

An integrated study on solubility, solubilization and pH of aqueous transition metal dodecylsulphates

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ABSTRACT

The present study deals with the measurements on solubility, solubilization and pH of aqueous transition metal [Cr(II), Mn(II), Fe(II), Co(II)] dodecylsulphates. The dissolution of these compounds in water has been found to be endothermic. The observed variation of solubility (mol dm^{-3}) for different compounds is as : Cr(II)DS > Co(II)DS > Mn(II)DS > Fe(II)DS. The observed common Krafft point is 40°C, which is obtained as inflection point in log S vs 1/T plots. Thermodynamic parameters for dissolution *i.e.*, ΔH_{sol} (kJ mol^{-1}) and ΔS_{sol} ($\text{JK}^{-1} \text{mol}^{-1}$) have been computed for these systems below and above the Krafft point. The spontaneous dissolving of a normally water insoluble substance with the help of a surfactant is termed solubilization. The observed maximum additive concentration (MAC) suggests that the solubility of 1-butanol and 2-methyl-1-propanol in water increases in presence of these surfactants. Sigmoid plots of MAC vs concentration are only in agreement with solubility vs. temperature plots for endothermic dissolution. It is observed that the plots of pH vs concentration indicate a rapid fall in pH upto the critical micelle concentration, cmc. The results suggest that the hydrolysis of these compounds occur mainly at lower concentration (premicellar region) and that the hydrolysis is subdued as the surfactant concentration increases while becoming almost negligible in the vicinity of c.m.c.

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Research workers in the past (Benatti, 2007; Bhat *et al.*, 2006 and Boonchan, 1998) have studied various aspects of solubility behaviour observed for different surfactants in various solvents. Recently, the versatility of solubility measurements has been indicated through a number of research studies (Cante *et al.*, 1975; Connor and Ottewill, 1971 and Cserhati and Forgacs, 1995). The phenomenon of solubilization is however of great interest from theoretical as well as practical point of view and many aspects thereof have been accordingly reviewed (Dar *et al.*, 2007 and Fuangswasdi *et al.*, 2007). The important consequences of solubilization employing various surfactant systems were examined by a number of research workers (Goldsipe and Blankschtein, 2006, 2006; Irani and Callis, 1960; Kleves, 1950 and Mehta *et al.*, 1979). There is however no dearth of *recent references* (Mc Bain *et al.*, 1948; Naeen *et al.*, 2006; Park and Choi, 2006; Patton and Lindlow, 1953 and Paul and Mitra, 2005) on enhanced solubilization using various kinds of surfactants.

The difficulty faced by Mc Bain in measuring the pH of the salts of normal fatty acids was due to the fact that hydrolysis began to play a part in many dilute solutions. Again, the turbidity of soap solutions may be attributed to the hydrolysis of soap solutions. Research workers in the past (Pohle, 1941; Ranjan *et al.*, 2006; Roig *et al.*, 1997; Steinharat *et al.*, 1977 and Strataki *et al.*, 2007) have

studied adsorption and cmc determination for various anionic surfactant systems. Also, the recent references (Tamamushi and Tamaki, 1959; Tsuji *et al.*, 1982; Van Eeden, 2004; Winsor, 1948 and Yao, 2007) conclusively prove the versatility of pH measurements employing different surfactant systems.

MATERIALS AND METHODS

As the dodecylsulphates of Cr, Mn, Fe, Co are not commercially available, these compounds were all prepared in our laboratory using GR grade (Merck/BDH) chromium oxide, manganese acetate, ferric chloride, cobalt nitrate, sodium dodecylsulphate and toluene. The respective dodecylsulphates were prepared by refluxing the stoichiometric amounts of chromium oxide/manganese acetate/ferric chloride/cobalt nitrate with sodium dodecylsulphate in toluene for about 5-6 hrs. The products so obtained were washed with methanol-benzene and vacuum dried. The crystalline grey-green chromium, grey-brown manganese, dull-brown iron and light-pink cobalt dodecylsulphates thus obtained were found to decompose in the temperature range, 220-270°C. The synthesis and the purity of the compounds were confirmed by CHNS (elemental) and IR techniques.

For solubility measurements, the saturated solutions of aqueous transition metal dodecylsulphates were prepared by vigorous shaking of the excess salt in water