

# CONDUCTANCE OF SODIUM DODECYLSULFATE IN PRESENCE AND ABSENCE OF $\text{Na}_2\text{SO}_4$ AND $\text{ZnSO}_4$ IN AQUEOUS MEDIA AT ROOM TEMPERATURE

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**Abstract:** Conductance measurement of sodium dodecylsulfate in the presence and in the absence of  $\text{Na}_2\text{SO}_4$  and  $\text{ZnSO}_4$  in aqueous media was done. The results showed sharp increase in conductance with increase in concentration of sodium dodecylsulfate. Also, the conductance increases with addition of salts. The conductance of sodium dodecylsulfate is found more in the presence of  $\text{Na}_2\text{SO}_4$  than  $\text{ZnSO}_4$  in aqueous media. In the presence of salts, the critical micelle concentration (cmc) value decreases which are explained on the basis of the nature and ion size of the added ion. The graph of conductance versus concentration is used in determining the critical micelle concentration (cmc).

**Keywords:** Sodium dodecylsulfate; Conductance; Critical micelle concentration.

## INTRODUCTION

Sodium dodecylsulfate has the chemical formula  $\text{C}_{12}\text{H}_{25}\text{NaO}_4\text{S}$  or  $\text{CH}_3-(\text{CH}_2)_{11}-\text{O}-\text{SO}_3-\text{Na}^+$  and its structure is presented below. SDS is a high production volume chemical. In solution, the sodium cation ( $\text{Na}^+$ ) dissociates from the anionic part of the compound (lauryl or dodecylsulfate), and this anionic compound is the active chemical.

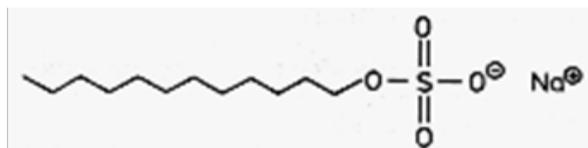


Figure 1: Chemical Structure of SDS.

SDS is an anionic surfactant, which is a class of chemicals used for their detergent properties. One end of the molecule is charged and therefore has an affinity for water and the other end is non polar and soluble in fat/oil. SDS has a negatively charged sulfonate group as its “hydrophilic” end and a saturated 12-carbon for its “lipophilic” end. SDS has a wide variety of applications. Among them, the major use of SDS is as a synthetic chemical surfactant for emulsion polymerization. Other major uses include, as an emulsifier in the electroplating industry: as a wetting agent and adjuvant in insecticides: as an emulsifier and penetrant in varnish and paint remover: as a whipping agent and surfactant in foods

and as a cleaning agent in a wide variety of personal care products, such as toothpastes, shampoos, bubble baths, shaving creams-any product that requires a thickening effect and the ability to create a lather.

The conductivity study for ionic surfactants are very popular<sup>1-5</sup>. 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<sup>6,7</sup>.

In this paper, we report a study of the aggregation process of SDS at room temperature in the absence and presence of  $\text{Na}_2\text{SO}_4$  and  $\text{ZnSO}_4$  by the conductivity method in aqueous media.

## EXPERIMENTAL

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  $1.15 \text{ cm}^{-1}$  and having an uncertainty of 0.01 %. The cell was calibrated by the method of Lind and co-workers<sup>8</sup> using the aqueous potassium chloride solution. 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 surfactant solutions. Sodium dodecylsulfate was purchased from Loba Chemical, India.  $\text{ZnSO}_4$  and  $\text{Na}_2\text{SO}_4$  were purchased from Ranbaxy Chemical, India. The water used in the experiments was doubly distilled.

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The solutions prepared at room temperature.

## RESULTS AND DISCUSSION

It is well-known, that the conductivity of any solution is directly proportional to the concentration of its ions. The point, where the micelle formation starts, is indicated on the concentration dependence of specific conductivity ( $k$ ) as a breaking point. The breaking point gives the cmc of the surfactant.

The sodium ion ( $\text{Na}^+$ ) is larger than the Zinc ion ( $\text{Zn}^{2+}$ ) because, the Zinc cation,  $\text{Zn}^{2+}$ , has a greater cationic charge than the  $\text{Na}^+$  cation. The conductivities of SDS in the presence of  $\text{Na}_2\text{SO}_4$  is more than in the presence of  $\text{ZnSO}_4$  because 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 of SDS in the presence of  $\text{Na}_2\text{SO}_4$  are high in comparison with  $\text{ZnSO}_4$  as shown in Figure 2.

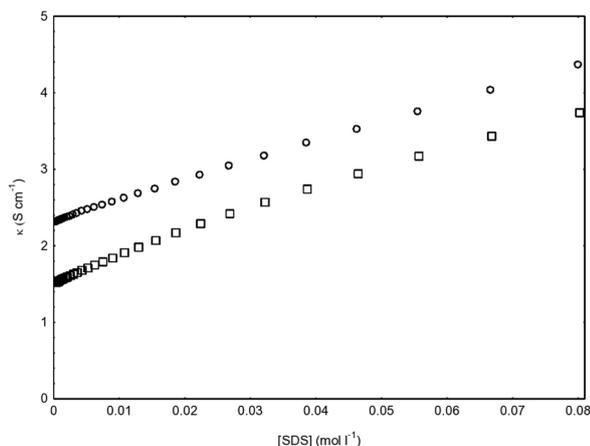


Figure 2: Specific conductivities of SDS in the presence of  $\text{Na}_2\text{SO}_4$  (circles, the higher graph) and  $\text{ZnSO}_4$  (squares, the lower graph) in aqueous media at room temperature.

Figures 3-5 gives the cmc values by plotting conductivities of SDS in the absence and presence of  $\text{Na}_2\text{SO}_4$  and  $\text{ZnSO}_4$  in aqueous media at room temperature.

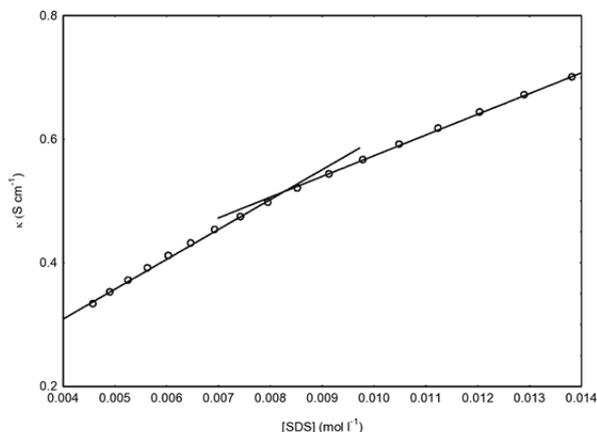


Figure 3: Specific conductivities of SDS versus surfactant concentrations at room temperature in aqueous medium (Breaking point, the cmc).

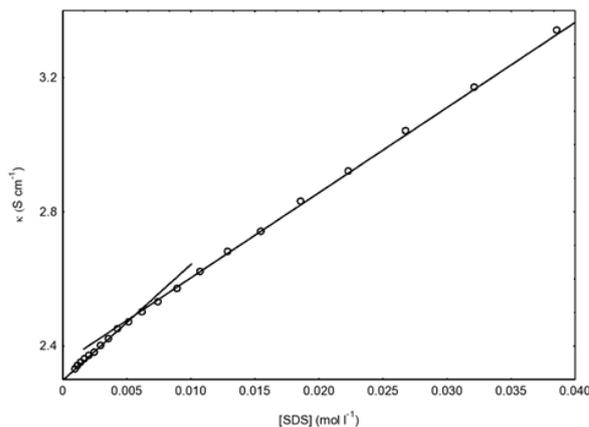


Figure 4: Specific conductivities of SDS versus surfactant concentrations in  $\text{Na}_2\text{SO}_4$  at room temperature in aqueous medium (Breaking point, the cmc).

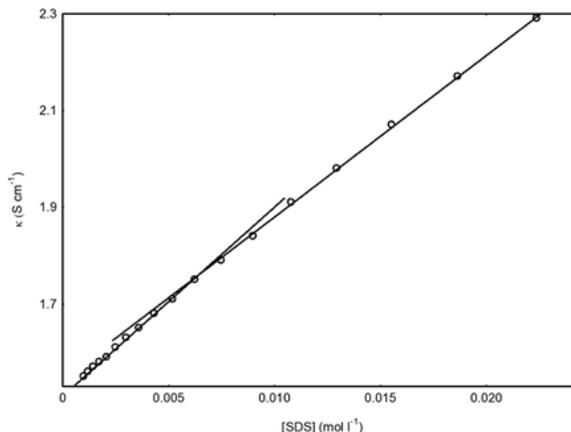


Figure 5: Specific conductivities of SDS versus surfactant concentrations in  $\text{ZnSO}_4$  at room temperature in aqueous medium (Breaking point, the cmc).

In water, the *cmc* of SDS at 298.15 K to be 8.00 mM<sup>9</sup> which verifies our experimental data of cmc of SDS at room temperature, 301.15 K (Table 1). Also, the cmc values of SDS in the absence and presence of  $\text{Na}_2\text{SO}_4$  and  $\text{ZnSO}_4$  at room temperature are shown in Table 1. As the salt is added, the electrostatic repulsive force between ionic head groups of the surfactant molecules is reduced by shielding of micelle charge, so that spherical micelles are more closely packed by the surfactant ions<sup>10,11</sup>, hence a decrease in the cmc values after adding salts. Salts decrease the cmc in the order:  $\text{ZnSO}_4 < \text{Na}_2\text{SO}_4$ . Here  $\text{Zn}^{++}$  is least effective in decreasing the cmc due to small size and large hydrated radius and would act as a water-structure promoter decreasing the availability of water to the micelles. Therefore, upon addition of  $\text{ZnSO}_4$  and  $\text{Na}_2\text{SO}_4$  in SDS,  $\text{Na}_2\text{SO}_4$  is more effective in reducing the cmc of SDS. Also, ionic strength of 0.01M  $\text{ZnSO}_4$  is more than that of 0.01M  $\text{Na}_2\text{SO}_4$ , the cmc of SDS is still

more in 0.01M ZnSO<sub>4</sub> because salts can monotonically raise the cmc with ionic strength<sup>12</sup>. Hence in our case Na<sub>2</sub>SO<sub>4</sub> decreases the cmc of SDS more than ZnSO<sub>4</sub> (Table 1).

**Table 1: The critical micelle concentration (cmc) of SDS obtained from conductivity measurement in the absence**

**and presence of Na<sub>2</sub>SO<sub>4</sub> and ZnSO<sub>4</sub>.**

Distilled water	0.01M ZnSO <sub>4</sub>	0.01M Na <sub>2</sub> SO <sub>4</sub>
Cmc	Cmc	Cmc
(mM)	(mM)	(mM)
8.23	6.52	5.75

### CONCLUSIONS

The following conclusions have been drawn from above result and discussions. The results showed an increase in conductivity of sodium dodecyl sulphate with the addition of salts. The conductance of sodium dodecyl sulphate is found more in the presence of Na<sub>2</sub>SO<sub>4</sub> than ZnSO<sub>4</sub> in aqueous media whereas in the presence of Na<sub>2</sub>SO<sub>4</sub>, the cmc of sodium dodecyl sulphate decreases more in comparison with the presence of ZnSO<sub>4</sub>.

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