Efficient control of rheological and surface properties by using C8-C18 fatty acids as co-surfactants

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Summary

Systematic experimental study is performed about the effects of fatty acids (FAc), used as co-surfactants to SLES+CAPB mixture on:

(1) Bulk viscosity of the concentrated solutions (10 wt %)

(2) Surface properties of diluted solutions (0.5 wt %)

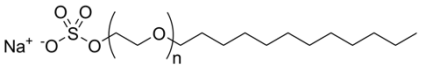
Main results could be summarized as follows [1]:

- ✓ C8-C10 FAc induce formation of wormlike micelles in the concentrated solutions, which leads to transformation of these solutions into visco-elastic fluids with very high viscosity;
- ✓ C8-C10 FAc shorten the characteristic adsorption time of the diluted solutions by more than 10 times;
- ✓ C14-C18 FAc increase the surface modulus above 350 mN/m, which leads to higher friction inside sheared foam and to much smaller bubbles in the formed foams.

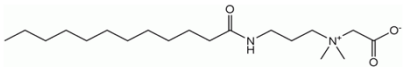
1. Z. Mitrinova, S. Tcholakova, J. Popova, N. Denkov, B. Desgupta, K. Ananthapadmanabhan, *Langmuir*, 29 (2013) 8255–8265.

Materials

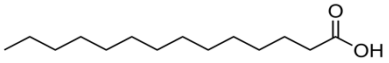
SLES



CAPB



C8 C18 fatty acids



Experimental results

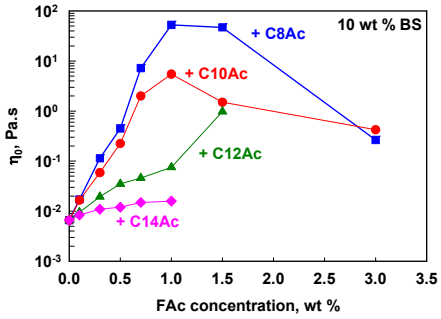
Rotational rheometer Gemini

τ vs $\dot{\gamma}$ $\quad \eta_{app} = \tau / \dot{\gamma}$

η_0 – viscosity at zero shear rate
η_{app} – apparent viscosity
τ – shear stress
$\dot{\gamma}$ – shear rate

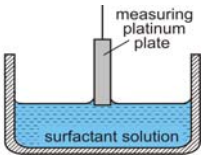
$$\eta_0 = \eta_{app}(\dot{\gamma} \rightarrow 0)$$

Rheological properties of concentrated solutions



C8-C10Ac induce the formation of wormlike micelles and visco-elastic behavior of concentrated solutions. No such effect for C14Ac-C16Ac

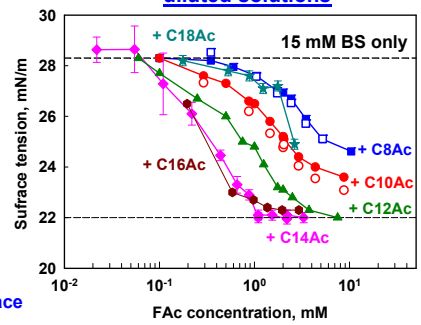
Wilhelmy plate method



σ_{EQ} vs C_{FAc}

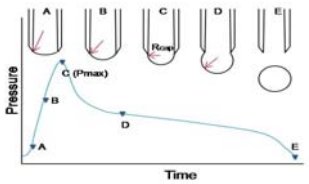
σ_{EQ} – equilibrium surface tension
C_{FAc} – fatty acid concentration

Effect of FAc on surface tension of diluted solutions



C14-C16Ac decrease σ down to 22 mN/m. Smaller decrease with C8-C10Ac.

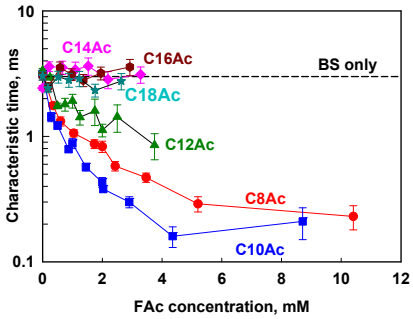
Dynamic surface tension



$$\sigma = \sigma_{EQ} + \frac{\sigma_0 - \sigma_{EQ}}{1 + \sqrt{t / t_c}}$$

σ – surface tension ; σ_0 – initial σ
σ_{EQ} – equilibrium σ; t –time
t_c – characteristic adsorption time

Characteristic adsorption time



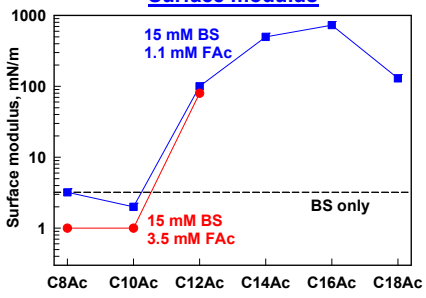
C8-C10Ac significantly reduces t_C
C12Ac has intermediate effect.
C14-C18Ac do not affect t_C.

Oscillating drop method

Surface modulus

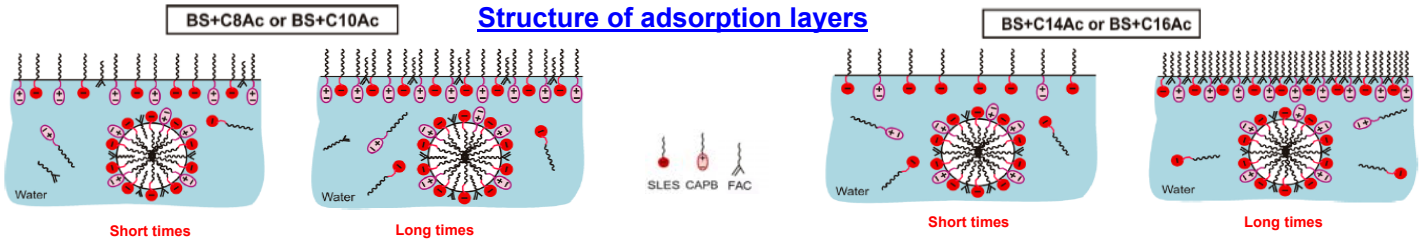
$$G_D = \left(G_{ST}^2 + G_{LS}^2\right)^{1/2}$$

Surface modulus



C8-C10Ac do not affect G_D.
G_D passes through a maximum at C16Ac with modulus G_D > 700 mN/m.

Structure of adsorption layers



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