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Study of β-cyclodextrin/fluorinated trimethyl ammonium bromide surfactant inclusion complex by fluorinated surfactant ion selective electrode

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Abstract

The construction and performance of a liquid membrane electrode responsive to *N*-(1,1,2,2-tetrahydroperfluorooctyl)-*N*,*N*,*N*-trimethylammonium bromide (FTABr) and its use for the study of β-cyclodextrin/fluorinated surfactant inclusion complex is described. The electrode is based on the use of tetrahydroperfluorooctyltrimethylammonium-tetraphenylborate ion pair as electro active material in polyvinyl chloride (PVC) matrix plasticized using 2-Nitrophenyl octyl ether (NPOE). The electrode exhibits a fast, stable, reproducible and "Nernstian" response (59 ± 2 mV) for FTABr over the concentration range of 10^{-5} to 2×10^{-3} mol L^{-1} at 298 K. The lowest detection limit is 2×10^{-6} mol L^{-1} and the response time is around 20–30 s. The validity of the electrode, for detection of fluorinated surfactant ions and hence to carry out electrochemical measurements to study micellization of fluorinated surfactant, is verified by comparing the critical micelle concentration (cmc) value of FTABr obtained by using the electrode, with that obtained by surface tension measurements. Association constant *K* for β-cyclodextrin/FTABr complex is evaluated from the potentiometric measurements carried out using this electrode and is observed to be $\sim 1.26 \times 10^5$. The results suggest that β-cyclodextrin forms an equimolar association complex with the FTA^+ surfactant ion.

Keywords: Ion selective electrode; Cationic fluorinated surfactant; β-cyclodextrin; Complexation constant

1. Introduction

Surfactants are important in various phenomena of interfacial science and continue to be critical in many applications in agrochemicals, water treatment, oil recovery, fire fighting, paper and plastic manufacturing [1]. Fluorinated surfactants are surface-active agents in which the hydrogen atoms of the hydrophobic moiety are partially or completely replaced by fluorine atoms [2]. The unique characteristic of fluorocarbon chains in fluorinated surfactants leads to differences in their micellar solution properties as compared to those of their hydrocarbon analogues and hence is responsible for their specific performance properties. Fluorocarbon surfactants exhibit lower critical micelle concentration (cmc) as compared to hydrocarbon surfactants having the same tail length [3–4], display tendency to form aggregates having low curvatures, including cylindrical micelles and bilayer structures [5–8]. Fluorocarbon surfactants are, thus, very important from fundamental as well as industrial point of view and have been found useful in various high performance applications like electroplating, wetting, biological oxygen carriers in artificial blood formulations, emulsion polymerization, templates for synthesis of mesoporous structures and so on [9–12].

Handling of surfactants for use, formulation or production needs simple, reliable analytical technique to determine their

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