantity of rinsing water, the lower the

residual surfactant on the fabric surface and two rinses with the highest volume of rinsing water (2,000 mL) were found to provide the best detergency performance in terms of both oil removal and surfactant removal.

To further study on microemulsion and detergency performance, the effect of water hardness and builder on microemulsion phase and detergency performance was investigated. In this work, the mixed surfactant system consisting of two types of surfactant which are Alfoterra and Tergitol was used to form microemulsion system with motor oil. The water hardness and builder was found insignificantly affect on microemulsion phase diagram. However, the detergency performance decreased with increasing water hardness while the IFT increased. With adding builder in the laundering under hard water condition, the detergency performance was improved at a certain level, even though an excess amount of builder was added in the washing bath.

7.2 Recommendations

The research on the detergency of mixed soils of particulate and oil is of great interest to study because the mixed soils can be found in the real situations for everyday life. The different surfactant systems (single nonionic, single anionic and mixed surfactant systems) should be investigated for the detergency performance and the concentration of each surfactant should be analyzed in each step of washing process in order to gain a better understand the effect of residual surfactants on the detergency performance. Contact angle, PZC and surfactant adsorption isotherm should be investigated in order to obtain a better understanding the washing process.

In addition, stains such as coffee, blood, tea and rust etc., which are commonly found in the daily life, should be investigated. For studying the stain removal, enzymes should be added in the detergent formulation and the effect of enzyme aging on the detergency performance should be evaluated.