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ORIGINAL CONTRIBUTION

Thermodynamics of cosolvent effect of surface-active ionic liquids on the micellization of conventional surfactant

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Abstract

The changes in the physicochemical properties of a cationic surfactant cetyldimethylethylammonium bromide (CDEABr) on the addition of two ionic liquids, namely, 1-butyl-3-methylimidazolium dicyanamide, [C_4mim][dca], and 1-octyl-3-methylimidazolium chloride, [C_8mim][Cl], were investigated. Different techniques which include conductivity method, fluorometry method, DLS studies, and UV–visible spectroscopy were employed in order to determine various properties like critical micelle concentration, *CMC*, aggregation number, peak diameter of aggregate micelles, and interaction parameters. [C_8mim][Cl] causes more decrease in *CMC* and more increase in aggregation number. In the case of [C_8mim][Cl], the presence of octyl chain length helps easy mixed micelle formation with CDEABr, whereas in case of [C_4mim][dca] this does not happen because of the absence of long alkyl chain length. The presence of different alkyl chain lengths of ILs and the mixed micelle formation of [C_8mim][Cl] is responsible for the different behavior towards micellization in aqueous cationic surfactant CDEABr.

Keywords Surface active ionic liquids · Conductivity · Fluorometry · DLS · UV–visible · Physicochemical properties

Introduction

The physicochemical properties of most of the surfactant solutions depend on the nature of the surfactant. The additives are added to control or to improve the stability or the physical characteristic properties of the amphiphilic solutions for various practical applications [1–10]. Generally, various organic and inorganic additives are added to tune the properties of conventional aqueous surfactant solutions [3–6]. For instance, the surface-active agents are used in textile dyeing, photography, and printing, and in various branches of chemistry [8, 9]. The surface-active ionic liquids (SAILs) as external additives are being currently exploited in enhancing the applicability of aqueous surfactant solutions [5, 10–15]. An important application of these mixed surfactants is exploited in pharmaceutical formulations and in industrial preparations [16, 17, 60–62]. The SAIL-type imidazolium-based ILs form aggregates or micelle-type structures in aqueous solution [18–22]. It has been observed that the addition of some inorganic salts results in a decrease in the electrostatic repulsions between hydrophilic heads favoring easy micelle formation, thus decreasing the *CMC* [23, 24]. However, it is also well known that ionic liquids can be used as media supporting amphiphile aggregation [25–31]. The addition of ILs to the conventional surfactants has been investigated by many researchers [3, 5]. In all these studies, it was found that the ILs influenced the physicochemical properties in the aqueous medium.

In this study, the effect of ILs, 1-butyl-3-methylimidazolium dicyanamide, [C_4mim][dca], and 1-octyl-3-methylimidazolium chloride, [C_8mim][Cl], on the physicochemical behavior of cationic surfactant cetyldimethylethylammonium bromide, CDEABr, has been studied. The current study may be helpful in understanding the effect of these two imidazolium-based room-temperature ionic liquids on the physicochemical properties of cationic surfactant CDEABr. These systems may be useful in solubilization of biomolecules and drugs [32–35, 60–62]

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