Chapter 7
Conclusion & future scope

The present research work was aimed to synthesize higher fatty alcohol based anionic phosphate gemini surfactants. For this purpose three higher fatty alcohols viz. tetradecanol, hexadecanol and octadecanol were subjected to phosphorylation using pyrophosphoric acid at 35 °C. The resulting mono alkyl phosphates were subjected to prepare phosphate gemini surfactants using three α-ω alkyl dibromides viz. 1,4 DBB, 1,6 DBH and 1,8 DBO at 35 °C. The effect of molar ratios of mono alkyl phosphate, TMAH and α-ω alkyl dibromides was also evaluated. The synthesized geminis were then successfully converted to their disodium salts in order to evaluate physico-chemical and surface active properties of synthesized phosphate gemini surfactants. The mono alkyl phosphate and phosphate gemini surfactants derived from tetradecanol, hexadecanol and octadecanol were characterized chemically and instrumentally. The anionic content of each phosphate gemini surfactant was determined by standard BIS method. The five performance properties viz. wetting ability, foaming ability and stability, emulsion stability, dispersion power and solubility were evaluated by using standard methods. The three surface active properties namely surface tension, interfacial tension and critical micelle concentration were also determined. On the basis of findings of the all three used higher fatty alcohols, finally following conclusions have been drawn:

For mono alkyl phosphates

(i) The temperature and duration of phosphorylation for preparing mono alkyl phosphate and phosphate geminis proved significant parameters with respect to yield of phosphate gemini surfactant.
(ii) The highest yield was obtained when the reaction was carried out at 35°C for 96h with equimolar ratios of alcohol and pyrophosphoric acid

(iii) The highest yield was reported for mono tetradecyl phosphate among all the synthesized mono alkyl phosphates.

For phosphate gemini surfactants and disodium salt of phosphate gemini surfactants

(iv) All the phosphate gemini surfactants were synthesized in maximum yield when reaction was carried out using 1:2:0.5 molar ratio of alkyl phosphate, TMAH and α-ω alkyl dibromides, respectively.

(v) Irrespective of alcohols disodium salts of gemini surfactants were prepared in highest yield with 1:1 molar ratio of synthesized phosphate geminis and ethanolic solution of sodium hydroxide.

(vi) Yield studies indicated that irrespective of alcohols, phosphate gemini surfactants and disodium salt of phosphate gemini surfactant having 1,6 DBH as spacer gave maximum quantity as compared to 1,4 DBB and 1,8 DBO.

(vii) The results of this study indicated that octadecanol is a better alcohol as compared to rest of the two alcohols with respect to the yield of phosphate gemini surfactant and disodium salt of phosphate gemini surfactant.

Physico-chemical properties and surface active properties

(viii) On account of anionic content and performance properties except solubility and wetting ability 1,6 DBH was found to be superior α-ω alkyl dibromide for deriving geminis from the alcohols underquestion whereas on account of
surface active properties 1,8 DBO was noticed to be better α-ω alkyl dibromide irrespective of type of alcohol used for this study.

(ix) Out of three studied alcohols, octadecanol was found to be excellent based on superior physico-chemical properties and surface active properties.

(x) Out of all the phosphate gemini surfactants studied tetradecanol based gemini surfactants were found to be soluble in maximum solvents as compared to the other synthesized geminis.

Future scope

Gemini surfactants are very versatile chemical molecules. They have tremendous potential of use in the various industrial applications because of their extraordinary surface properties. Out of various gemini surfactants anionic gemini surfactants have got most importance because of their high surface activity and low cmc values in the various application viz. emulsifiers, dispersants, hydrotropic agents, cleaning agents in cosmetics, shampoos, mild for use in personal care products, used as detergents and antifoaming agents. The research work presented in this thesis has exploited the use of higher fatty alcohol to convert to highly effective anionic phosphate gemini surfactants. The future researchers can do some studies to formulate the compositions based on phosphate gemini surfactants with existing conventional anionic surfactants and nonionic surfactants. In future different preparation strategies for making cost effective phosphate geminis may also explored using C_{20}-C_{22} alcohol chains.

In the present course of work α-ω alkyl dibromides (C_{4}-C_{8}) have been used but (C_{10}-C_{12}) may also be studied in future. Preparation of gemini surfactants using same alcohols but different variety of spacers viz. polar, non polar and rigid are also possible. As geminis are highly surface active so micelles studies, aggregation and contact angle studies of synthesized gemini surfactants are also possible. Geminis are gaining popularity because of their versatility and high surface active performances, therefore in future mechanical stability of treated fabrics and enviornmentl aspects of gemini surfactants may also be investigated.