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Interactions of tricyclic antidepressant drug chlomipramine hydrochloride with imidazolium based surface active ionic liquid in aqueous solution

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ABSTRACT

Tricyclic antidepressant drug, Chlomipramine hydrochloride (CLP) with surface active ionic liquid (SAIL), 1-octyl-3-methylimidazolium chloride, was investigated using electrical conductivity. Various theoretical models were employed to calculate various interaction parameters and thermodynamic parameters. Different mole fractions of CLP with SAIL were studied to evaluate the critical micelle concentration (*CMC*) using electrical conductivity measurements. The change in Gibbs free energy of micellization, change in enthalpy of micellization, change in entropy of micellization, micellar mole fraction, $\chi_{1,}$ of the CLP, and the interaction parameter, β, activity coefficients f_1 and $f_2$were calculated. The χ_{Ideal} and χ_1 values were observed to increase on increasing the mole fraction of CLP from 0.4 to 0.6. This may be an indication of drug molecules being adsorbed on the micellar surface. As a result the mixed system (CLP and SAIL) were found to form stable mixed micelles.

1. Introduction

The surface active ionic liquids (SAILs) are thoroughly studied owing to their immense advantages over the conventional surfactants [1]. These SAILs are exploited in various ways, as emulsifiers, dispersants, wetting agents, hair conditioners, and in various other applications in textile industries as fabric softeners [2]. As the immidizolium based SAILs are found to be having antimicrobial activity and are thus exploited in the field of biology as well [3–6]. Ionic liquids (ILs) can influence the self-assembly of surfactants, mostly through hydrogen bonding along with electrostatic and hydrophobic interactions. The micellization process depends on the hydrocarbon chain length of ILs as well as on the concentration of ILs [7,8]. It is generally observed that at low concentration, ILs act as electrolyte and decreases the *CMC* values by electrostatic stabilization of micelle surfaces. At high concentration ILs act as cosolvent and therefore increase the *CMC* values [9–12]. The aggregation behavior of imidazolium based ILs has been studied intensively in recent years by many researchers [13–21]. A lot of researchers focused the attention on aggregation behavior of these SAILs in presence of different additives such as drugs [1], in presence of conventional surfactants [23,9] and different biomolecules [22].

The intention of drug solubilization is to lower the side effects which are caused because of high concentration. Therefore the solubilization of the drug molecules with other favorable drug carriers becomes a necessity. The mixed micelles may be an alternative to reduce the toxicity of these drug molecules. It is well reported that the drug carriers other than surfactants are not efficient enough to function as drug carriers [24–26]. The amphiphilic drugs particularly those with analgesics, antibiotics, anaesthetics, and antidepressants self-associate into micelles of small aggregation number, and thus showing affinity toward biological membranes [23]. The chlomipramine hydrochloride is a tricyclic antidepressant drug with an alkyl chain possessing a nitrogen atom as well. These drug molecules have the capacity to self-assemble in aqueous solution. This self-assembly or aggregate formation can be easily detected using electrical conductivity [27]. The *CMC* values of CLP in aqueous solution is reported as 23 mM at 298 K and aggregation number (N_{agg}) of 6 at 303 K [28]. Most of these tricyclicic antidepressant drugs undergo phase separation depending upon pH, temperature, and additive concentration. At very low concentration, these drugs show their pharmacological effects, it is thus possible that the presence of additives may decrease their *CMC* value and therefore helps in aggregation formation [29–31]. These drugs form mixed micelles with the surfactants

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