УДК 544.77:661.185

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SURFACE ACTIVE AND FOAMING PROPERTIES OF GENAPOL LRO SPECIMEN WITH POLYVINYLPYRROLIDONE

Surface-active properties of systems "water – surfactant Genapol LRO", "water – polyvinylpyrrolidone", "water – Genapol LRO – polyvinylpyrrolidone", depending on the amount of components were studied. It was established that polyvinylpyrrolidone is a surface-inactive substance, and the surface activity of the preparation Genapol LRO is 32.9 (J · l)/(m^2 · mol). Foaming capacity of water solutions of the SAS in the concentration 0.02–50.00 g / l was defined. Over the whole range of concentrations highly resistant foams were obtained. It was confirmed that the preparation Genapol LRO performs the functions of both frother and stabilizer. It was investigated the influence of polyvinylpyrrolidone on solutions to foam and them stabilization for the surfactant of 2.0 g / l. The quantity of polyvinylpyrrolidone, providing the production of hygienic detergent in accordance with the requirements of STB 1675-2006, was determined.

Introduction. Cosmetic preparations, including hygienic froth cleaning means are usually multicomponent systems. Some of the basic ingredients of these cosmetic preparations are surfactants (surface active substances) and macromolecular compounds. Surfactants in cosmetics provide foaming and cleaning (detergent) properties, solubilization of water-insoluble ingredients, etc.

To increase the viscosity of systems, solubilize components and to improve detergency as well as to provide conditioned effect water soluble polymers are introduced into the formulation of detergents [1]. Joint use of surfactants and polymers in cosmetics entails their mutual influence on each other's properties, which manifests itself primarily in a change of properties of surfactants at the interface "surfactant solution – air".

The aim of this work was to study the influence of flow of polyvinylpyrrolidone (PVP) on the surface-active properties and foaming ability of the surfactant Genapol LRO. Elaborating the cosmetic compositions it is important to understand the regularities of physical and chemical processes in the interfacial layers, depending on the nature and content of the main components of HDM (Hygienic detergent means).

Materials and methods. Preparation Genapol LRO represents a translucent, colorless liquid with a content of surfactants, about 70%. In chemical composition it is a mixture of sodium diethoxyllaurilsulfate and dietoksimiristylsulfate, i.e, it is a typical representative of anionic colloidal surfactants.

Polyvinylpyrrolidone (product of polymerization of vinylpyrrolidone having an average molecular weight of 8,000) is an amorphous, hygroscopic white powder, soluble in water. In aqueous solutions, the PVP has a weak base and may associate in water with anionic surfactant [2]. In the composition of hygienic detergents PVP generally performs the function of a thickener. Furthermore, it is known [3] that it forms complexes with drug substances and dyes; it possesses anti-inflammatory action, creates a protective coating on the hair, etc.

Surface-active properties of the solutions of surfactants and PVP preparations were studied by stalagmometric method [4]. Foaming capacity of investigated systems and stability of the foams obtained were determined on Ross – Miles device [5].

Aqueous solutions of the preparation surfactant Genapol LRO with concentrations 0.02–50.00 g / l and PVP with concentrations 0.05–50.00 g / l were used in the experiment. The solutions were prepared using distilled water in order to avoid the influence of hardness salts.

Main part. The surface tension of aqueous solutions of the preparation Genapol LRO and PVP (temperature (18 ± 1)°C). Fig. 1 shows the surface tension isotherms σ = f (ln c).

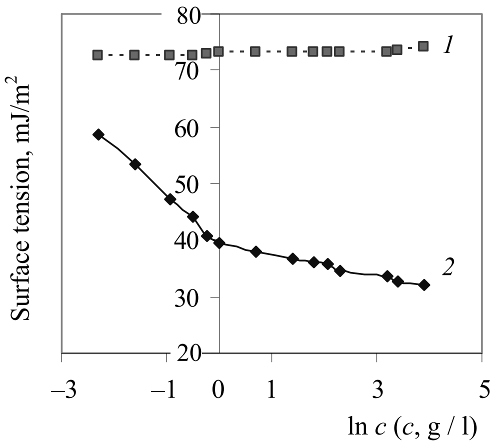

Fig. 1. Dependence of surface tension of aqueous solution components on the concentration (c):
1 – PVP; *2* – Genapol LRO

The presented dependences show that the surface tension of aqueous solutions of PVP (Fig. 1, line 1) is almost constant in the studied concentration (0.1–50.0 g / l). This indicates that the PVP is acting towards the water surface as an inactive substance.

There are two rectilinear areas on the isotherm of the surface tension of aqueous solutions in the preparation Genapol LRO (Fig. 1, line 2): a sharp decrease in the surface tension (from 58.78 to 40.79 mJ/m^2) when the concentration changes from 0.1 to 0.8 g / l and less significant area reduction σ (from 39.50 to 31.93 mJ/m^2) with concentration change from 1.0 to 50.0 g / l. The first area corresponds to the formation of a saturated monolayer at the interface "surfactant solution – air" and precedes the appearance of micellar structures in solution. As we consider, further reduction of the surface tension (second area) is the result of the surface layer restructuring, as two types of surface-active ions are in an aqueous solution of the preparation. Besides, one of them (etoxyllaurilsulfate) has higher mobility because of a smaller size, and the second (etoxymiristilsulfate) possesses a higher capacity to push itself into the surface layer from a polar medium (adsorb).

The isotherm of surface tension was built to determine the surface activity of the preparation in coordinates $\sigma = f(c)$ in area of low concentrations (0.05–1.00 g / L). Surface activity of the preparation Genapol LRO was $32.9 \cdot 10^{-2}$ (J· l) / (m^2 · mol).

It was studied the effect of the rate of surfactant preparation on its foaming capacity (FC, mm) and stability (S, %) of the obtained foams. Foaming capacity was evaluated by foam number which was determined by the height of foam column in millimeters, measured in 30 seconds after the expiration of 200 cm^3 in the preparation solution from a height of 900 mm on the surface of the same solution [5]. Stability study was calculated as the ratio of the foam column height foam in 5 minutes to foam column height measured in 30 seconds. Fig. 2 shows received data.

Fig. 2 (line 1) shows that increasing the concentration of the surfactant solution from 0.02 to 0.80 g / l the foam number greatly increases (from 65 to 229 mm) than in the concentration area 1.0–50.0 g / l (from 235 to 262 mm). Comparing the regularities shown in Fig. 1 (line 2) and Fig. 2 (line 1) makes it possible to conclude that the foaming ability of the preparation Genapol LRO is associated with its surface-active properties, which does not contradict the theoretical data [6]. This relationship is explained by the fact that a decrease in surface tension takes less work for obtaining the same amount of foam.

Preparation Genapol LRO relates to foam formers of the second type [7], forming in water colloidal systems which deliver highly stable foams. Consequently, these foaming agents also foam stabilizers. According to method of Davis [8] calculated hydrophilic-lipophilic balance (HLB) of the surfactant formulation was 13.8. It is known [9] that if the HLB number is 8–18, such surfactants are good stabilizers of direct emulsions, and the greater the HLB value, the more effective is the stabilizing effect. Since the foam is a dispersed system in which the medium as in direct emulsion is a polar liquid (water), the resulting HLB value confirms that the preparation Genapol LRO can be a good stabilizer of foams.

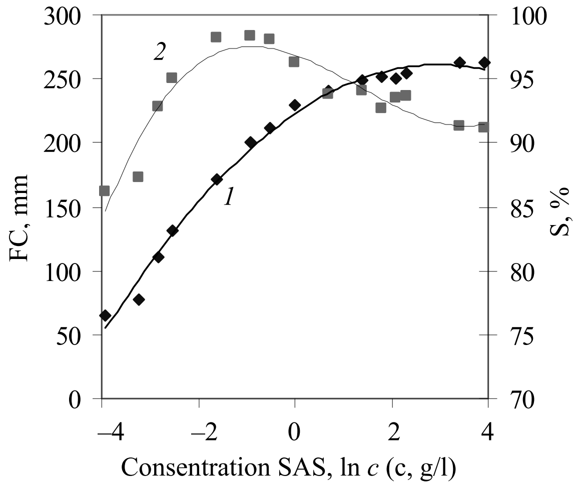

Fig. 2. Dependence of foam number (*1*) and foam stability (*2*) on the surfactant concentration

Indeed, Fig. 2 (line 2) shows that highly resistant foams are obtained in the whole area of investigated concentrations of preparation (S = 87–98%). Dependence of the stability S = f (ln c) is of an extreme nature: the maximum stability is achieved at surfactant concentrations of 0.2–0.8 g / l.

Foams formed by blowing agents of the second type are metastable. Egress in such foams stops at a certain time and foam frame can be stored for a long time in the absence of the destructive action of external factors. Stabilization of the films formed using the preparation Genapol LRO is determined by the following thermodynamic factors: structural and mechanical properties of adsorption-solvation layers formed in the result of the interlacing nonpolar hydrocarbonic radicals of anionic surfactant; disjoining pressure associated with the formation of the electric double layer.

Fig. 3 presents the results of investigation of the influence of flow of PVP on the surface tension of aqueous solutions of the preparation Genapol LRO.

As can be seen from the data, PVP availability in solutions of the preparation Genapol LRO (in the studied concentration range) increases the surface tension at the air interface. This suggests that the PVP molecules can be adsorbed at the interface "aqueous – air". The number of molecules of the

PVP increases in the surface layer while the amount of the surfactant molecules decreases with increasing content of PVP in the solution of surfactant of the same concentration. The greater the concentration of the surfactant solution, the fewer molecules PVP get to the phase boundary.

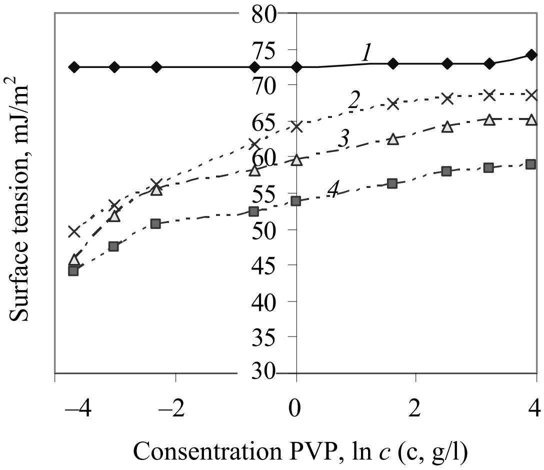

Fig. 3. Dependence of surface tension on the content of PVP in surfactant solutions with concentration, g / l:
1 – 0; *2* – 1; *3* – 5; *4* – 10

The foaming properties of surfactant preparation solutions with concentration of 2.0 g / l with PVP are studied. Fig. 4 shows the data obtained.

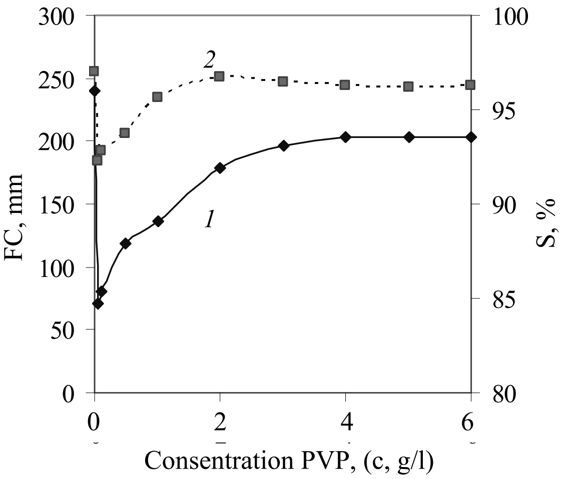

Fig. 4. Influence of PVP concentration on the foam number (*1*) and the stability of foams (*2*)

Fig. 4 shows that the introduction of PVP in amount up to 0.05 g/l reduces foaming capacity in the preparation Genapol LRO by 3.5 (the foam number decreases from 240 to 69 mm). Thus the stability of the obtained foams was also reduced from 98 to 94%. Further increase of PVP content in the system up to 3.0 g / l leads to an increase of these parameters, and then remains practically unchanged. Anomalous drop in foaming properties at low concentration areas of PVP, in our opinion, may be related to the ability of its molecules to interact with surfactant ions with formation of peculiar complexes "surfactant – polymer" [2].

To understand the mechanisms of the processes completely it is necessary to examine surfactants and foaming properties of aqueous solutions of surfactants with concentration of less than 2.0 g / l in the range of PVP content 0.001–10.000 g / l.

Kinetics of foam stability got from aqueous solutions of surfactant preparation containing PVP in various amounts was studied. Fig. 5 shows the data obtained.

It was established that the rate of the foam destruction (prepared from a solution with surfactant concentration of 2.0 g / l) after 1 minute is 7 mm / min, and in systems with PVP is 3 mm / min. Therefore, PVP has an additional stabilizing effect on the foam because of the kinetic stability factor which makes slower the thinning of the film by increasing its viscosity with high-molecular compounds.

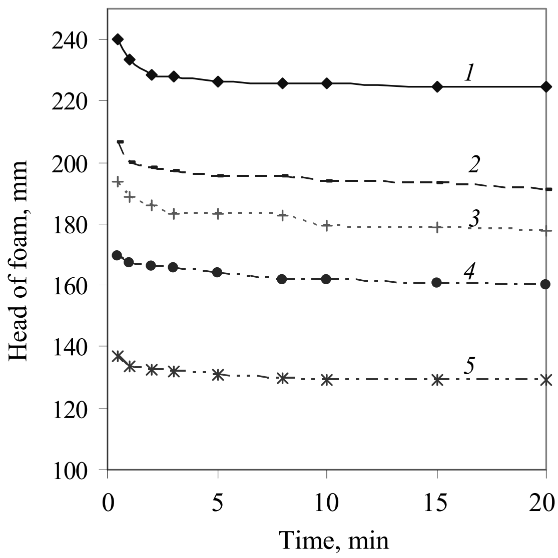

Fig. 5. Kinetics of foam stability with PVP content, g / l:
1 – 0.0; *2* – 10.0; *3* – 5.0; *4* – 2.0; *5* – 1.0

The destruction of foams practically stops in four minutes. It is suggested that because of the egress, additional increase in the viscosity of the remaining liquid layer occurs by extra structurization.

Conclusion. Surveys have shown that PVP has a significant impact on both surfactant and on foaming properties of the preparation Genapol LRO. The nature of this effect is ambiguous and depend on the concentration of the surfactant solution and the content of PVP. It was determined that in aqueous solutions of surfactants with concentration of 2.0 g / l, containing PVP in amounts of 1.0–

10.0 g/l, foaming capacity and stability of the foams are in accordance with the requirements of STB 1675-2006.

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Received 28.02.2013