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Effects of concentration, relative permittivity on the transport properties of Sodium dodecyl sulphate in presence and in absence of potassium bromide and Sodium chloride 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 KBr and NaCl in methanol-water mixed solvent media containing 0.1, 0.2 and 0.4 volume fractions of methanol at 308.15K are reported. The concentrations were varied from ~ 0.001 to ~ 0.03 $mol.l^{-1}$. 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 KBr than NaCl in methanol-water mixed solvent media containing 0.1, 0.2 and 0.4 volume fractions of methanol.

Key words: Conductance; sodium dodecyl sulphate; relative permittivity; mixed solvent media

1. Introduction

Several works has been done on conductivity of ionic surfactants [1-5]. 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[6,7], while with many electrolytes, specific interactions between the surfactant ion and electrolyte counterion will lead to a reduction in solubility[8].

The transport properties have been investigated for a wide variety of electrolytes in methanol- water mixed solvent media in great details [9-16]. There are very few works on the transport properties of polyelectrolytes in methanol – water mixed solvent media [17, 18], 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 KBr and NaCl.

2. 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 0.00005g.cm^{-3}, which is satisfactory for our purpose and a co-efficient of viscosity of 0.47424 ± 0.00005 m Pa. s which was determined by the use of the viscometric method. Measurements were performed at 308.15 K using a Schultz-Immergut-type viscometer [19] 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 [20]. 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 taken from our published works [5,14,17,21]. 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].

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 [23] using aqueous potassium chloride solution. Sodium Chloride and Potassium 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 [24,25]. 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.

3. Results and Discussion

The conductivities of Sodium dodecyl sulphate in pure water and three different methanol-water mixtures (containing 0.10, 0.20 and 0.40 volume fractions of methanol) at 308.15 K is depicted in fig.1.

It is evident from fig.1 that the specific conductivities exhibit a sharp decrease with increasing concentration of methanol within the concentration range investigated here. The decrease in the conductance with increase in concentration of methanol is due to decrease in the dielectric constant of the mixture. 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. Fig. 1 also shows that conductance increase with increase in concentration. The increase in conductance with increase in concentration is due to increase in number of ions per unit volume of the solution. It has been studied earlier that the conductivity value decreases with increase of methanol in the system [17]. The conductance decreases with increase of alcohol content for the studied methanol-water mixed solvent system.

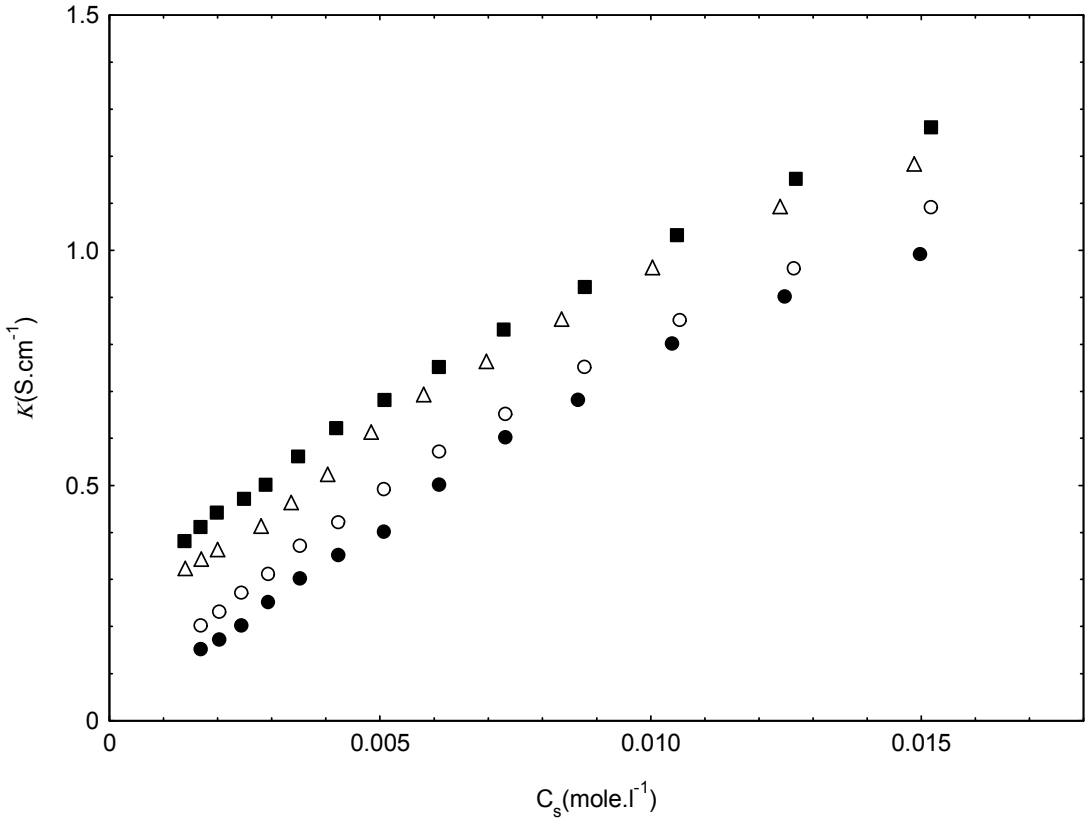

Fig.1: Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in 308.15 K: Closed squares, triangle, open circles and closed circles represent pure water, 0.10, 0.20 and 0.40 volume fractions of methanol in the solvent mixture respectively.

Figs. 2-5 represent the specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and presence of 0.1N KBr and 0.1N NaCl at 308.15 K: in distilled water and different composition of methanol.

From the figs. 2 to 5, it is evident that the specific conductivities of Sodium dodecyl sulphate exhibit increase with addition of salt. The conductivity of Sodium dodecyl sulphate in presence of KBr is more than in presence of NaCl. Also, from figs. 2-5, it is clear 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 KBr is more than in presence of NaCl. Because the smaller ions are strongly hydrated than larger ions, so they need to pull more water molecules with them that results decrease in mobility of ions. Hence the conductivity values for sodium dodecyl sulphate in presence of KBr is more than in comparison with NaCl.

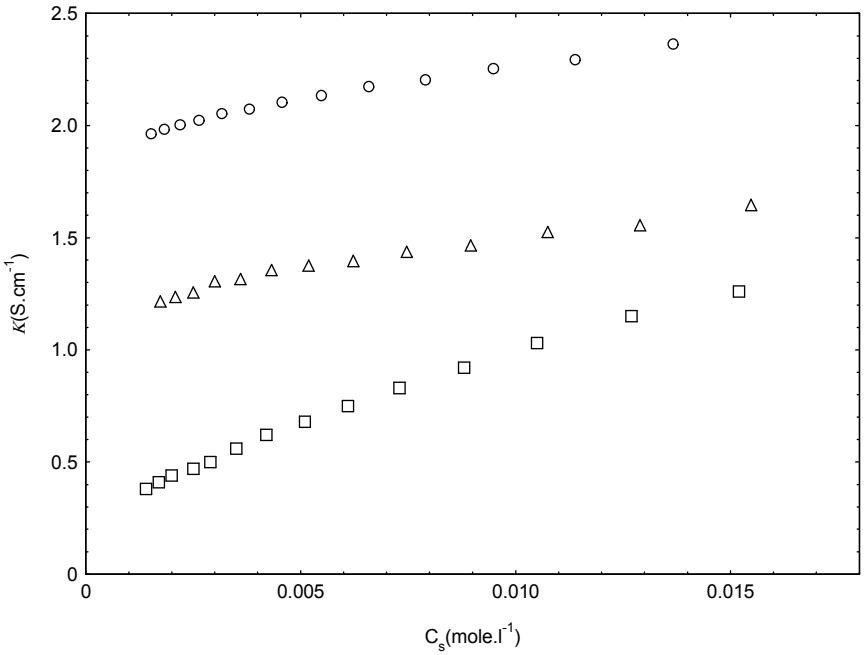

Fig. 2: Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and in presence of 0.1N KBr and 0.1N NaCl at 308.15 K: Circles, triangles, and squares represent presence of 0.01N KBr, 0.01N NaCl and absence of salt in distilled water i.e. in '0' Volume fractions of methanol in the solvent mixture respectively.

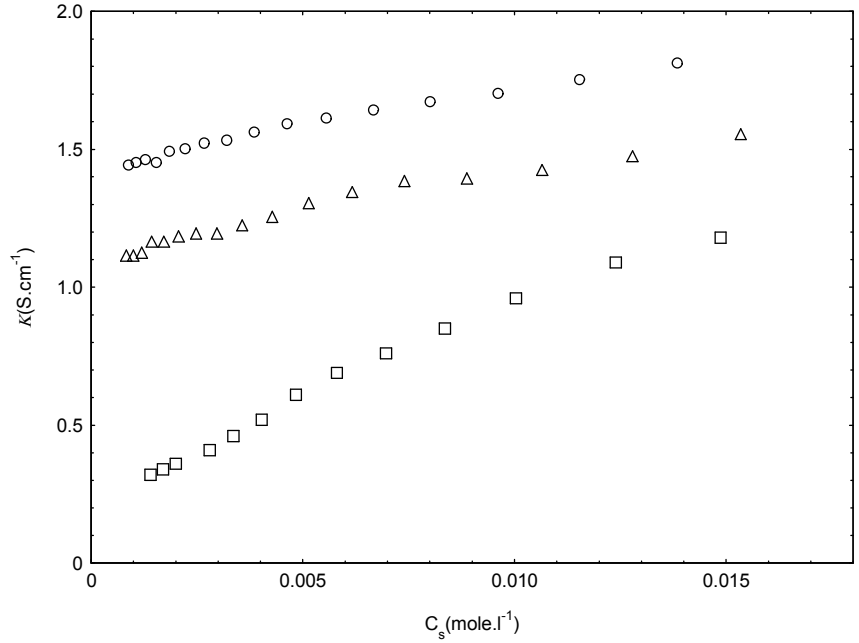

Fig. 3: Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and in presence of 0.1N KBr and 0.1N NaCl at 308.15 K: Circles, triangles, and squares represent presence of 0.01N KBr, 0.01N NaCl and absence of salt in 0.1 volume fractions of methanol in the solvent mixture respectively.

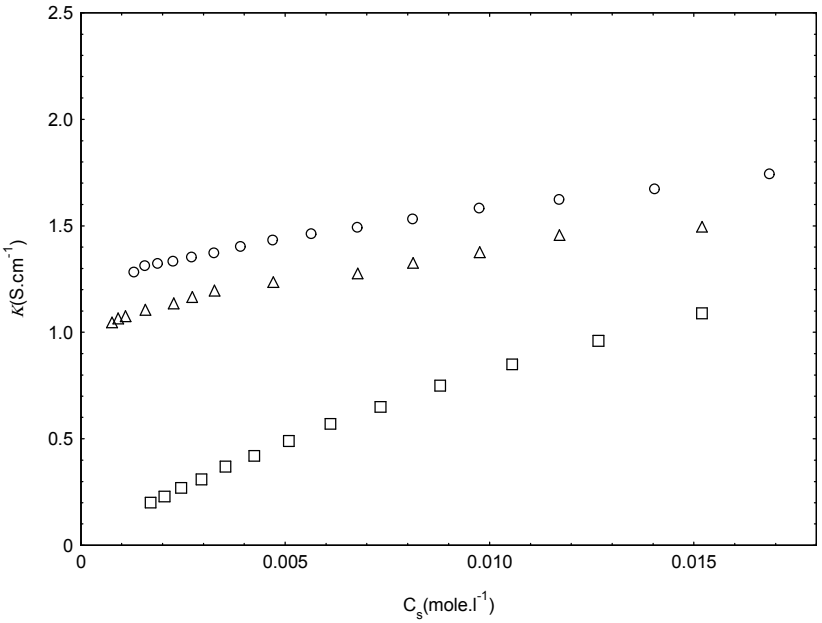

Fig. 4: Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and in presence of 0.1N KBr and 0.1N NaCl at 308.15 K: Circles, triangles, and squares represent presence of 0.01N KBr, 0.01N NaCl and absence of salt in 0.2 volume fractions of methanol in the solvent mixture respectively.

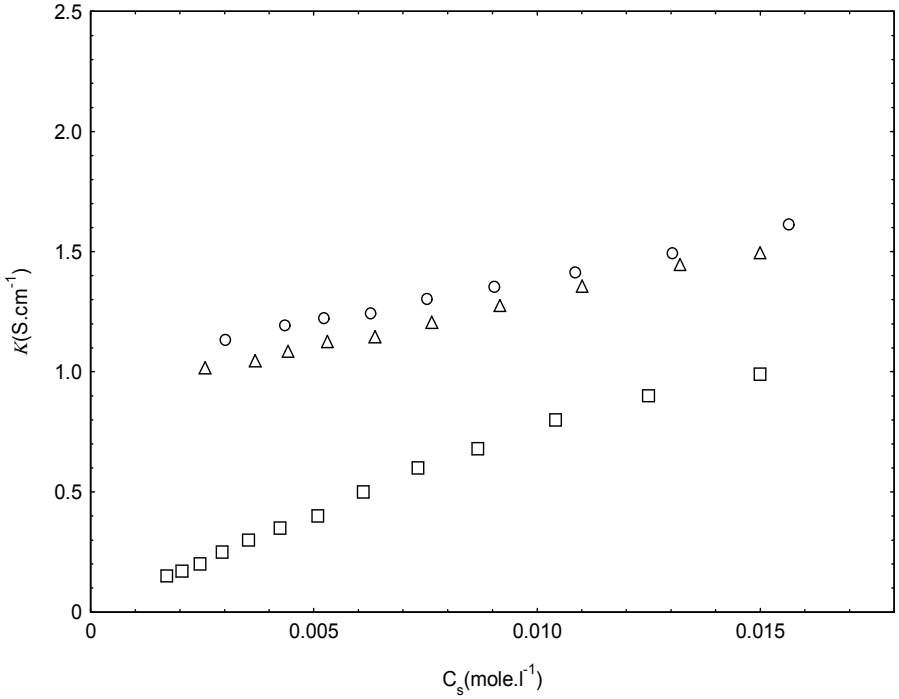

Fig. 5: Specific conductivities of Sodium dodecyl sulphate as a function of concentration (c_s) in absence and in presence of 0.1N KBr and 0.1N NaCl at 308.15 K: Circles, triangles, and squares represent presence of 0.01N KBr, 0.01N NaCl and absence of salt in 0.4 volume fractions of methanol in the solvent mixture respectively.

4. Conclusions

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 KBr and NaCl 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 KBr found to be more than in Presence of NaCl in pure water and three different compositions (0.10, 0.20 and 0.40 volume fractions of methanol) of methanol-water mixed solvent media.

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