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STUDY OF THE OIL DETERGENT AND OIL DISPERSING PROPERTIES OF QUATERNARY AMMONIUM SALTS TREATED WITH HEPTANE ACID WITH TRIETHANOLAMINE

Abstract

At present, the wide application of surfactants in various fields such as detergents, foam and emulsion stabilizers, fluorogens, hydrophobizers, corrosion inhibitors makes their synthesis considered one of the urgent issues. In the article, the results of the study of oil collecting and oil dispersing properties of the quaternary ammonium salt formed by triethanolamine (TEA) of heptanoic acid, which is a monobasic carbonic acid, in distilled, drinking, and seawater contaminated with Balakhani oil are given. The surface activity property of the products of different concentrations of this complex was calculated using a tensiometer, and the element content was calculated using the calculation method. The complex formed by heptanoic acid with TEA shows high surface activity by reducing the surface tension from 71.98 mN/m to 26.3 mN/m at that boundary.

In the quaternary ammonium salt of heptanoic acid with TEA, the mass fraction of carbon is 55.9%, the mass fraction of hydrogen is 10.5%, the mass fraction of oxygen is 28.6%, and the mass fraction of nitrogen is 5%.

The complex of heptanoic acid and TEA exhibits the ability to accumulate oil in seawater, both in the pure and 5% percent form of the reagent.

Solutions of various concentrations of the complex formed by heptanoic acid with triethanolamine are well soluble in ethyl and isopropyl alcohols.

Keywords: *oil accumulation, oil dispersion, surface tension, surfactant, carbonic acid*

Introduction

Currently, like other water basins of the world, the pollution of the reservoir of the Caspian Sea and the related deterioration of the ecological situation here are considered urgent issues. Examples of sources of pollution of this sea include tankers carrying oil, and accidents during oil extraction and transportation.

Oil spills degrade water quality and disrupt the balanced relationship of the upper water layers with the atmosphere, leading to a disruption of oxygen to living organisms.

Oil-based films that reflect the sun's rays prevent the energy from being absorbed by the water. The removal of such spots is especially necessary for the life of marine inhabitants, because more than a hundred species of fish, 95% of the world's sturgeon population live in the Caspian Sea.

Surfactants (SAMs) used to remove thin layers of oil from the water surface are divided into oil dispersants and oil collectors (Asadov, Ahmadova, Rahimov, Mammadova, 2011: 1012–1017; Asadov, Nasibova, Poladova, Rahimov, Asadova, 2012. 16: 175–178; Asadov, Tantawy, Zarbaliyeva, Rahimov, 2012: 2; Asadov, Akhmedova, Agazadeh, Nasibova, Zarbalieva, Bagirova, Ragimov, 2012, 1916–1927; *Asadov, Salamova,* Eyyubova, Yolchuyeva, 2020, 388-398; Asadov,

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Rahimov, Salamova, 2012, 505-511; Asadov, Tantawy, Zarbaliyeva, Rahimov, 2012, 199–200; Asadov, Tantawy, Zarbaliyeva, Rahimov, Ahmadova, 2012, 136–145; Asadov, Tantawy, Zarbaliyeva, Rahimov, 2012: 621–630; Asadov, Tantawy, Zarbaliyeva, Rahimov, 2013: 261–267; Asadov,Tantawy, Azizov, Zarbaliyeva, Rahimov, 2013: 13–23; Asadov, Zarbaliyeva, Rahimov, Salamova, Eyyubova, Ahmadova, Asadova, 2014: 205–214).

The presented article is dedicated to the study of the oil-collecting and oil-dispersing properties of the complex formed by heptanoic acid with TEA.

The surface activity of substances was determined at the air-water interface using a KSV Sigma 702 tensiometer (Finland) with a Du Nui ring.

Methodology of the Experiment

Heptanoic acid is insoluble in water, relative molecular mass 130.2 g/mol, an oily, colorless liquid with a general formula of $C_6H_{13}COOH$, boiling point 223°C, sparingly soluble in water but well soluble in ethanol, has an unpleasant oily odor. is a saturated monobasic carbonic acid.

Triethanolamine (TEA) is a colorless, transparent, ammoniacal weak base with a molar mass of 149.19 mol/g.

Conduct of Research

The reaction between heptanoic acid and TEA was carried out under laboratory conditions in a 1:1 molar ratio at room temperature with vigorous stirring.

The scheme of the reaction is as follows:

$C_6H_{13}COOH + N(C_2H_4OH)_3 \rightarrow$

$[\ C_6H_{13}COO^- N^+ H(C_2H_4OH)_3]$

The quaternary ammonium salt obtained based on heptanoic acid and TEA has a relative molecular mass of 279.4 g/mol, and solutions of 0.75% and 0.1% form colloidal solutions in water, dissolving well in ethyl and isopropyl alcohols.

According to the results of the element composition research by calculation method, the mass share of carbon in the quaternary ammonium salt of heptanoic acid with TEA is 55.9%, the mass share of hydrogen is 10.5%, the mass share of oxygen is 28.6%, and the mass share of nitrogen is 5%.

Results and their discussions

The surface activity property of the complex formed by heptanoic acid with TEA was determined using a tensiometer at the water-air interface at a temperature of 21°C (Table 1).

Based on the surface tension values measured by the tensiometer, surface tension isotherms were constructed in the γ-lnC coordinate (Figure 1).

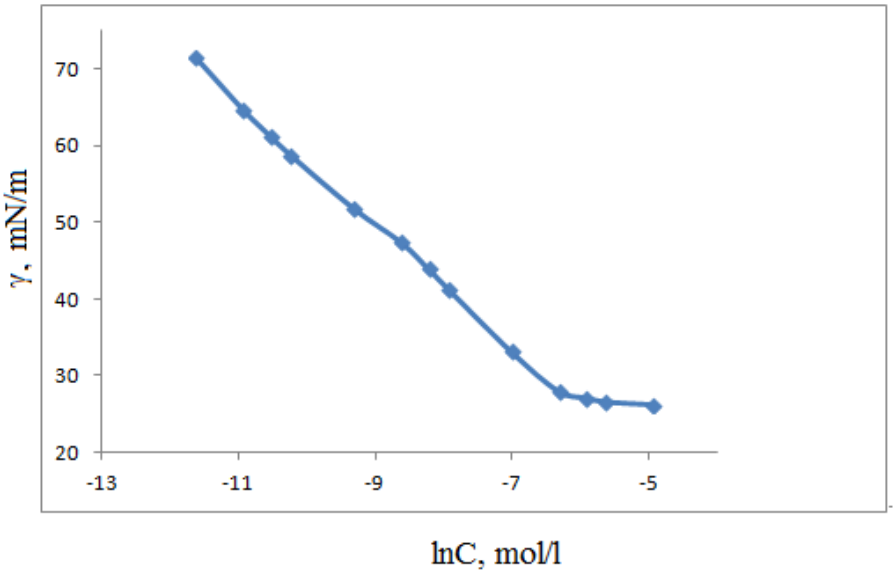

Figure 1 – Surface tension isotherms of salts of heptanoic acid with TEA

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Based on this picture, the dγ/dlnC value was determined graphically. The surface tension at the water-air boundary in a non-reagent environment is equal to 72.5 $mN \cdot m^{-1}$. The stabilization of the surface tension values of the salt formed by heptanoic acid with TEA occurs at 26.7 $mN \cdot m^{-1}$, respectively. Table 1 lists the colloid-chemical parameters of the synthesized non-ionic SAMs.

Table 1 - Colloid-chemical parameters of salts of heptanoic acid formed with TEA

KMQ×10^{-4}, $mol \cdot dm^{-3}$	Γ_{max} ×10^{-10}, $mol \cdot sm^{-2}$	A_{min}×10^{-2}, nm^2	γ_{KMQ}, $mN \cdot m^{-1}$	π_{KMQ}, $mN \cdot m^{-1}$	pC_{20}	ΔG_{mis}, kC/mol^{-1}	ΔG_{ad}, kC/mol^{-1}
3.58	1.93	88.18	26.7	45.8	4.06	-23.6	-47.4

Understanding the processes of micelle formation and adsorption is important to explain the effects of structural and environmental changes.

Note: KMQ is the critical micelle formation density, γ_{KMQ} is the surface tension of the solution during KMQ, Γmax is the maximum adsorption, Amin is the minimum surface area of the polar group, γ_{KMQ} – KMQ is the surface pressure or efficiency, pC_{20} is the efficiency value, ΔG_{mis} is the enthalpy change during micelle formation. , ΔG_{ad} is the enthalpy change during the adsorption process.

Conclusion

The complex formed by heptanoic acid with TEA shows high surface activity by reducing the surface tension from 71.98 mN/m to 26.3 mN/m at that boundary.

The complexes formed by heptanoic acid with TEA were studied as an oil collector and oil dispersant in cleaning the water surface clouded with an oil layer with a thickness of 0.17 nm. The effectiveness of this reagent was studied in the laboratory on waters with different degrees of mineralization using the Balakhani light oil sample. The reagent was used both in its pure form and in the form of a 5% aqueous solution. The reduction of the area of the initial oil layer due to the penetration of the reagent into oil-contaminated waters determines its effectiveness. The oil accumulation coefficient is a quantity that characterizes this effect. K is calculated as the ratio of the initial area of the oil layer to the area of the oil spot formed by the effect of the reagent.

Table 3 – Research results of the oil collection and oil dispersing ability of the TEA complex of heptanoic acid (Balakhani oil; thickness 0.17 mm)

The case of giving the reagent to the surface of the oil	Distilled water		drinkable water		Sea water	
	τ, saat	K(K_D,%)	τ, saat	K(K_D,%)	τ, saat	K(K_D,%)
Undiluted product	0-24 48-72 72-96	Dispersed	0-24 48-72 72-96	Dispersed	0-24 48-72 72-96	Dispersed
5% aqueous dispersion	0-24 48-72 72-96	4 Dispersed	0-24 48-72 72-96	5 Dispersed	0-24 48-72 72-96	Dispersed

As can be seen from Table 3, the complex of Heptanoic acid and TEA exhibits the ability to

accumulate oil in seawater for both application forms of the reagent.

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