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PHASE BEHAVIOUR OF FATTY ALCOHOL SULPHATE AND FATTY ALCOHOL ETHER SULPHATE FROM PALM BASED

(Kelakuan Fasa Lelemak Alkohol Sulfat Dan Lelemak Alkohol Eter Sulfat Berasaskan Sawit)

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Abstract

The phase diagrams of fatty alcohol sulphates (FAS)/ fatty alcohol ether sulphates (FAES)/water and mixed FAS:FAES (1:1)/propylene glycol/water were constructed at room temperature. Another phase diagram of mixed FAES/FAS/soap (4.5:4.5:1.0)/propylene glycol/water were established at 60˚C. Birefringence was observed under cross-polarized light and their phase changes examined under a polarized microscope. The liquid crystalline region for FAES and FAS occurred only in a small region. The optical patterns of lamellar liquid crystal observed were oily streaks and a typical fine cross-striated structure.

Keywords: lamellar liquid crystal, FAS, FAES, anionic surfactant, ternary phase diagram

Abstrak

Gambarajah fasa campuran lelemak alcohol sulfat (FAS)/lelemak alcohol eter sulfat (FAES)/sabun (4.5:4.5:1.0)/propelina glikol/air telah dibina pada suhu bilik. Selain itu, gambarajah fasa FAS/FAES/sabun (4.5:4.5:1.0)/propilena glycol/air turut dibina pada suhu 60˚C. Dwibiasan telah diperhatikan melalui pengutub bersilang manakala perubahan fasa telah dikaji dengan menggunakan mikroskop berkutub. Keputusan menunjukkan hablur cecair bagi FAS dan FAESterbentuk pada kawasan yang kecil. Ciri optikal bagi hablur cecair lamella didapati mempunyai struktur carikan berminyak.

Kata kunci: hablur cecair lamella,FAS,FAES, surfaktan anionik, gambarajah fasa tenari

Introduction

Soap and anionic surfactants have traditionally been the major constituents in many cleaning agents [1]. FAS and FAES derived from palm oil are produced from Chemiton technology in the Malaysian Palm Oil Board (MPOB). However, they show low activity and were therefore mixed for a synergistic effect on their properties. Many other works on other mixed have shown the advantages of using mixed surfactants in terms of enhancing the performances of single surfactants [2-6]. But for the mixing to be successful, it is necessary to understand the physico-chemical behaviour of the surfactants, and a study of their ternary phase systems was carried out to identify the contributions of the different components in the formulation of new products [7]. The phase behaviour and other properties of mixed surfactants have been studied by Hoffman *et al*. [8-10]. The mesophase changes can be described from phase diagrams. The type of liquid crystal has a major influence on product properties. About seven different classes of liquid crystals have now been recognised, the major ones being lamellar, hexagonal, cubic, nematic and gel phase [11]. Liquid crystal surfactants are common in products such as detergents, shampoos and household cleaners. The aim of this work was to identify the phase behaviour in ternary systems of FAES/FAS/water, FAES/FAS (1:1)/PG/water and FAES/FAS/soap (4.5:4.5:1.0)/PG/ water.

Materials and Methods

Materials

The surfactants were FAS and fatty alcohol ether sulphate (FAES), obtained from the Advanced Oleochemicals Technology Centre (AOTC), MPOB (Figure 1). The specifications of these compounds are shown in Table 1. Soap was obtained from Unichema Sdn Bhd and its specifications shown in Table 2. Propylene glycol (PG) was of 99% purity. All these chemicals were used without further purification.

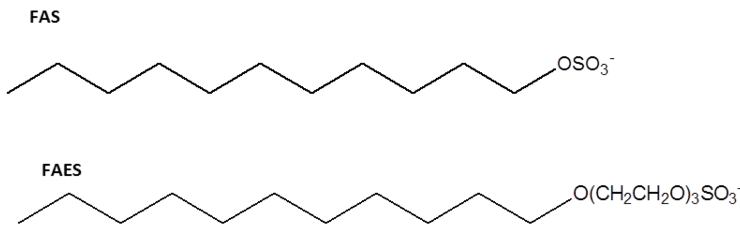

Figure 1. Structures of FAS and FAES

Table 1. Specification of FAS and FAES

Properties	FAES	FAS
Active	27.37 %	27.65
Unsulphonated matter	0.32%	0.74%
Moisture	68.62%	71.77%
Color	0.4 R,	2.0 R,
Petroleum ether extraction	3.7 Y	10.0 Y
PH (10%)	-	1.13%
	-	9.61

Table 2. Specification of soap

Properties	
Total fatty matter %	9-81
Moisture %	10.5-12.5
Free fatty acids %	1.3 max
Sodium chloride %	0.4-0.6
Glycerol %	0.1-0.2
Sequestrants	Present
Typical titer (Fatty acids) deg. C	44-47

Three phase diagrams, FAES/FAS/ water (phase diagram 1), FAES/FAS (1:1)/PG/water (phase diagram 2) and FAES/FAS/soap (4.5:4.4:1.0)/PG/water (phase diagram 3), were prepared at room temperature (25˚C) with the exception of phase diagram 3 which was prepared at 60˚C to dissolve the soap component. The procedure of preparation was the same with only the components and their ratios different. 0.5 g mixtures were placed in test tubes, approximately 0.5% deionised water added and the mixture homogenized at 4,000 rpm for 15 minutes (Jouan CR3I) to eliminate air bubbles. Each sample was centrifuged for at least 3 times and then allowed to equilibrate in a water bath at 25˚C for at least 15 minutes. The phases were identified by observation through polarized film and crossed polarizing microscope with a heating stage (Olympus AX70). More water was added to the test tube and the procedure repeated.

Results and Discussion

Phase diagram 1

The ternary system of FAES/FAS/ water was plotted at room temperature (Figure 2). The phase changed from lamellar liquid crystalline phase (LC) → two-phase region (2p) → isotropic region (1p) with the results summarized in Table 3. liquid crystal region were observed in 80/20, 70/30, 60/40, 50/50 and 40/60. The optical patterns observed under a microscope for each phase transition are shown in Figure 3. The texture of the lamellar liquid crystal obtained was comparable with those in the literature (7 and 8).

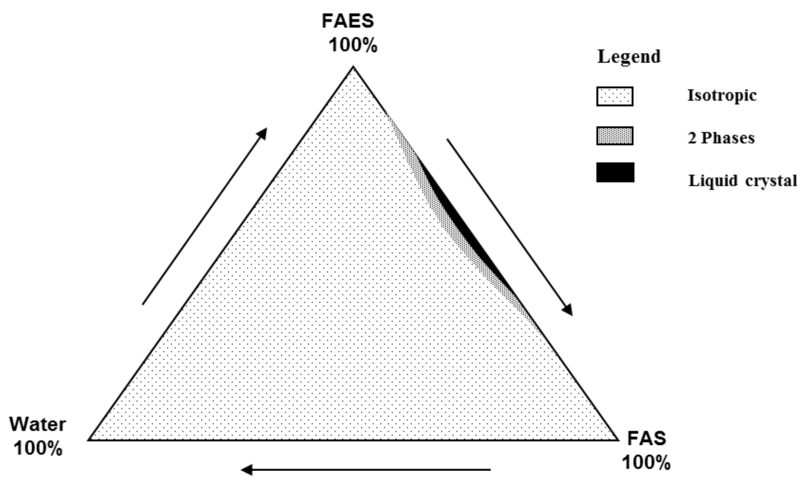

Figure 2. Phase diagram of FAES:FAS:Water at room temperature

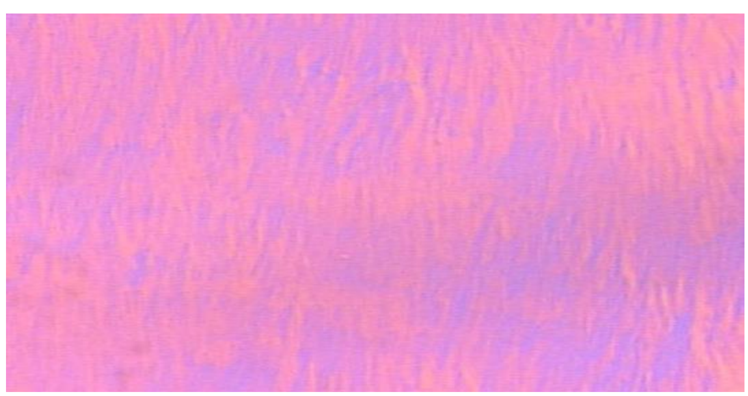

Figure 3. The optical patterns of FAES:FAS:Water at room temperature.

Table 3. Phase transition summary of FAES/FAS/water at room temperature

FAES/FAS (w/w%)	Phase Transition
100/0	1p
90/10	1p
80/20	LC →2p →1p
70/30	LC →2p →1p
60/40	LC →2p →1p
50/50	LC →2p →1p
40/60	LC →2p →1p
30/70	1p
20/80	1p
10/90	1p
0/100	1p

Phase diagram 2

Based on phase diagram 1, the liquid crystalline regions of FAES and FAS at 1:1 ratio were selected for further study of their phase behaviour by adding PG. The ternary system of FAES/FAS (1:1)/PG/water at room temperature was plotted as in Figure 4. The smallest liquid crystalline region was obtained in 100% FAS without PG. The rest of ratios started from 100/0 to 10/90 exhibit isotropic region. The phase transition results are summarized in Table 4. The optical patterns of LC, 2p and 1p observed are shown in Figure 5.

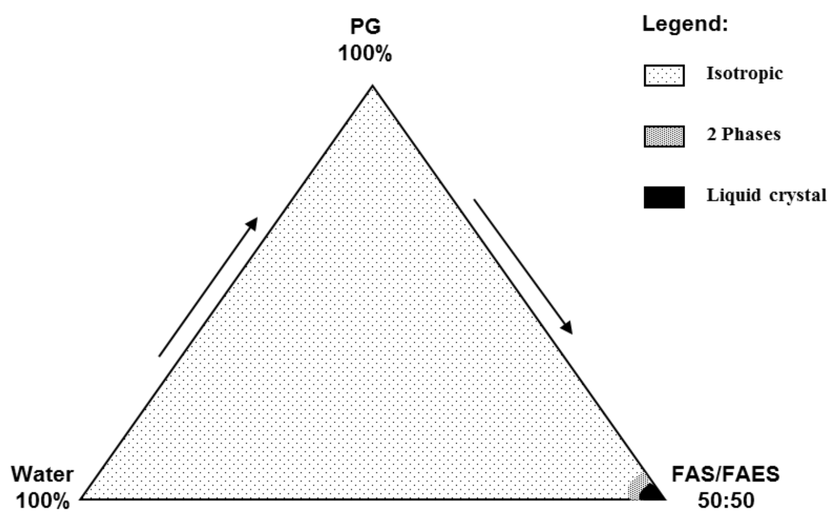

Figure 4. Phase diagram of FAES/FAS:PG:Water at room temperature

Table 4. Phase transition summary of mixed FAES/FAS(1:1)PG/water at room temperature

(FAES/FAS)/PG (w/w%)	Phase Transition
100/0	1p
90/10	1p
80/20	1p
70/30	1p
60/40	1p
50/50	1p
40/60	1p
30/70	1p
20/80	1p
10/90	1p
0/100	LC→2p →1p

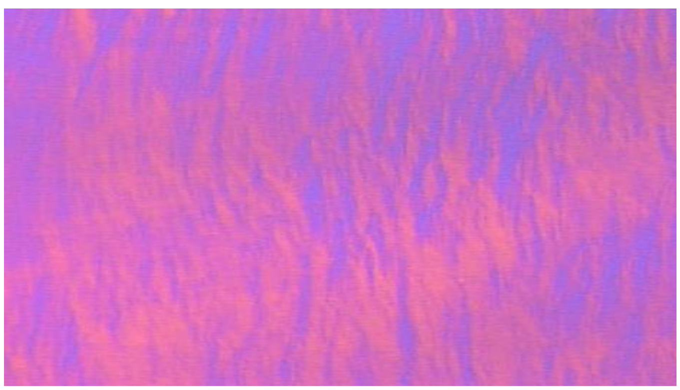

Figure 5. The optical patterns of FAES/FAS:PG:Water at room temperature.

Phase diagram 3

Using the same amounts of FAS and FAES, soap was added, i.e. a ratio of 4.5:4.5:1.0 of mixed FAS:FAES:soap, as shown in Figure 6. The LC region formed at 100% FAS with soap in 4% to 14% water. The phase transition results are summarized in Table 5. The optical patterns of LC, 2p and 1p observed were as shown in Figure 7. Mixtures of FAES and FAS with water as the third component, a large LC area was found compared to the mixture of FAES, FAS and soap. When water was replaced with PG, no improvement in LC region occurred as in phase diagrams 1 and 2. The surfactant mixtures of FAES/FAS/water exhibited oily streaks and a fine cross-striated texture implying a lamellar liquid crystal structure.

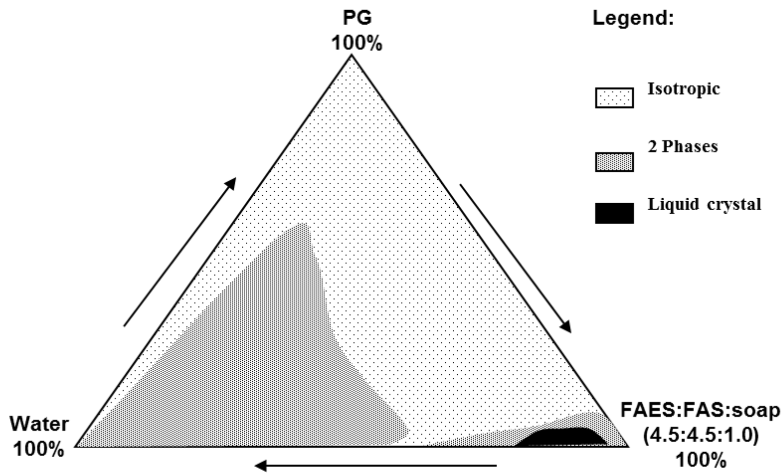

Figure 6. Phase diagram of (FAES/FAS:soap):PG:Water at 60^{o}C

Table 5. Phase transition summary of the ternary system of (FAES/FAS/soap)/PG/water at 60^{o}C

(FAES/FAS/soap) /PG (w/w%)	Phase Transition
100/0	1p
90/10	1p→2p
80/20	1p→2p
70/30	1p→2p
60/40	1p→2p
50/50	1p→2p
40/60	1p→2p
30/70	1p→2p
20/80	1p→2p
10/90	2p→ 1p→2p
0/100	2p→ LC → 2p→1p →2p

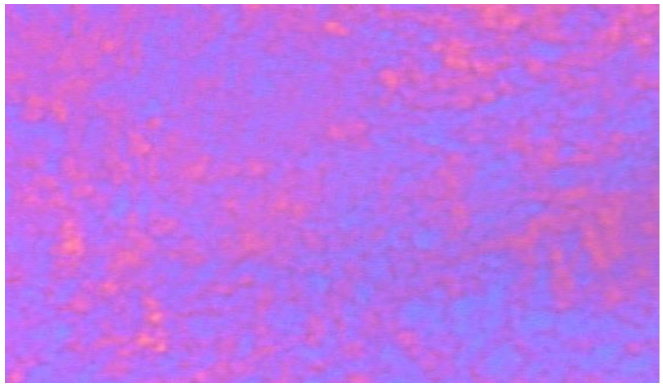

Figure 7. The optical patterns of (FAES/FAS:soap):PG:Water at 60^{o}C.

Conclusion

In conclusion, the phase diagrams based on various combination of fatty alcohol sulphates , fatty alcohol ether sulphates, water, propylene glycol and soap were constructed at different condition. Birefringence was observed under cross-polarized light and their phase changes examined under a polarized microscope showed formation of lamellar liquid crystal identified as oily streaks and a typical fine cross-striated structure.

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