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STUDY OF THE CLOUD POINT OF NONIONIC SURFACTANT AND NONIONIC-CATIONIC SURFACTANT MIXTURE: EFFECT OF ELECTROLYTES

Çiğdem KARTAL, Halide AKBAŞ
Department of Chemistry, Faculty of Sciences and Letters,
Trakya University, 22030, Edirne, Turkey

ABSTRACT

Clouding phenomenon generally occurs with nonionic surfactants when the temperature of the system is raised to a certain value. This critical temperature is termed the cloud point (CP). The aqueous solutions of nonionic surfactants show complex phase behaviour including liquid-liquid phase separation at this temperature. The cloud point of aqueous surfactant solutions is influenced by the presence of other materials. In this study, we used cetyltrimethylammonium bromide (CTAB) as cationic surfactant and polyoxyethylene (10) lauryl ether ($C_{12}EO_{10}$) as nonionic surfactant. We report the effect of electrolytes (NaCl, KCl, $CaCl_2$ and MgC_{l2}) on the CP of nonionic surfactant and nonionic with cationic surfactant mixture. All the electrolytes have a large amount of effect on CP.

INTRODUCTION

Surfactants contain both hydrophobic and hydrophilic regions, which make possible molecular aggregate disolution in water. This amphiphilic molecules form dynamic aggregates namely micelles, which makes the solubilization of water-insoluble molecules in an aqueous matrix possible [1, 2].

Clouding is a phenomenon familiar in nonionic surfactants; upon raising the temperature, the system becomes cloudy and phase-separates at a well-defined temperature. The phase separation in nonionic micellar solutions is due to the van der Waals attractive forces between the micelles, and there exists a temperature at which the degree of hydration of the hydrophilic portion is just insufficient to solubilize the remaining hydrocarbon portion. At this temperature, surfactant is no longer soluble in water and solution becomes hazy and cloudy. Nonionic surfactants are widely used as solubilizers, emulsifiers and detergents in many industrial processes. Furthaermore, they are used as auxiliaries improving dye adsorbtion and levelling or dispersing agents [3, 4, 5]. Therefore, the cloud point (CP) data are of considerable practical

interest and also this parameter is important, for example, when designing detergents for use in hot water.

Many research activities have been focused on mixed systems of anionic-anionic, cationic-cationic and ionic-nonionic surfactants but systematic investigations of cationic-anionic surfactant mixtures are sparse. Mixtures are usually preferred in commercial applications not only due to the increased expense with pure surfactant preparations but also because mixed systems often exhibit enhanced properties through synergism. In this study, we report the effect of kind and concentration of electrolytes on CP nonionic surfactant and cationic-nonionic surfactant mixture.

MATERIALS AND METHODS

Cationic surfactant, cetyltrimethylammonium bromide (CTAB) and the electrolytes (NaCl, KCl, $MgCl_2$ and $CaCl_2$) were supplied by Merck. Nonionic surfactant, polyoxyethylene (10) lauryl ether ($C_{12}EO_{10}$) was received from Aldrich.

$CH_3\ (CH2)_{15}N^+\ (CH_3)\ Br$ **(CTAB)** $C_{12}H_{25}\ (OCH_2CH_2)_{10}OH$ **($C_{12}EO_{10}$)**

Cloud points of surfactant solutions were determined visually noting the temperature at which the turbidity was observed.

RESULTS AND DISCUSSION

For the $C_{12}EO_{10}$ / CTAB / NaCl system, results obtained after CP formation are shown in Fig. 1. When only $C_{12}EO_{10}$ was used a temperature as 89 ^oC for CP was obtained. When CTAB was added to system (0.01, 0.02 and 0.04 % w/v), without NaCl addition, the CP of $C_{12}EO_{10}$ – CTAB mixtures was above 100 ^oC. According to the literatures, the CP of nonionic surfactants was dramatically increased with small amounts of ionic surfactants. As the ionic surfactant molecules are added to the system, part of them is incorporated into the nonionic micelles, thus charging the micelle surface. This increases the micelle-micelle repulsion and makes the micelles more hydrophilic [6, 7].

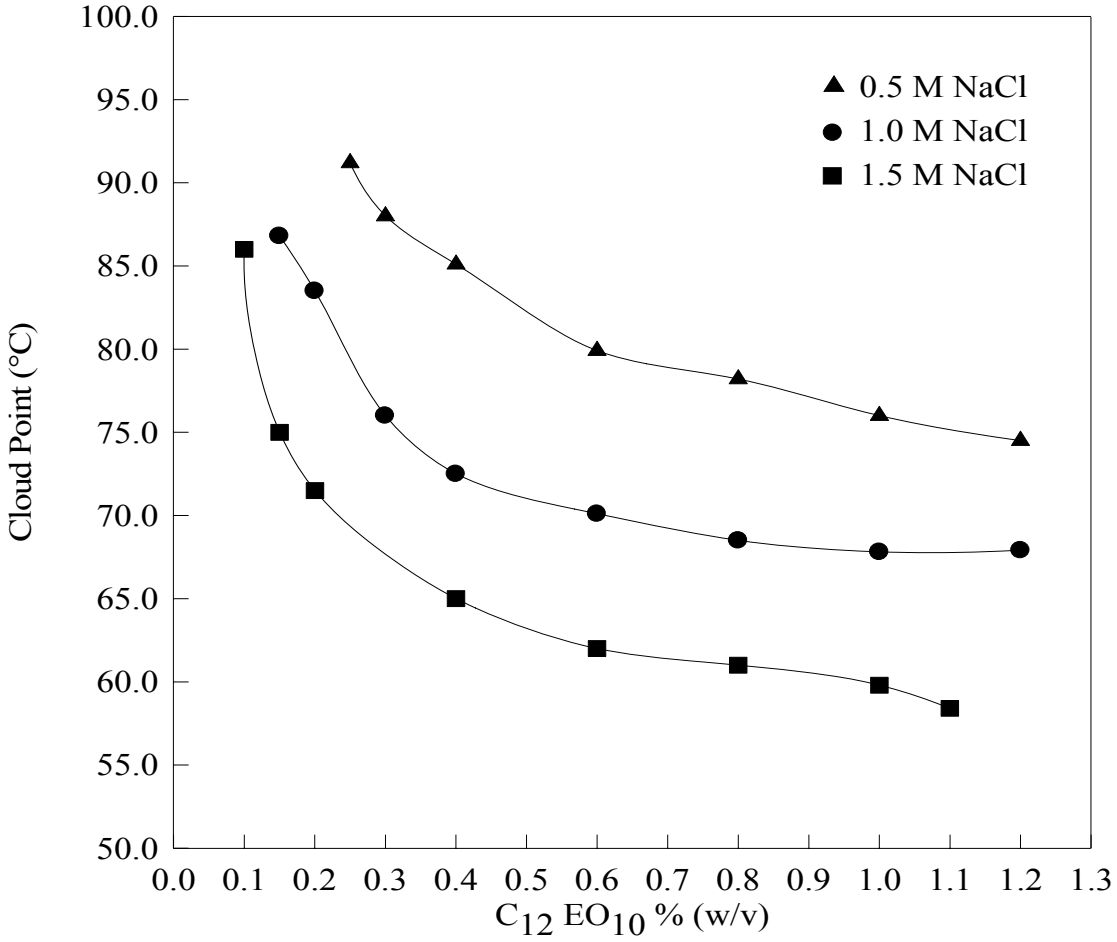

Figure 1: *Effect of NaCl concentrations on cloud point using $C_{12}EO_{10}$ solutions at different concentrations*

The electrolyte effect on the CP from mixed nonionic-ionic surfactant systems plays an important role. When small amounts of inorganic salts are added to the system, a decrease in the CP was noted. If the concentration of the added electrolyte is high enough, the cloud points of some mixed systems could be even lower than those of pure nonionic surfactant solution. The addition of electrolytes affects both the hydration amount and the properties of hydration water. The influence of electrolytes can be separates into the effect of cations and that of anions. In the Fig. 2, the effect of NaCl, KCl, $CaCl_2$ and $MgCl_2$ on the CP of $C_{12}EO_{10}$ (1% w/v) are shown.

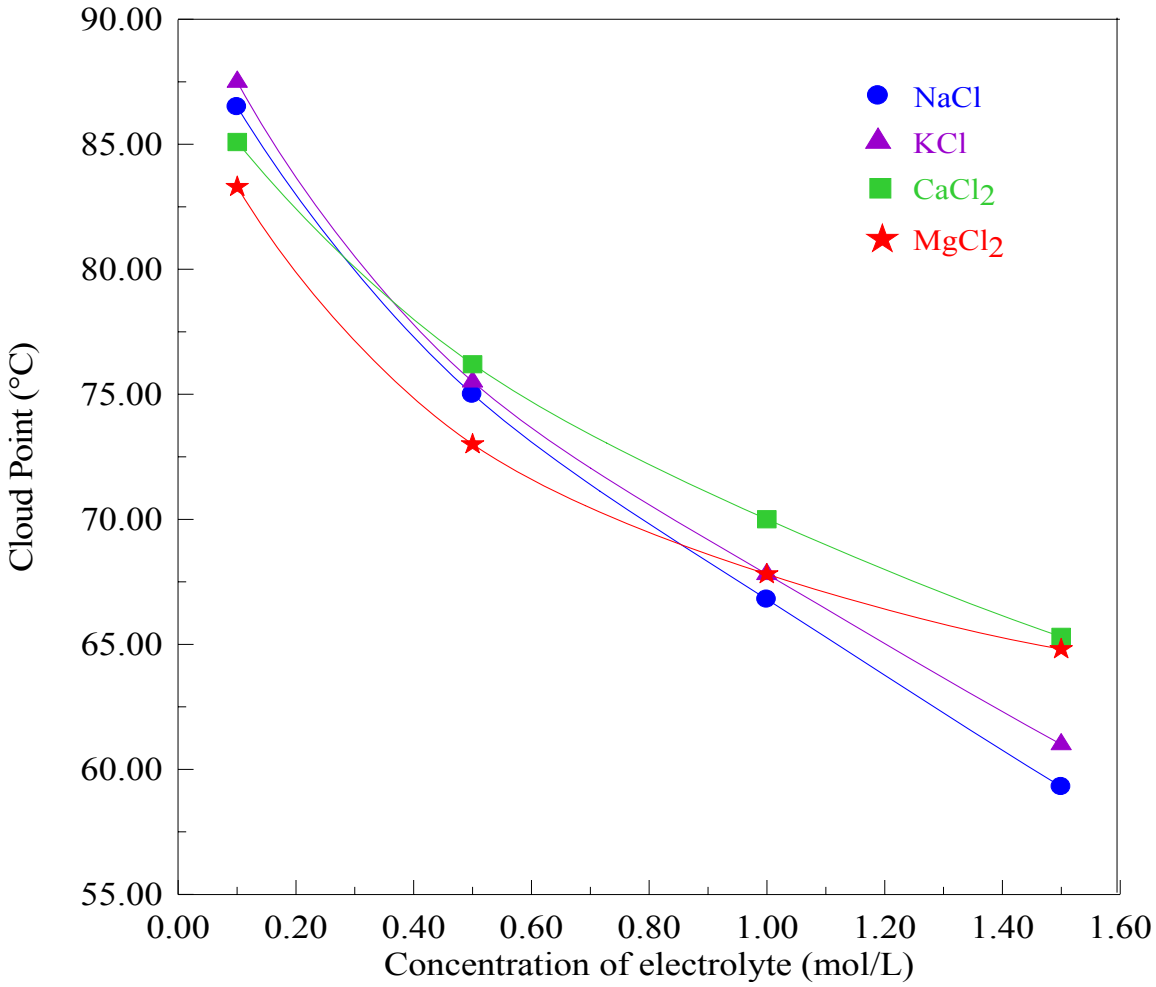

Figure 2: *Effect of different electrolytes on the CP of $C_{12}PO_{10}$ (1% w/v).*

The CP of $C_{12}PO_{10}$ – CTAB mixed surfactant system in presence of NaCl and KCl decreases and these electrolytes have almost similar effect on the CP of $C_{12}PO_{10}$ in all electrolyte concentrations. In the small electrolyte concentrations, $MgCl_2$ be of the higher effect than other electrolytes but in the high electrolyte concentrations, its effect decreases. $CaCl_2$ has the smallest effect and the CP of $C_{12}PO_{10}$ lower decreases.

REFERENCES

1. E. Pellizzetti, E. Pramauro, Anal. Chem. Acta, 169 (1985) 1
2. M. F. Silva, L. Fernandez, R.A. Olsina, D. Stacchiola, Anal. Chem. Acta, 342 (1997) 229
3. J.B. Hayter, M. Zulauf, Colloid Polym. Sci., 260 (1982) 1023
4. H. Akbaş, Ç. Kartal, Spectrochim. Acta A, 65 (2006) 95
5. T. Gu, S. Qin, C. Ma, J. Colloid Interf. Sci., 127 (1989) 586
6. C.C. Nascentes, M.A. Z. Arruda, Talanta, 61 (2003) 759
7. T. Gu, P.A. Galera-Gomez, Colloids Surf. A, 104 (1995) 307