The effect of salt and temperature on the liquid-liquid phase diagrams of aqueous Polypropylene Glycol + Salt Solutions

Rahmat Sadeghi, Bahman Jamehbozorg
(bj_chem60@yahoo.com) (rsadeghi@uok.ac.ir),
Department of Chemistry, University of Kurdistan, Sanandaj, Iran

Introduction

Ternary aqueous solutions of water soluble polymers and certain electrolytes separate into a polymer-rich and a salt-rich phase over part of the composition space. Aqueous two-phase systems of this nature are useful for the separation and purification of biomaterials where the employment of a nonpolar solvent/aqueous phase system would lead to degradation of biological activity [1,2]. Polyethylene glycol (PEG), which is a hydrophilic polymer, is often used in aqueous two-phase partitioning studies. Polyethylene glycol (PPG) is a water-soluble polymer which has a similar structure with PEG, can also be used for the separation of biomolecules, since its aqueous solutions with a suitable polymer or a salt forms a two-phase system. Liquid-liquid equilibrium (LLE) data for some aqueous PPG + salt two-phase systems have been reported only at 298.15 and there is no report on the effect of temperature on the phase diagrams of aqueous PPG + salt systems in the literature. In this work, the phase diagrams and LLE data have been determined for aqueous two-phase systems containing PPG and sodium phosphates at various temperatures. The effect of temperature, anion charge and type of polymer on the phase diagrams and LLE data of investigated systems have been studied. Finally, the segment based local composition Wilson model [3,4] has been applied to correlate the experimental LLE data of investigated aqueous two-phase systems.

Keyword: Thermodynamic, Liquid-liquid equilibrium

Experimental

PPG with a quoted molar mass 400 was obtained from Flucka. Sodium phosphates were obtained from Merck. The polymer and salts were used without further purification, and double distilled, deionized water was used. The experimental apparatus employed is essentially similar to the one used previously [5-7]. A glass vessel, was used to carry out the phase equilibrium determinations. The glass vessel was provided
with an external jacket in which water at constant temperature was circulated using a thermostat. The binodal curves were determined by a titration method. A salt solution of known concentration was titrated with the polymer solution or vice versa, until the solution turned turbid. The composition of the mixture was determined by mass using an analytical balance with a precision of ±1 \cdot 10^{-7} \text{ kg}. To determine the compositions of coexisting phases, feed samples were prepared by mixing appropriate amounts of polymer, salt and water in the vessel. The thermostat was set at a desired temperature, and the sample was stirred for 1 h. After separation of the two transparent phases, the concentrations of the salts in the top and bottom phases were determined by flame photometry. The concentration of polymer in both phases was determined by refractive index measurements performed at 298.15 K.

Results and discussion

For the aqueous PPG_{400} + sodium phosphates two-phase systems, the binodal curve and the tie line data for the compositions of conjugate solutions have been obtained at 298.15, 303.15, 308.15, 313.15 and 318.15 K. It was found that the two-phase area is expanded with increasing temperature. In other words, if we take a sample with a known composition on the binodal curve, this mixture becomes a two-phase system at increasing temperature as has been observed experimentally. The results show that increasing the charge on the anion from -1 (H_{2}PO_{4}^{-1}) to -3 (PO_{4}^{3-}) lowers the salt concentration at which phase separation occurs. This trend has also been observed for aqueous PEG-salt [6] and PVP-salt [7] systems with the same phosphates. Furthermore, the extended local composition model Wilson has been used to correlate the phase behavior of the investigated systems.

References
