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Influence of Antidepressant Drug on the Conductivity of Cationic Surfactant

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Abstract—In this study, the electrical conductivity of the antidepressant drug—nortriptyline hydrochloride and conventional surfactant—cetyldimethylethylammoniumbromide are investigated. The experimental critical micelle concentration and related thermodynamic parameters, such as Gibbs free energy, enthalpy, entropy change, as well as and excess change in Gibbs free energy are calculated using standard equations. The values of change in Gibbs free energy for the mixed nortriptyline hydrochloride with cetyldimethylethylammoniumbromide are found to be more negative further suggesting the mixed micellization to be favourable. However, the high values of change in entropy are observed owing to the charge on the head groups which are being partially neutralized by the counter ions upon micelle formation.

Keywords: antidepressant drug, nortriptyline hydrochloride, cationic surfactant, cetyldimethylethylammoniumbromide, thermodynamic parameters, drug-surfactant interactions, conductivity

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INTRODUCTION

It is well known that the interaction between the hydrocarbon chains of surfactants in aqueous medium stabilize the electrostatic repulsion between the head groups supporting easy micelle formation [1–10]. The parameters which are related with the micellization are aggregation number (N_{agg}), critical micelle concentration (CMC), shape and size of micelles. These parameters define the solubilization of additives or delivery of these additives such as drugs. Many drug delivery systems (lipid particles, synthetic polymers, liposomes, microcapsules, cell ghosts, micelles, etc.,) are being developed to enhance the drug bioavailability by reducing its degradation and prevent the side effects affecting the cells or tissues [2, 3]. The careful choosing of drug delivery system is a prerequisite to nullify any adverse effects. The addition of one type of amphiphile to another results in synergism or antagonism accordingly affecting the solution properties of the mixed systems [11, 12]. The mixture of amphiphiles with drugs can be tuned in such a way to change the properties and increase the applicability of these systems. There are many studies of antidepressant drugs (chlorpromazine hydrochloride, amitryptyline hydrochloride, promethazine hydrochloride, chlomipramine hydrochloride) with various types of surfactants. The main outcome of these studies is solubilization and whether the mixtures form thermodynamically stable systems or not [13–15]. To evaluate various thermodynamic and related parameters electrical conductivity [5, 6], surface tension [14, 15], fluorescence [16] as well as UV-visible spectroscopy [14] are widely used. For instance [17], the electrical conductivity was measured to determine the interaction between antidepressant drug and different cationic surfactants [17–22]. In one more study, the authors [16] reported interaction of chlorpromazine and trifluoperazine with sodium dodecyl sulfate (SDS) using UV-visible and fluorescence techniques and calculated the binding constants between the amphiphiles. In this study, the interaction between amphiphilic drug nortriptyline hydrochloride (NOT) and cetyldimethylethyl ammonium bromide (CDEABr) was investigated to understand the behavior of their mixture in aqueous medium by electrical conductivity measurements.

EXPERIMENTAL

Chemicals and Preparation of the Samples

The cationic surfactant CDEABr (Sigma Aldrich) was recrystallized from ethanol (S.D. Fine Chem. Ltd., India, purity 99.9%) and was dried under vacuum over P_2O_5 before use. The NOT (Sigma Aldrich, purity 99%) was used without further purification. Water with conductivity less than 2 μ S cm^{-1} at 298.15 K was used for the preparation of solutions. A stock solution of 2.0×10^{-5} M (mol L^{-1}) NOT in water