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Aggregation Behaviors of Tetradecyltrimethylammonium Bromide in Aqueous Solution of Aluminium Sulfate at 303.15 K Temperature

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***Abstract* - The conductivity measurement of tetradecyltrimethyl-ammonium bromide (TTAB) has been done in water and in aqueous solutions of aluminium sulphate of concentrations 0.0025 M, 0.005 M and 0.0075 M. The presence of salt in the aqueous solution decreases the cmc of TTAB, further the increase in concentration of aluminium sulphate decreases the cmc of the TTAB. The decrease in cmc of TTAB is explained on the basis of shielding effect by the addition of aluminum sulfate.**

Keywords - TTAB, Cmc, Surfactants

I. INTRODUCTION

Surfactants are the surface-active substances reduce the surface-tension of water. These are the amphiphiles that means these have hydrophilic polar head and hydrophobic non-polar tail. The Surfactants are classified according to charge on their head groups, that is the polar head may be positive or negative or both positive and negative charged or no charge. On the basis of charge, these are cationic, anionic, zwitterionic or non-ionic surfactants. TTAB (tetradecyltrimethylammonium bromide) is a cationic surfactant, which is also called Cetrimide commercially. Its chemical formula is $C_{17}H_{38}N^{+}Br^{-}$, and its molecular weight is 336.4. The structure of TTAB is as given below;

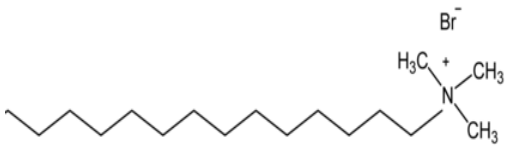

Fig. 1. Structure of TTAB

The surfactants are extensively used in domestic as well as in industrial purposes but their activities in the form of surfactant begin after the micelles formation process. [1].

II. EXPERIMENTAL METHOD

The Cetrimide employed in these investigations was purchased from SD Fine Chem Limited, Mumbai, India. The water used in preparation solvent was obtained by triply distillation of ordinary water using potassium permanganate and sodium hydroxide. The specific conductivity of the pure water used was 10^{-6} $S.cm^{-1}$ at 303.15 K. The weight of the various chemicals used were measured with an electronic balance having 0.0001 gm sensitivity, made by KERN company, Germany.

The conductivity data were generated by using a digital conductivity meter from the manufacture Labtronics, India. The conductivity meter runs at a frequency of 2000 Hz and also has a dip-type cell with a cell constant of 1.15 cm^{-1} and having an uncertainty of 0.01%. The conductivity cell was calibrated by using the method developed by Lind and his co-workers, 1959 using aqueous potassium chloride solution. For conductivity measurements, at first, stock solutions of cetrimide and aluminium sulphate were prepared in conductivity water at 303.15 K in a thermosate. Also the conductivity measurements were made in a water bath maintained within ± 0.005 K of the desired temperature.

III. RESULTS AND DISCUSSION

A. Critical micelle concentration

Micelles are the association colloids formed by the aggregation of surfactant molecules after certain concentration. The minimum concentration of surfactant at which micelles start to form is known as critical micellization concentration (*cmc*) of the surfactant. The *cmc* is a measurement that quantifies the ability of a surfactant to form micelles; the lower the *cmc*, the greater the ability of the surfactant to form micelles and vice versa. Electrical conductivity method is applied for the measurement of cmc of AOT in the water and aqueous solutions of alumunium sulphate. In this method, a graph is plotted between electrical conductivity versus surfactant concentration and in the graph, conductivity increases linearly with concentration but after a point, the slope of the curve will decreases as shown in figures. 2, 3, 4 and 5, i.e. there will be two straight lines with different slopes. The intersection point of two lines corresponds to concentration of surfactant; give the cmc of the surfactant, AOT [2].

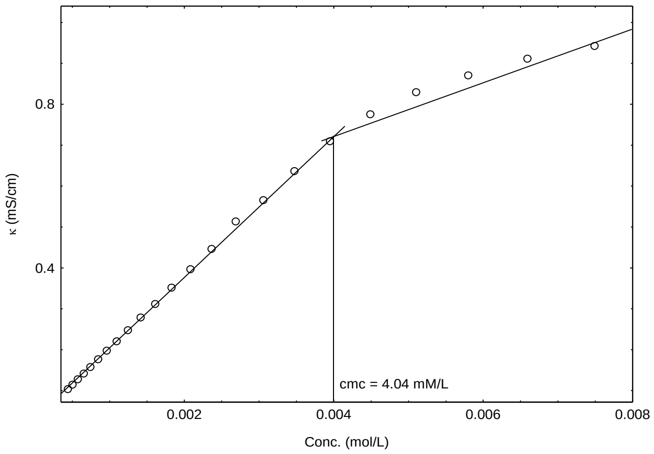

Fig. 2. Conductivity of TTAB as a function of concentration at 303.15 K. in water.

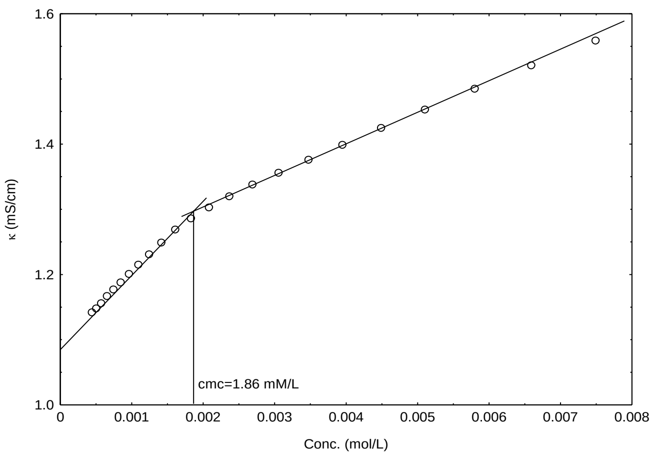

Fig. 3. Conductivity of TTAB as a function of concentration at 303.15 K. in 0.0025 M aqueous $Al_2(SO_4)_3$ Solution.

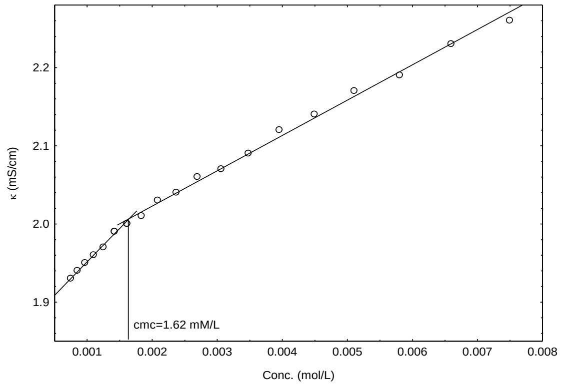

Fig. 4. Conductivity of TTAB as a function of concentration at 303.15 K. in 0.005 M aqueous $Al_2(SO_4)_3$ Solution.

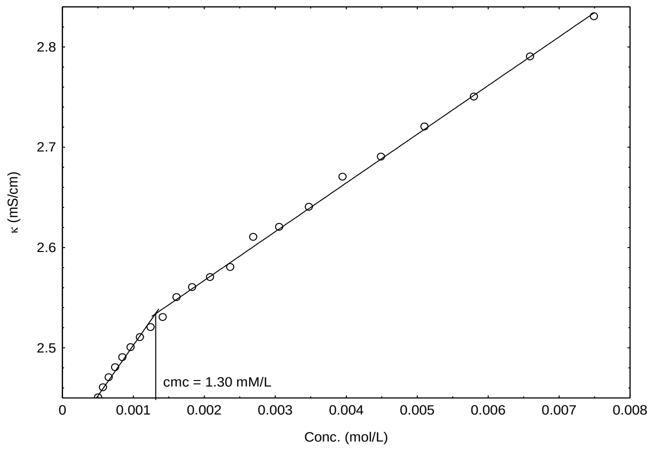

Fig. 5: Conductivity of TTAB as a function of concentration at 303.15 K. in 0.0075 M aqueous $Al_2(SO_4)_3$ Solution.

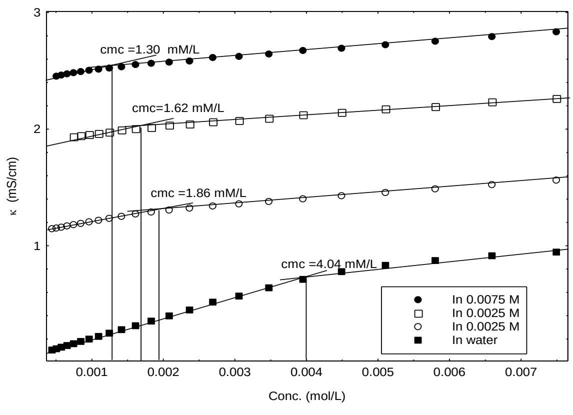

Fig. 6. Conductivity of TTAB as a function of concentration at 303.15 K. in water, 0.0025, 0.005 & 0.0075 M aqueous $Al_2(SO_4)_3$ Solution

TABLE I

Concentration $Al_2(SO_4)_3$, Cmc of TTAB and ionic strength of $Al_2(SO_4)_3$ (μ) Solutions at 303.15 K.

$[Al_2(SO_4)_3]$ (Mol/L)	Cmc (mMol/L)	μ
0.0000	4.04	-
0.0025	1.86	0.0375
0.0050	1.62	0.0750
0.0075	1.30	0.1125

B. CMC in Presence of Salts

The cmc of surfactants depend on the various factors such as temperature, length of alkyl chain, dielectic constant of solvent, addition of co-surfactant, addition of inorganic electrolyte etc. In the table 1 and also in figure 6, it is seen that the cmc of the TTAB is decreasing in presence of the electrolyte $Al_2(SO_4)_3$. Furthermore, the increasing ionic effect of the solvent by increasing the concentration of the $Al_2(SO_4)_3$ helps to earlier formation of the micelles of the TTAB in the given temperature. The addition of salt reduced electrostatic repulsion among the surfactant head groups, is a key factor to influence the morphology of aggregates in ionic surfactant solutions. It was reported that for various single-chain cationic surfactants, the shape of the micelles may change from global to rod like or wormlike with the addition of inorganic salts. Hence the *cmc* of surfactant found to decrease with addition of inorganic salts [3, 4]. As the salt is added, electrostatic repulsive force among the ionic head groups of the surfactant molecules is reduced by shielding of micelle charge, by the counter ions from salt, so that spherical micelles are more closely packed by the surfactant ions [5], hence a decrease in the *cmc* values for TTAB in aqueous solution after addition of salt $Al_2(SO_4)_3$.

IV. CONCLUSIONS

The increasing ionic strength of an aqueous solution by the addition of an inorganic electrolyte $Al_2(SO_4)_3$ helps to the earlier formation of the micelles in the aqueous solution i.e. the presence of $Al_2(SO_4)_3$ in the aqueous solution decreases the cmc of the TTAB at 303.15 K.

V. REFERENCES

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