GREEN SYNTHESIS AND RESEARCH OF SURFACTANTS AND THEIR APPLICATION AREAS IN VARIOUS DIRECTIONS

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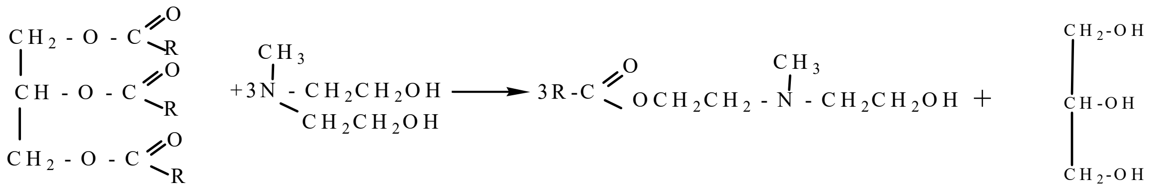
Surface-active substances find a wide application in all branches of the national economy [1,2]. Especially, the surfactants produced from environmentally -safe and reproducible initial materials attract the attention of specialists [3-4]. This paper is devoted to the obtainment of new representatives of such reagents and an investigation of their antimicrobial activity.

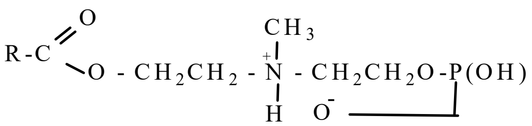
Aminoester was prepared based on fatty acids and bis(2-hydroxyethyl)(methyl)amine by heating at 140-150ºC during 13-14 hours in an autoclave equipped with a temperature regulator. Subsequently, phosphating of the obtained aminoester was performed by the interaction of the aminoester with orthophosphoric acid at 50-60ºC during 5-6 hours.

The scheme of the reaction of fatty acids with bis(2-hydroxyethyl)(methyl)amine is depicted below:



where R is alkyl group. Glycerol was removed from the final mixture applying washing procedure with cold water. The isolated aminoester is soluble in water and kerosene.

In the next step, the obtained bis(2-hydroxyethyl)(methyl)amine ester was phosphated using orthophosphoric acid. The chemical formula of the synthesized surfactant is illustrated as following:



where R is a saturated or unsaturated hydrocarbon group. The final product is a brown substance of low viscosity.

Both the aminoester and its phosphate surfactants are viscous liquids of brown color.

Structure and composition of the obtained products were confirmed by means of IR-spectroscopy.

Bis(2-hydroxyethyl)(methyl)amine ester and its phosphate have good solubility in isopropanol, isooctane, kerosene, benzene, carbon tetrachloride, a partial solubility in ethanol and water.

Surface tension data of the synthesized surfactants 1and 2 were obtained at 25 and 26ºC, respectively, γ versus concentration (-c) of the surfactants.

Based on these isotherms, the main parameters of the surface activity may be determined. The values of critical micelle concentrations (CMC) of the surfactants were found. Moreover, γ_{CMC}, surface pressure (π_{CMC}), C_{20} (the concentration for reducing γ by 20 mN/m), adsorption efficiency ($pC_{20} = -logC_{20}$) values for the surfactants were calculated according to [4]

Maximum adsorption-Γ_{max}values were calculated according to the following equation:

$$\Gamma_{max} = -\frac{1}{n * R * T} * \lim_{c \to c_{CMC}} \frac{d\gamma}{dlnc}$$

where R is universal gas constant (R=8.3145 C/mol*K) and T is absolute temperature. The value of n was taken as 2 because dissociation of the surfactants (explained later) molecules leads to formation of 2 ions.

The minimal value of the area per surfactant molecule after adsorption at the water-air interface (A_{min}) was calculated by the equation

$$A_{min} = \frac{10^{16}}{N_A \times \Gamma_{max}}$$

Specific electrical conductivity versus concentration plot was built for bis(2-hydroxyethyl)(methyl)amine ester at 27°C and for the phosphate of bis(2-hydroxyethyl)(methyl)amine ester at 27.5 °C.

Slopes of the straight line before (S_1) and after (S_2) CMC value for both surfactants were determined. Such important thermodynamic parameters as Gibbs free energy of micellization (ΔG_{mic}) and Gibbs free energy of adsorption (ΔG_{ad}) values were determined from the following equations:

$$\Delta G_{mic} = (2 - \alpha) \times R \times T \times \ln(CMC)$$

$$\Delta G_{ad} = (2 - \alpha) \times R \times T \times \ln(CMC) - 0.6023 \times \pi_{CMC} \times A_{CMC}$$

where A_{CMC} is surface area per surfactant molecule at the interface in terms of $Å^2$.

A degree of dissociation – α and a degree of the counter-ion binding –β were computed using the formulas:

$\alpha = S_2/S_1$ and $\beta = 1-\alpha$

As is seen, the ΔG_{ad} values are more negative than the ΔG_{mic} values that points out to a preference of the adsorption of the surfactant molecules over their micelle formation.

In addition to having high surface-active properties of the synthesized reagents, their petrocollecting and petrodispersing, as well as antimicrobial and anti-corrosion abilities have also been proven through laboratory experiment.

References

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