Colloids and Surfaces A: Physicochem. Eng. Aspects 419 (2013) 233–237

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Synthesis and physic-chemical properties of anion–nonionic surfactants under the influence of alkali/salt

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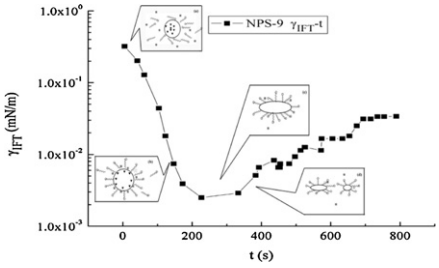
HIGHLIGHTS

- A series of anion–nonionic surfactants (alkyl polyethoxysulfonic acids) was studied.
- The values of surface tension and other physic-chemical properties were evaluated.
- The mixture of alkaline/salt and surfactants can be used as oil recovery agent.
- A model is used to explain the mechanism of dynamic interface tension.

GRAPHICAL ABSTRACT

A series of anion–nonionic surfactants for EOR with different hydrophobic tails and hydrophilic head-groups was synthesized. Some physic-chemical properties of these surfactants especially the behaviors at air/water interface had been fully studied. A hypothetical mechanism was pictured above to explain the interaction of alkaline/salt and surfactant during the dynamic oil/water interface tension measurement. Firstly, when oil drop injects into solution, surfactant, alkaline and acids in crude oil migrate to the oil/water interface. Secondly, the reaction of alkaline and oil acids takes place quickly in the interface, and produces surface active species. The oil drop is deformed by the hydrophobic interaction. Interface tension instantly reduces to ultra-low. At last, we make a daring imagination that when the instantaneous interface tension is low enough about 10^{-4} mN m^{-1} the smaller drop will be obtained.



ARTICLE INFO

Article history:
Received 22 August 2012
Received in revised form
15 November 2012
Accepted 24 November 2012
Available online 4 December 2012

Keywords:
Surface tension
Anion–nonionic surfactants
Critical micelle concentration
Enhance oil recovery
Equilibrium interface tension

ABSTRACT

This paper presented a series of anion–nonionic surfactants with different hydrophobic tails and hydrophilic head-groups. Changes in physic-chemical properties of these products and their influencing factors were carefully studied. The CMC (critical micelle concentration) ranges from 1.1×10^{-2} mass% for NPS-4 to 4.8×10^{-2} mass% in the case of NPS-10. The values (γ_{cmc}) of surface tension at CMC are from 31.62 mN m^{-1} for NPS-4 to 44.50 mN m^{-1} for AES-9. Maximum surface excess concentration (Γ_{max}) was more than 0.73×10^{-6} mol m^{-2} and minimum area per molecule at the water/air interface (A_{min}) was less than 2.270 nm^2 molecule^{-1}. Results show that CMC and γ_{cmc} were efficiently improved, and the ability of reducing equilibrium interface tension (IFT_{eq}) was weakened due to the increasing of repeat units. The study demonstrated that the detergents with the additional rigid group in the hydrophobic tail had a higher CMC than those with the alkyl chain. In addition, we figured out some IFT_{eq} results of the surfactants solution under the influence of alkaline/salt. Ultra-low IFT_{eq} can be obtained only when the concentration is greater than the optimal value of alkaline/salt. Dynamic interface tension (IFT_{dy}) was analyzed and a hypothetical mechanism was used to explain the interesting phenomena IFT_{dy}.

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http://dx.doi.org/10.1016/j.colsurfa.2012.11.062