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1961

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Abstract

Full Text

PHYSICAL CHEMISTRY

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THE EFFECT OF LYOPHILIC COLLOIDS ON THE SOLUBILIZATION OF HYDROCARBONS IN SOLUTIONS OF DETERGENTS

Solutions of lyophilic colloids do not possess detergent action or significant surface activity, but they are widely used as active additives that increase the effectiveness of detergents, drilling fluids, emulsifiers, and flotation reagents ([1–6]). The mechanism of action of lyophilic colloids on the micellar structures of surface-active substances has not yet been sufficiently clarified. Contradictory views are known in this field. It is assumed that lyophilic colloids, being adsorbed from solution onto surfaces, impart to them a negative charge and prevent the deposition of soil from the bulk of the detergent solution onto the surface being washed ([7]). According to other views, carboxymethylcellulose and its water-soluble analogues are adsorbed not on the surface being washed, but on particles of soil ([4]). In this case, protective films of molecules of lyophilic colloids are formed on their surface. Owing to this, the particles of soil cannot stick together or settle on the surface being washed. Up to the present time, the indicated ideas have been confirmed experimentally.

Fig. 1. Effect of additions: **1** —gelatin, **2** —casein, **3** —starch, on the solubilization of toluene in 0.3 M solutions of potassium laurinate.

We have shown that the critical concentration of micelle formation and the solubilizing capacity are specific properties of detergents ([8, 9]), and that, from their values, the comparative effectiveness of different surface-active substances can be objectively assessed. Any additive that changes the critical concentration of micelle formation and the solubilizing capacity also changes the practically important properties of a detergent solution. The positive influence of additives of lyophilic colloids on detergent action and other properties of detergents apparently consists in the fact that they shift the degree of their colloidality into the optimal region.

Fig. 2

Figure 2: Fig. 2

Fig. 3

Figure 3: Fig. 3

In the present work are given the results of a study of the influence of carboxymethylcellulose, gelatin, casein, saponin, starch, lecithin, and sodium humate on the solubilizing capacity of a 0.3 M solution of potassium laurinate and sodium naphthenates. Determination of the change in the solubilization of hydrocarbons in soap solutions under the influence of additions of increasing amounts of lyophilic colloids was carried out by the volumetric method described earlier (10). The results of the study are presented in Figs. 1, 2, 3, and 4. From the experimental data it is evident that additions of gelatin, casein, and starch exert different effects on the solubilizing capacity of soap solutions. Additions of soluble starch in amounts up to 35% by weight

potassium laurinate do not exert a significant influence on the solubilization of toluene. For casein and gelatin an increase in the solubilization of toluene is observed in a 0.3 M solution of potassium laurinate, with the gelatin additions proving more effective (Fig. 1). An even greater effect on the solubilizing capacity of potassium laurinate solutions is exerted by increasing additions of saponin, carboxymethylcellulose (sodium salt), sodium humates, and lecithin (Fig. 2). Lecithin and sodium humates more sharply increase the solubilizing capacity of soap solutions in comparison with carboxymethylcellulose. Saponin, gelatin, and casein proved less effective than carboxymethylcellulose (Figs. 1 and 2). With respect to their effect on the solubilizing capacity of 0.3 M potassium laurinate solutions, the lyophilic colloids investigated may be arranged in the following decreasing order: lecithin > sodium humates > carboxymethylcellulose > saponin ≥ gelatin > casein > starch.

Fig. 2. Effect of additions: 1 –lecithin, 2 –sodium humate (chlorinated), 3 –sodium humate, 4 –carboxymethylcellulose (sodium salt), and 5 –saponin on the solubilization of toluene in 0.3 M solutions of potassium laurinate.

Carboxymethylcellulose affects the increase in solubilization of toluene in 0.3 M solutions of sodium naphthenates. The solubilizing capacity of the sodium naphthenate solution with the higher molecular weight increases more sharply from equal additions of carboxymethylcellulose than for the lower-molecular-weight homolog (Fig. 3). Thus, for example, with additions of 25% carboxymethylcellulose, calculated on the weight of sodium naphthenates with molecular weights 242 and 270, the solubilization of toluene increases respectively by 1.3 and 1.7 times. Comparative data on the increase in the solubilizing capacity of sodium naphthenate solutions (molecular weight 242) from additions of certain lyophilic colloids are given in Fig. 4.

Fig. 3. Effect of additions of carboxymethylcellulose on the solubilization of toluene in 0.3 *M* solutions: 1 –sodium naphthenate (mol. wt. 270), 2 –sodium naphthenate (mol. wt. 242).

Additions of soluble starch practically do not affect the solubilization of toluene in sodium naphthenate solution, as in the case of potassium laurinate (Figs. 1, 4). Gelatin is less effective than carboxymethylcellulose. Sodium humate, obtained from brown coal of the Alexandria deposit by the procedure described earlier ([11]), proved to be a more effective enhancer of hydrocarbon solubilization than carboxymethylcellulose. With respect to their effect on increasing the solubilization of toluene in 0.3 *M* solutions of sodium naphthenate, the lyophilic colloids investigated may be arranged in the following order: sodium humates > carboxymethylcellulose > gelatin > starch. Lyophilic col-

colloids at the temperature of the experiments (about 60°) practically have no solubilizing ability.

On the basis of the experimental data obtained and of earlier work (8, 9), it may be concluded that lyophilic colloids are adsorbed on the micellar structures of soaps and, upon joint association with detergents, form mixed micelles. The solubilizing ability of micellar structures of mixed composition is higher than that of micelles consisting only of soap molecules. In addition, lyophilic colloids and detergents, peptizing hydrocarbons to a colloidal degree of dispersion, form on their surface protective layers that are negatively charged, with hydrophilic groups directed into the aqueous phase. Such particles with a protective layer acquire diphilic properties similar to those of detergent micelles containing solubilized hydrocarbon, and they may be called pseudomicelles. With the aid of colloidal structures, soil is retained in the volume of washing solutions, which is one of the factors increasing their effectiveness.

Fig. 4. Effect of additions: 1 –sodium humate, 2 –carboxymethylcellulose (sodium salt), 3 –gelatin, 4 –starch on the solubilization of toluene in 0.3 M solutions of sodium naphthenate (mol. wt. 242)

Such mixed micelles possess more oleophilic properties, which brings them closer to micellar structures formed by soap homologs with more developed hydrocarbon radicals. In the present work it has been shown that, with the aid of carboxymethylcellulose and other lyophilic colloids, it is possible to regulate the degree of colloidality of washing solutions and their practically important properties.

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Received
22 V 1961

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