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Role of 1-methyl-3-octylimidazolium chloride in the micellization behavior of amphiphilic drug amitriptyline hydrochloride

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ABSTRACT

The mixed micellization behaviour of amitriptyline hydrochloride (AMT) with ionic liquid (IL) 1-methyl-3-octylimidazolium hydrochloride, [C_8mim][Cl], have been investigated using electrical conductivity, at different temperatures. The non-ideal behaviour (i.e., synergistic interaction) of AMT–[C_8mim][Cl] binary mixtures, explained by the deviations in critical micelle concentration (*cmc*) from ideal critical micelle concentration (*cmc**) and micellar mole fraction (X^m) from ideal micellar mole fraction (X^{ideal}) values. The values of interaction parameter (β) and activity coefficients (f_1 and f_2), also confirm the synergistic interaction. The excess free energy (ΔG_{ex}) for the AMT–[C_8mim][Cl] binary mixtures explains, stability of mixed micelles in comparison to micelles of pure, AMT and [C_8mim][Cl]. The calculated thermodynamic parameters (viz., the standard Gibbs energy change, ΔG_m°, the standard enthalpy change, ΔH_m°, the standard entropy change, ΔS_m°), suggest the dehydration of hydrophobic part of the drug at higher temperatures (>313 K), not only in case of AMT but also in the presence of [C_8mim][Cl].

1. Introduction

In recent years amphiphilic ionic liquids (ILs), i.e., a class of salts composed of bulky organic cation and appropriate anion exists in a molten state around room temperature, are of immense importance. They possess significant promise in miscellaneous industrial applications, where high surface areas, modification of the interfacial activity or stability of colloidal systems are required. The low volatility, non-flammability, wide electrochemical window, high thermal stability, and wide liquid range [1–4] are unique properties of these salts that are applied for catalysis [5], electrochemistry [6], chemical separation [7–9] and as a novel solvent in organic synthesis [10,11].

Additionally, the self-assemblies of amphiphilic molecules in a solvent have many potential applications such as nanomaterial synthesis [12–14], drug delivery [15,16], separation process, pharmaceutical formulation, and other dispersant technologies [17]. A typical imidazolium IL analyzed by the structure activity relationship (SAR), guide the assumption that ILs could acquire surface active properties similar to surfactants and would allow the ILs to form micelles in aqueous solution [18,19]. As shown in Scheme 1(a), the anion or cation of IL consist of a charged hydrophilic head group and a hydrophobic 'tail' domain, suggesting that IL have properties analogous to amphiphiles.

Extensive work has been done related to the surfactant self assemblies in imidazolium based room temperature ILs (RTILs). Anderson et al. [5] has been reported the formation of micelles by anionic and nonionic surfactants in 1-butyl-3-methylimidazolium chloride [Bmim][Cl] and hexafluorophosphate [Bmim][PF_6]. Fletcher and Pandey have also studied the aggregation behaviour of anionic SDS, cationic CTAB, nonionic Brij, Triton X-100 and Tween 20 in 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide [Emim][Tf_2N] by using solvatochromic probe technique [6]. Tang et al. [8] has also been reported the temperature dependent self-assembly of Brij surfactant in [Bmim][BF_4].

Currently, the ILs have been combined with active pharmaceutical ingredients (APIs), and supposed to be a third generation of ILs [20]. Such IL–API compounds, offer new and improved properties like stability, solubility, permeability and drug delivery, as compared to the corresponding solid pharmaceutical forms.

Many drugs, particularly those with the local anesthetic, tranquillizing, antidepressant and antibiotic actions, are amphiphilic in nature, and exert their activity by interaction with biological membranes [21]. The tricyclic antidepressant drugs are a family of structurally similar compounds possessing an almost planar tricyclic ring system with a short hydrocarbon chain carrying a terminal, charged nitrogen atom (Scheme 1(b)). It has been shown that these drugs form aggregates (or micelle) of approximately

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