The Effect of Electrolytes and Non-electrolytes on the Surface Tension of the System Water-Lithium Laurate and Butanol-1

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The effect of various electrolytes on the surface tension of aqueous soap solutions has been studied by Petrova[1] and by Camp and Durham.[2] The changes in the surface tension of the soap solutions produced by the addition of acids, basis and salts have been investigated by several workers.[3-9] The effect of cresol on the surface tension of aqueous solutions of sodium salts of fatty acids has been studied by Angelescu and Popescu.[10] A study of the surface tension of the solutions of sodium salts of fatty acids in a mixture of water and different

1) N. Petrova, *Maslob. Zhir. Delo,* **1935**, 142.
2) M. Camp and K. Durham, *J. Phys. Chem.*, **59**, 993 (1955).
3) F. Bottazzi, *Atti. accad. naz. Lincei.*, **21**, 365 (1913).
4) W. Windisch and W. Dietrich, *Kolloid Z.*, **26**, 193 (1920).
5) J. Mikumo, *Kogyo Kagaku Zasshi (J. Soc. Chem. Ind. Japan)*, **30**, 75 (1927).
6) W. D. Harkins and G. L. Clark, *J. Am. Chem. Soc.*, **47**, 1854 (1925).
7) J. Powney, *Trans. Faraday Soc.*, **31**, 1510 (1935).
8) H. L. Cupples, *Ind. Eng. Chem.*, **27**, 1219 (1935).
9) A. Lottermoser and B. Baumgürtel, *Trans. Faraday Soc.*, **31**, 200 (1935); *Kolloid Beih.*, **41**, 73 (1934).
10) E. Angelescu and D. M. Popescu, *Kolloid, Z.*, **51**, 247, 336 (1930).

alcohols has been carried out by Bose and his co-workers.[11,12]

The present work has been initiated with a view to comparing the effectiveness of different compounds in changing the surface tension of the water-lithium laurate and butanol-1 system.

Experimental

All the chemicals have been purified, and the soap and the solutions have been prepared by the methods described in a previous communication.[13] The surface tension of the solutions has been determined by means of a stalagmometer at 30.0+0.05°C, and the densities have been measured by means of a pycnometer.

Results and Discussion

The results (Fig. 1) show that the surface tension of the solutions increases with the increase in the concentration of the acids in the water-0.2 N lithium laurate and butanol-1 system. It has also been observed that the surface tension at first de-

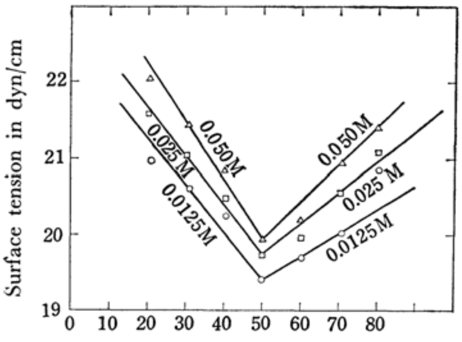

Fig. 1. Myristic acid.

creases linearly as the concentration of butanol-1 in solutions increases from 10% to 50%, and then in-increases with a further increase in the butanol-1 concentration. This may be due to the fact that the acid is incorporated in the micelles below a 50% butanol-1 concentration, whereas above such a concentration the acid is dissolved in the excess of butanol-1. A change in the behaviour at the 50% butanol-1 concentration has also been observed in viscosity studies.[13]

The effectiveness of these acids in increasing the surface tension of the solutions is in the order:

Myristic>Lauric>Phthalic>Succinic>Oleic> Salicylic acid.

It has also been observed that the addition of equivalent amounts of *p*- and *m*-nitrobenzoic acids increases the surface tension of the solutions to the same extent; they are more effective than 3 : 5-dinitrobenzoic acid. The results show that the surface tension is increased more rapidly by the addition of *o*-aminobenzoic acid than by that of an equivalent amount of *m*-aminobenzoic acid. It may also be pointed out that benzoic acid is more effective than chlorobenzoic acid in increasing the surface tension, and that the surface tension of the solutions in the presence of acetamide is higher than that of the solutions containing equivalent amounts of benzamide and urea.

The results reveal that the surface tension of the solutions increases with the increase in the benzene concentration in the system. It has also been observed that the surface tension of solutions containing the same amount of benzene decreases with the increase in the butanol-1 concentration in the system.

A study of the effect of the concentration of the hydroxy compounds on the surface tension of the water-lithium laurate and butanol-1 system shows that the surface tension of the solutions increases with the increase in the concentration of these compounds in the system. It has also been observed that, in the case of hydroxy compounds and urea, the surface tension first decreases rapidly as the concentration of butanol-1 in the solutions increases from 10% to 40%, and then shows a slow change with the further increase in butanol-1 concentration. The plot of the surface tension against the volume percent of butanol-1 (Fig. 2) shows a break at the 50% butanol-1 concentration in the presence of all the hydroxy compounds. A similar change in the surface tension of the system has also been observed at a 50% butanol-1 concentration in the presence of acids.

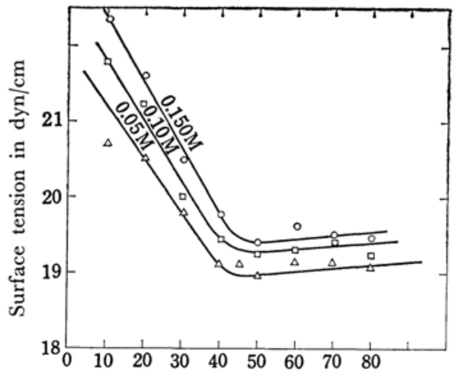

Fig. 2. Resorcinol.

Electrolytes. A study of the effect of potassium salts on the surface tension of the water-lithium laurate and butanol-1 system shows that the surface tension of the solutions increases with an increase

11) A. N. Bose and J. Misra, *ibid.*, **139**, 165 (1954).
12) A. N. Bose and K. N. Mehrotra, *ibid.*, **150**, 151 (1957).
13) K. N. Mehrotra and S. C. Bhargava, *Z. Phys. Chem.*, **233**, 97 (1966).

in the concentration of the salt in the solution. This may be due to the reduced dissociation of the carboxylic group of the soap molecule. It has been suggested by Demchenko[14] that the micelles formed in the presence of electrolytes are more oleophilic, thus causing the elongation of the hydrocarbon radical of the soap and the increase in the surface tension of the solutions.

It has also been observed that the surface tension of the system in the presence of electrolytes decreases with the increase in the concentration of butanol-1 from 10% to 40% in the system. It may be pointed out that the solutions of 50% and 60% butanol-1 could not be prepared in the presence of even small amounts (0.0125 N) of potassium salts, and that the 40% and 70% solutions could only be prepared in the presence of less than 0.0125 N potassium salts, whereas, in the presence of higher concentrations of potassium salts, it has not been possible to prepare solutions containing 40% to 70% butanol-1. This may be due to the fact that the palisade layers are saturated with butanol-1 molecules in the presence of from 40% to 70% butanol-1, whereas in the presence of lower concentrations of butanol-1 the number of alcohol molecules in the palisade layers is not sufficient to saturate them and so it is possible to prepare solutions with higher concentrations of potassium salts.

The effectiveness of the potassium salts in increasing the surface tension of the water-lithium laurate and butanol-1 system is in the order:

Sulphite > Arsenate > Phthalate > Oxalate > Tartarate > Chromate > Bicarbonate > Citrate > Phosphate > Ferrocyanide > Ferricyanide > Carbonate > Chloride > Sulphate > Nitrate.

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14) P. A. Demchenko, *Kolloid. Z.,* **23**, 528 (1960).