CHAPTER VII
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In this research, the mechanistic studies of the particulate soil removal in laundry detergency were investigated. Three particulate soils (hydrophobic soil: carbon black and hydrophilic soil; ferric oxide and kaolinite), five surfactants; anionic surfactant (SDS, MES and LAS), nonionic surfactant (OP(EO)10), and cationic surfactant (CTAB) and two types of fabrics (hydrophobic substrate; polyester and hydrophilic substrate; cotton) were studied. The zeta potential, solid/liquid spreading pressure, contact angle and surfactant adsorption of both soil and fabric are correlated to detergency over a range of surfactant concentrations and pH levels. In all cases, detergency increased with increasing solution pH and reached the maximum performance at pH 11. The results imply that electrostatic repulsion between fabric and soil particles is the primary mechanism responsible for detergency for anionic, nonionic, and cationic surfactants studied for both hydrophobic soil (carbon black) and hydrophilic soil (ferric oxide and kaolinite). The adsorption of anionic surfactants onto the negatively charged studied fabrics and studied particulate soil were found experimentally to increase the summation of electrical potentials between studied soil and fabric, resulting in detergency improvement. The studied nonionic surfactant caused the surface of fabric and soil to become more negatively charged and the steric repulsion appears to aid detergency in this case. The cationic surfactant showed the lowest detergency due to poor rinseability and a part from the electrostatic forces, the IFT reduction due to surfactant adsorption aids cationic surfactant detergency. For the hydrophobic soil (carbon black), detergency was higher for the polyester compared to the cotton which is attributed to the higher electrical potential as well as a smoother surface of the polyester fiber. Furthermore, the SEM images showed that the hydrophobic soil (carbon black) tended to form larger aggregates on the polyester than those on the cotton. In contrast, both hydrophilic soils (ferric oxide and kaolinite) tended to form larger aggregates on the cotton than those of the polyester. The adhesion of larger particles is hypothesized to be weaker than that of smaller ones. Hence, this helps explain why higher removal of kaolinite and ferric oxide from cotton and vice versa for carbon black. MES showed the best detergency performance compared to SDS and LAS, in which MES was found to exhibit the highest electrostatic repulsion force between all studied fabrics and soils. The presence of any studied surfactant was found to provide better stability of suspensions as compared to surfactant-free system.

7.2 Recommendations

This research covered all types of surfactants (anionic, nonionic and cationic surfactants) relating to the particulate soil detergency in single surfactant systems at a constant temperature of 30°C in the absence of water hardness and salinity. Further study should be done for mixtures of surfactants, mixed particulate soils and a mixture between particulate soil and oily soil which is close to the real situations for everyday life. In addition, other variables related to the detergency performance such as temperature, water hardness and salinity should be investigated.

Furthermore, solid non-particulate soil such as margarine and solidified hamburger grease etc., as well as stains such as coffee, tea and blood etc., which are commonly found in daily life, should be investigated. For a solid non-particulate soil, it acts as oil at temperatures higher than its melting point and becomes solid particles at temperatures lower than its melting point. Hence, temperature should be studied which can help to clarify the dominant force governing the solid non-particulate soil removal. For stain removal, enzymes should be added into the washing solution containing different types of surfactants and the effect of enzyme aiding detergency performance in surfactant-containing systems should be investigated.