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Conductance of Sodium dodecyl sulphate in Presence and in Absence of KCl and NaBr in Methanol-Water mixed solvent media at 308. 15 K

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Abstract

Precise measurements on conductivity of sodium dodecyl sulphate in presence and in absence of KCl and NaBr in methanol-water mixed solvent media containing 0.1, 0.2, 0.3, and 0.4 volume fractions of methanol at 308.15K are reported. The concentrations were varied from ~ 0.001 to ~ 0.05 mol^{-1}*. The results showed a sharp increase in conductivity with increase in concentration of sodium dodecyl sulphate. Also,the conductivity of sodium dodecyl sulphate increases with addition of salts. The conductivity of sodium dodecyl sulphate decreases with increase in amount of methanol. The conductance of sodium dodecyl sulphate is found more in presence of KCl than NaBr in methanol-water mixed solvent media containing 0.1, 0.2, 0.3, and 0.4 volume fractions of methanol.*

***Keywords**: Conductivity, sodium dodecyl sulphate, relative permittivity, mixed solvent media.*

Introduction

The conductivity of ionic surfactants are determined generally by plotting specific conductivity versus concentration[1-4]. The aggregation of ionic surfactants in aqueous solution is influenced by the presence of electrolytes. The addition of an electrolyte will, in general, tend to induce the formation of aggregates at concentrations below the critical micelle concentration (cmc) of the pure surfactant, [5,6] while with many electrolytes, specific interactions between the surfactant ion and electrolyte counterion will lead to a reduction in solubility[7].

Sodium dodecyl sulphate has significant application as very effective surfactant in a number of industrial products and in recent studies it is considered as a novel microbicide against different viruses[8,9].

Methanol water mixtures have very special properties, which are different from that of the other alcohol + water mixtures. Ion association has been found to be negligible up to a methanol content of about 80% in the binary solvent. It may be due to the larger dielectric constant of the methanol-water mixtures and the smaller ion size. The transport properties have been investigated for a wide variety of electrolytes in methanol- water mixed solvent media in great details[10-17]. There are very few works on the transport properties of polyelectrolytes in methanol – water mixed solvent media, [18,19] whereas the transport properties of ionic surfactants in methanol-water mixed solvent media are relatively rare. It is our interest to see the effects of concentration and relative permittivity on the transport properties of sodium dodecyl sulphate in methanol – water mixed solvent media in presence and in absence of KCl and NaBr. In the future , we will also study on the micellization of an anionic surfactant, sodium dodecyl sulphate (SDS) in methanol water mixed solvent media in presence of various monovalent salts at different temperatures and able to calculate the critical micelle concentration (cmc) with the help of conductance measurements.

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Experimental Methods

Methanol (Merck, India) was distilled with phosphorous pentoxide and then redistilled over calcium hydride. The purified solvent had a density of 0.77723 ± 0.00004 g.cm^{-3} which was measured by the use of an Ostwald-Sprengel type pycnometer of about 25 cm^3 capacity. The solvent was transfused into the pycnometer by using a medical syringe. The pycnometer was then tightly fixed in a thermostat at the experimental temperatures within 0.005 K. After thermal equilibrium was attained, the mass of the pycnometer was measured with an electronic balance, and the density was calculated. Density measurements are precise within 0.00005 g . cm^{-3}, which is satisfactory for our purpose and a co-efficient of viscosity of 0.47424 ± 0.00005 mPa.s which was determined by the use of the viscometric measurements were performed at 308.15 K using a Schultz-Immergut-type viscometer [20] with a sintered disc fitted to the widest arm to filter the solution/solvent from dust particles, if any and these values are in good agreement with the literature values.[21] Triply distilled water with a specific conductance less than 10^{-6} S.cm^{-1} at 308.15 K was used for the preparation of the mixed solvents.

The physical properties of methanol-water mixed solvents used in this study at 308.15 K are shown in Table 1. The relative permittivity of methanol-water mixtures at the experimental temperatures were obtained by regressing the relative permittivity data as function of solvent composition from the literature.[22]

Table 1. *Properties of Methanol-Water Mixtures Containing 0.1, 0.2, 0.3, and 0.4 volume fractions of Methanol at 308.15 K.*

T*/*K*	ρ_0 */g.cm^{-3}	η_0 */ mPa.s	*D**
	0.1 volume fractions of methanol		
308.15	0.9797	0.8665	71.57
	0.2 volume fractions of methanol		
308.15	0.9663	1.0217	68.14
	0.3 volume fractions of methanol		
308.15	0.9516	1.1418	64.25
	0.4 volume fractions of methanol		
308.15	0.9310	1.2034	60.34

* Literatures [15,18, 23]

Sodium dodecyl sulphate employed in these investigations was purchased from Merck Specialties Private Limited, Mumbai, India. Conductance measurements were carried out on a Pye-Unicam PW 9509 conductivity meter at a frequency of 2000 Hz using a dip-type cell with a cell constant of 1.15 cm^{-1} and having an uncertainty of 0.01%. The cell was calibrated by the method of Lind and co-workers, [24] using aqueous potassium chloride solution. Potassium Chloride and Sodium Bromide employed in these investigations were purchased from Ranbaxy Chemical Company, Mumbai, India. The measurements were made in a water bath maintained 308.15 K within ± 0.005 K. The details of the experimental procedure have been described earlier.[25,26] Several independent solutions were prepared and runs were performed to ensure the reproducibility of the results. Due correction was made for the specific conductance of the solvent by subtracting the specific conductance of the relevant solvent medium from those of the electrolyte solutions.

In order to avoid moisture pickup, all solutions were prepared in a dehumidified room with utmost care. In all cases, the experiments were performed in three replicates.

Results and Discussion

The experimental specific conductivities of Sodium dodecyl sulphate in pure water and four different methanol-water mixtures (containing 0.10, 0.20, 0.30 and 0.40 volume fractions of methanol) at 308.15 K is depicted in figure 1. From this figure, it is evident that the specific conductivities exhibit a sharp increase with increasing concentration within the concentration range investigated here. The increase in the conductance with concentration is due to an increase in the number of ions per unit volume of the solution.

Obviously, the concentration dependence of the specific conductivity follows the same pattern at all solvent composition investigated. It has been studied earlier that the conductivity value decreases with increase of methanol in the system[18]. The conductance decreases with increase of alcohol content for the studied methanol-water mixed solvent system. The presence of methanol reduces the dielectric constant of the solvent phase and makes easier for the formation of ion-pairs in the solution phase. However, solvents with high dielectric constants yield more conducting solutions.

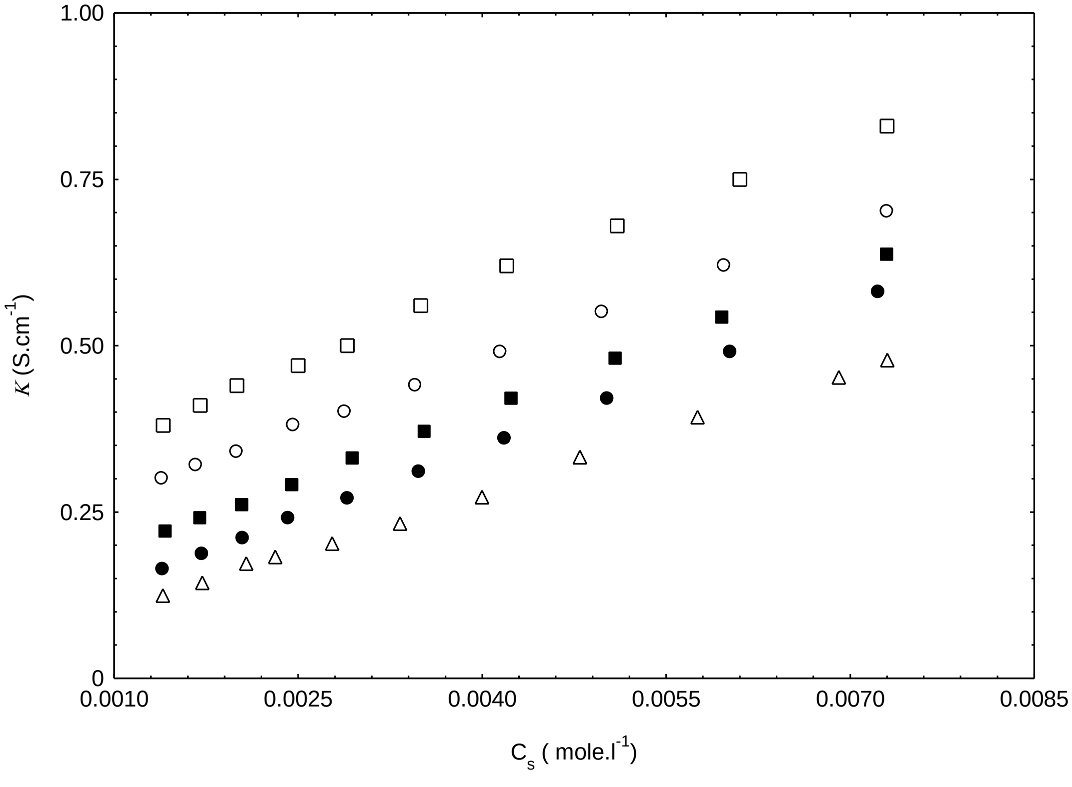


Figure 1: *Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in 308.15 K: open squares, open circles, closed squares, closed circles and triangles represent pure water, 0.10, 0.20, 0.30 and 0.40 volume fractions of methanol in the solvent mixture respectively.*

From figures 2a-d, it is evident that the specific conductivities of sodium dodecyl sulphate exhibit a sharp increase with addition of salts in all the measured solvent composition of methanol-water mixture. The increase in conductance of sodium dodecyl sulphate in methanol water mixed solvent media with addition of salts is because of increase in current carrying species in the solution. The conductivities of sodium dodecyl sulphate in presence of KCl is more than in presence of NaBr. The smaller ions are strongly hydrated, so they need to pull more water molecules with them which makes them less mobile. Hence the conductivity values for sodium dodecyl sulphate in presence of KCl is high in comparison with NaBr.

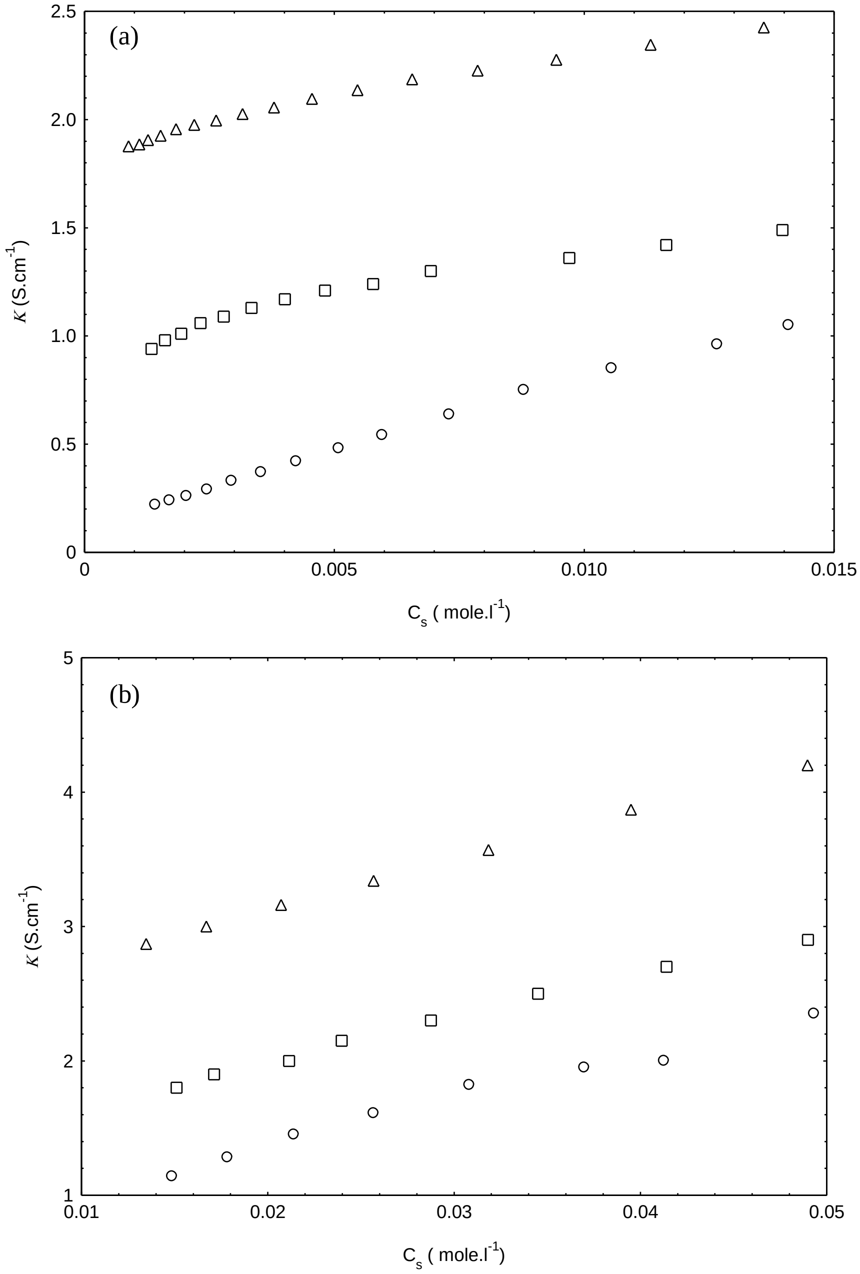
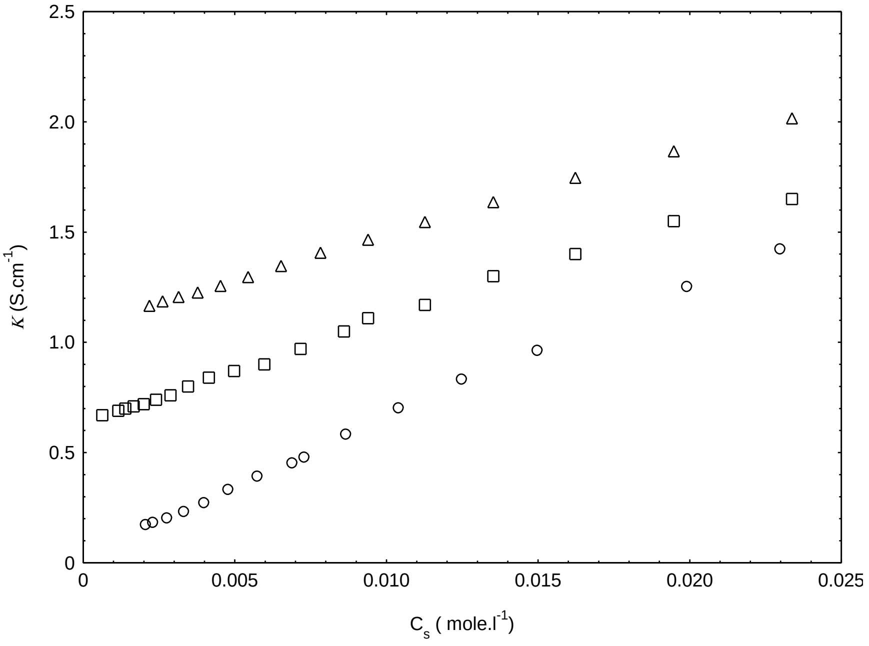


Figure 2a-b: *Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and presence of KCl and NaBr at 308.15 K: triangles, squares and circles represent 0.1N KCl, and 0.1N NaBr in (a) 0.1 volume fractions of methanol in the solvent mixture and (b) 0.2 volume fractions of methanol in the solvent mixture, respectively*



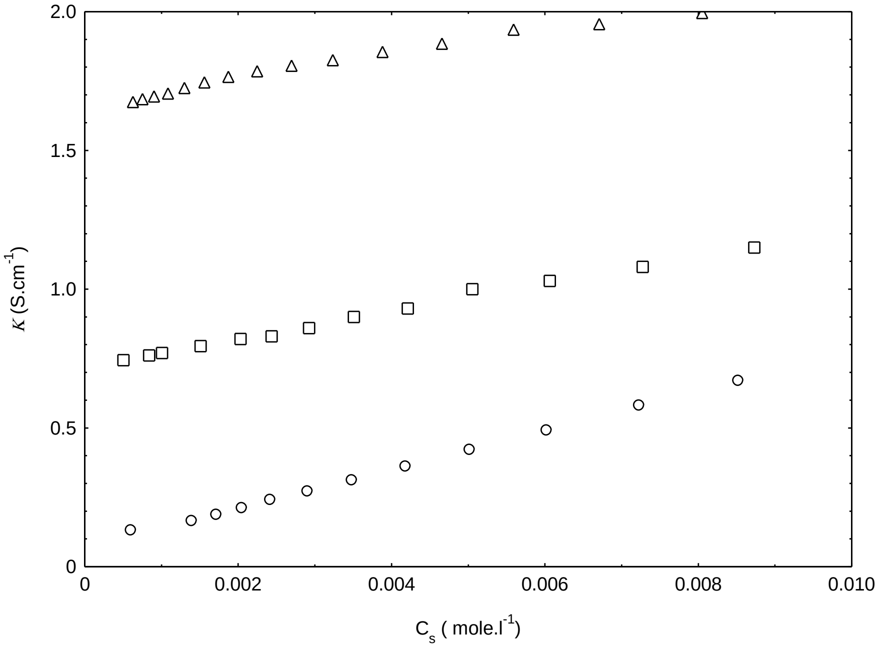


Figure 2c-d: *Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_S) in absence and presence of KCl and NaBr at 308.15 K: triangles, squares and circles represent 0.1N KCl, and 0.1N NaBr in (c) 0.3 volume fractions of methanol in the solvent mixture and (d) 0.4 volume fractions of methanol in the solvent mixture, respectively.*

Conclusions

Effects of concentration and solvent composition on the conductance of sodium dodecyl sulphate in absence and presence of KCl and KBr in methanol (1) + water (2) mixed solvent media have been studied by measuring specific conductance through conductometric method. The following conclusions have been drawn from the above results and discussion. Experimental results for the specific conductivity of solution of sodium dodecyl sulphate in absence and presence of KCl and KBr in methanol-water mixed solvent media have been presented as a function of salt concentration and different percentage composition of (methanol + water) mixed solvent media. The specific conductivities are found to increase with increase in concentration over the entire concentration range investigated whereas the specific conductivities of sodium dodecyl sulphate decrease with decreasing dielectric constant of solvent composition. Also, the specific conductivities of sodium dodecyl sulphate in presence of KCl found to be more than NaBr in four compositions (0.10, 0.20, 0.30 and 0.40 volume fractions of methanol) of methanol-water mixed solvent media.

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