Micellization of Sodium Lauryl Sulphate in Aqueous Sodium Oxalate Solution

Naveen Chandra[1], K. Pandey[2], B. Chandra[3], N.D. Kandpal[4]

[1,2,3,4,]Physical Chemistry laboratory, Department of Chemistry, Kumaun University,

S.S.J. Campus, Almora 263601, Uttarakhand, (India)

ABSTRACT

The Conductometry is reliable method for various investigations of properties of aqueous solutions of solute. The micellar properties of sodium lauryl sulphate(SLS) in water in presence of sodium oxalate have been studied conductometrically. The molecular conductance value at infinite dilution for sodium oxalate and sodium lauryl sulphate has been calculated $252.7 Scm^2 mol^{-1}$ and $81.88 Scm^2 mol^{-1}$ at 298K respectively. The micellization of SLS in presence of sodium oxalate in aqueous solution has shown that the formation of aggregates takes place between surfactant and ions formed by sodium oxalate with increase in concentration of the surfactant at the saturation point beyond which ionization or dissociation of aggregates takes place which justify by the binding capacity. The values of cac, critical aggregation concentration csc, critical saturation concentration and binding capacities have been calculated.

Keywords –Aggregation, binding capacity, Sodium lauryl sulphate, Sodium oxalate, micellization.

I.INTRODUCTION

Surfactants are known to play vital role in many processes of interest in both fundamental and applied sciences. The formation of colloidal sized clusters in solutions known as micelles has particular significance in pharmacy because of their ability to increase the solubility of sparingly soluble substances in water [1, 2].   and role in the formation of emulsion[3].Micellar aggregates have served as an important bridge between microscopic and macroscopic chemical species in the development of new technologies. The importance of colloid science is now fully recognized and it has established as the basic foundation of nearly all fields of solution science. [4] The micellar properties of surfactant in presence of electrolyte, polar or non-polar organic compound and other surfactant have been studied during the past several years [5, 6, 7]. The additives affect the micellization by their structure braking or making character in water. There is report on physico-chemical properties of oxalic acid in aqueous solution, in which they behave as structure maker in water [8]. But there is no any study in micellar solution.

II. EXPERIMENTAL

Sodium oxalate, CDH grade and sodium lauryl sulphate, Pro analysis MERCK grade were used as such without further purification. All the solution was prepared in double distilled water having specific conductance of the order $2x10^6 \Omega cm^{-1}$. Conductance measurement of solution were made using conductivity meter, Systronies 306 with a dipping type conductivity cell having plativized electrode. The temperature of the solution was kept constant with the help of thermostat (Tanco, Kanpur). The conductivity meter was calibrated with standard KCl

solution. The accuracy of the conductivity meter was 0.01 mscm[1] during the study. The results were checked for constant readings.

III. RESULTS AND DISCUSSION

Keeping the concentration of oxalate constant in aqueous solutions, the concentration of sodium lauryl sulphate is varied and the value of specific conductance obtained for each solution are given in Table in 1.The variation of specific conductance with concentration was analyzed by plotting a graph between specific conductance. The graphs were plotted in the concentration range .002 to .007 mol dm^{-3}, .008 to .014 moldm^{-3} and .016 to .019 mol $dm^{-3}$of SLS. The graph for each concentration range in given in Fig1, Fig2 and Fig3 respectively.

Table .1

Variation of specific conductance of SLS with different concentrations

of sodium oxalate at 298 K

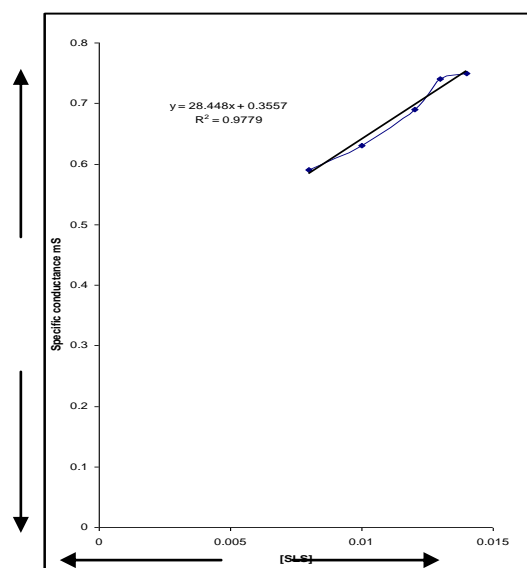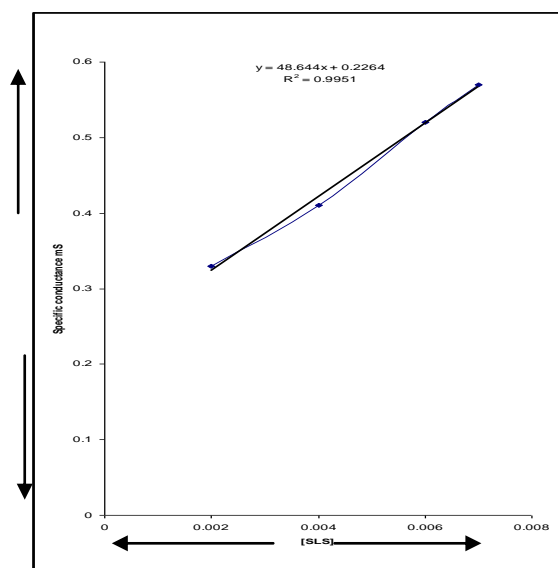| S.No.	[SLS] mol dm^{-3}	Temp K	Specific conductance (mS)		
			$[Na_{ox}]$		
			0.0005 mol dm^{-3}	0.001 mol dm^{-3}	0.002 mol dm^{-3}
1.	0.002	298	0.28	0.33	0.60
2.	0.004	298	0.38	0.41	0.71
3.	0.006	298	0.46	0.52	0.78
4.	0.007	298	0.49	0.57	0.85
5.	0.008	298	0.54	0.59	0.89
6.	0.010	298	0.60	0.63	0.94
7.	0.012	298	0.68	0.69	0.96
8.	0.013	298	0.69	0.74	0.98
9.	0.014	298	0.72	0.75	1.00
10.	0.016	298	0.78	0.88	1.07
11.	0.018	298	0.83	0.91	1.11
12.	0.019	298	0.84	0.93	1.19

Fig.1 Plot for 0.001mol dm^{-3} Sodium oxalate at 298 K   Fig.2 Plot for 0.001mol dm^{-3} Sodium oxalate at 298 K
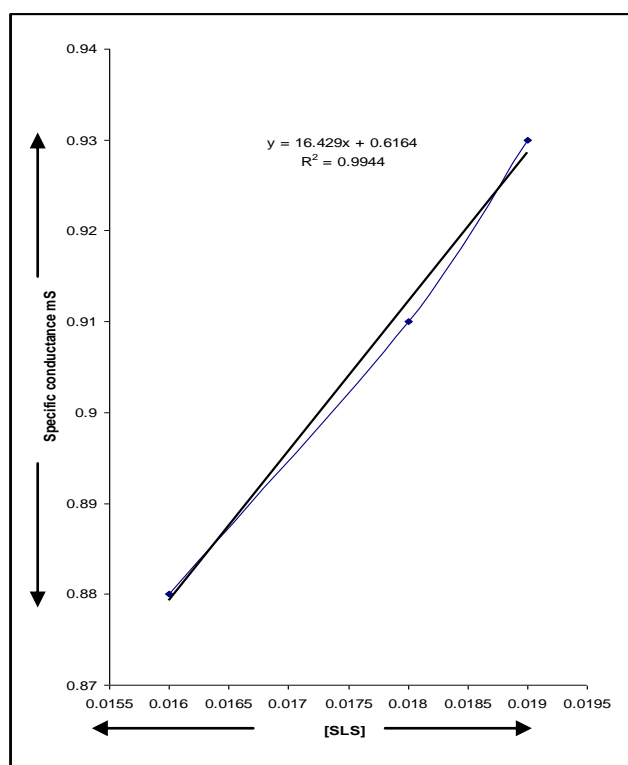

Fig. 3 Plot for 0.001mol dm^{-3} Sodium oxalate at 298 K

It is well established that in general, in aqueous solution the plot between concentration and specific conductance consist a break point in the linear behaviour which correspond to critical micelle concentration, [cmc] value of the surfactant. In the present study the data analysis indicate the presence of two break points in the plot between concentration and specific conductivity. In order to confirm the presence of two break points,

the slope of the curve were calculated by plotting the graph in three different regions. In such region linearity is greater than 0.97.

The micellization studies in presence of sodium malonate also have same nature as reported in literature [9]. In this study the second break point in the plot is defined as cmc of polymer surfactant complex or polymer saturation point in the aqueous solution. In our study the micellization of sodium lauryl sulphate (SLS) in presence of salts of oxalate in aqueous solution is somewhat similar to the reported behaviour in presence of polymer. In this study the second break point can be taken as critical saturation concentration, (csc).The values of csc obtained in the study are given in Table 2.

Table 2

Value of csc, cac and binding capacities of salt SLS complex / aggregates

S.No.	Sodium oxalate mol.dm^{-3}	cac mmol	csc mmol	Binding Capacity Mmol. SLS/mol. Oxalate	Degree of ionization (α)
		298 K	298 K	298 K	298 K
1.	0.0005	0.6	1.3	14.0	0.49
2.	0.001	0.7	1.6	9.0	0.33
3.	0.002	0.7	1.4	3.5	0.77

The critical micelle concentration, cmc of the surfactant in presence of salts in solution corresponds to the first break point in the plot between concentration and specific concentration. It has been found that the cmc of the SLS in presence of the salt is nearly equal to the cmc of SLS in water. As the salt is electrolyte hence in the study in place of the cmc the notation cac critical aggregation has been used.

As seen from the experimental data the value of cac remain constant. This indicates that the SLS and the salt can exist in ionic form below cac. To ascertain the nature of the salt and surfactant, the molecular conductances have been calculated for salt and SLS-separately in water. The plot between molecular conductance and $\sqrt{c}$ for the salt and SLS have linear nature which indicates applicability of Debye Hukel equation for strong electrolytes. The representative plot is given in Fig. 4.
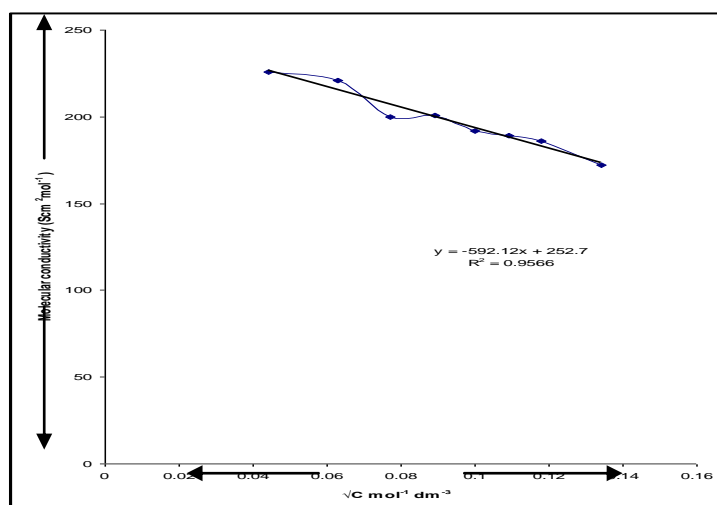

Fig. 4 Plot between sodium oxalate vs $\sqrt{c}$ at 298K

In case of strong electrolytes the value of molecular conductivity, at infinite dilution, λ^o_m can be obtain from the intercept is equal to λ^o_m at c=0 of Debye Hukel plots and Onsager. The molecular conductance at infinite dilution of sodium oxalate (252.7 scm^2mol^{-1}) and 81.88 scm^2mol^{-1} sodium lauryl sulphate (SLS) at 298 K.From the above results the micellization of SLS in presence of sodium oxalate salt under the experimental conditions used can be explained by the following considerations:

I. Sodium oxalate behave as strong electrolyte as shown by the molecular conductance in water. SLS also behaves like a strong electrolyte in water.

II. The λ^o_m has been regarded as a measure of solute-solvent interaction [10]. The large magnitude of λ^o_m shows the greater solute-solvent interaction. The trend of λ^o_m values obtained in the study indicates the magnitude of solute-solvent interaction.

III. On comparing the values of λ^o_m for oxalate ion in aqueous solution. The λ^o_m values of malonate is more or less the same. The solvation of carboxylate ion in water it may be stated here that oxalate ion have no $-CH_2$ group and have electrostatic hydration, whereas malonate has both electrostatic as well as hydrophobic hydration increasing with chain length, due to the presence of $-CH_2$ groups [9]

IV. The hydrophobicity of oxalate ion facilitated them to incorporate with the SLS micelles. In view of the above, it is suggested that the oxalate ions interact at on micellar surface.

The situation is responsible for critical aggregation of surfactant monomer. The close packing of surfactant molecule in the aggregates attains saturation in the presence of oxalate ions but the micellar/aggregate loosened in the higher concentration of ions above critical saturation point.

IV. CONCLUSION

In this study, it has been observed that the formation of oxalate ion-SLS aggregation / micelle takes place, which was justified by the value obtained for binding capacities at different concentration. At higher concentration of SLS the interaction with oxalate ions decreased beyond the critical saturation concentration salt of oxalate ions. Sodium oxalate acts as strong electrolyte. The study may be useful for the studies on ionic solutions.

REFERENCES

[1.] V.N. Mishra, N.D. Kandpal, Fluorescence and light scattering measurement on solubilization of 2-methyl naphthalene in surfactant miscelles., Tenside detergents, 19(4),1982, 222-224.

[2.] S. Acharya, R. Jangid, Micellar solubilization of pantylenetetrazole, J Ind Council chem 24, 2007, 58-62.

[3.] S. Paul, A.K. Panda, Physico-chemical studies on microemulsion; Effect of co surfactant chain length on the phase behaviour, formation dynamics, structural parameters and viscosity of water poly sorbate-20+n-alkanol 3/n-Heptane waters-in-Oil microemulsion, J surfact Deterg 14, 2011, 473-486.

[4.] Y. Morai, Micelles Theoretical and applied Aspects, Plenum press, New york,**1992**.

[5.] N.D. Kandpal, H.K. Sanwal, Thermodynamics of micellization of Linear alkyl Benzene sulphonate (LABS) is sodium Chloride solutions, Int J Chem Sci, 3 (4), 2005, 690.

[6.] N. D. Kandpal, R. Singh, S.K. Joshi and K. Kandpal, Micellization of linear Alkyl Benzene sulphonate in dilute aqueous solution of glycine, Phys Chem. An Indian J, 2, 2007, 127.

[7.] N. D. Kandpal, R. Singh S.K. Joshi and K Pandey, Thermodynamic Parameters of micellization and transfer of amino acids from water to aqueous linear alkyl benzene sulphonate, J Indian Chem. Soc, 87, 2010, 487.

[8.] K. Pandey, B. K. Joshi, S. K. Joshi and N. D. Kandpal, Interaction studies of dilute aqueous oxalic acid, E- journal of chemistry, 4(4), 2007, 574-580.

[9.] N. Chandra, S. Mishra, R. Joshi, B. chandra, K. Tamta and N. D. Kandpal, Micellization of sodium Lauryl sulphate in aqueous sodium malonate solution, Pelagia Research Library Der Chemica Sinica, 5(2),2017, 44-50.

[10.] R. A. Robinson, R. H. Stokes, Electrolyte solutions (Butter worths London), 1970, 407.