

New approaches to aqueous polymer systems: Theory, thermodynamics and applications to biomolecular separations

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Abstract – A summary is presented of the main qualitative features of aqueous two-phase systems. Some aspects of the application of such systems to biomolecular separation are discussed. A brief description of a recent theoretical approach to aqueous two-phase systems based on statistical geometrical concepts is considered and some links are made to measurable thermodynamic properties.

Some polymer-polymer pairs or polymer-inorganic salt pairs, when in a "good" solvent, can form two immiscible homogeneous liquid phases.^{1,2} If the solvent is water, we call the systems formed "aqueous two-phase systems." Fig. 1 illustrates these two types of aqueous two-phase systems with typical compositions.

Examples of other pairs of polymers which form aqueous two-phase systems include: Dextran + Ficoll, and polyethylene glycol + Ficoll, polyvinylalcohol.* Other examples of polymer + salt aqueous two-phase systems are (see also ref. 2 and 3): methoxypolyethylene glycol + potassium phosphate, polyvinylpyrrolidone + potassium phosphate, polyethylene glycol + sodium sulphate, polyethylene glycol + sodium carbonate and polyethylene glycol + sodium chloride.

Special types of aqueous two-phase systems are those containing polyoxyethylene detergents.⁴ The formation of these systems arises from the inverse temperature/solubility behaviour of non-ionic detergents carrying polyoxyethylene groups as the hydrophilic moiety. On raising the temperature above room temperature phase separation occurs. In the two resulting phases, one is a detergent rich coacervated phase and the other is the water rich depleted phase. Terstappen *et al.*⁵ have systematically and quantitatively studied protein partitioning in

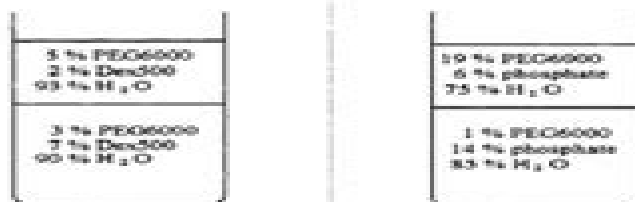


Figure 1 An illustration of the typical phase compositions of PEG 6000+Dex500 and PEG 6000+phosphate aqueous two-phase systems. The concentrations shown are based on weight.

* Usually polyethylene glycol (PEG) is a linear polymer and has the structural unit $-(CH_2CH_2O)-$. Methoxypolyethylene glycol has one end of the PEG molecule methoxylated. Dextran is composed predominantly by poly(α -1,6-glucose), Ficoll is a nonionic synthetic polymer of sucrose, polyvinyl alcohol has the structural unit $-(CH_2CHOH)-$.

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