

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

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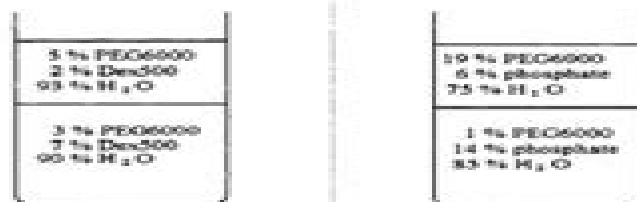
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**Abstract** – A summary is presented of the main qualitative features of aqueous two-phase systems. Some aspects of the application of such systems to biomolecular separation are discussed. A brief description of a recent theoretical approach to aqueous 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.<sup>1,2</sup> 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.<sup>4</sup> 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.*<sup>5</sup> 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( $\alpha$ -1,6-glucose), Ficoll is a nonionic synthetic polymer of sucrose, polyvinyl alcohol has the structural unit  $-(CH_2CHOH)-$ .

# Chapter 6 Aqueous Thermodynamics Oli Systems

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## **Table of Contents Chapter 6 Aqueous Thermodynamics Oli Systems**

1. Understanding the eBook Chapter 6 Aqueous Thermodynamics Oli Systems
  - The Rise of Digital Reading Chapter 6 Aqueous Thermodynamics Oli Systems
  - Advantages of eBooks Over Traditional Books
2. Identifying Chapter 6 Aqueous Thermodynamics Oli Systems
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Chapter 6 Aqueous Thermodynamics Oli Systems
  - User-Friendly Interface
4. Exploring eBook Recommendations from Chapter 6 Aqueous Thermodynamics Oli Systems
  - Personalized Recommendations
  - Chapter 6 Aqueous Thermodynamics Oli Systems User Reviews and Ratings
  - Chapter 6 Aqueous Thermodynamics Oli Systems and Bestseller Lists
5. Accessing Chapter 6 Aqueous Thermodynamics Oli Systems Free and Paid eBooks
  - Chapter 6 Aqueous Thermodynamics Oli Systems Public Domain eBooks
  - Chapter 6 Aqueous Thermodynamics Oli Systems eBook Subscription Services
  - Chapter 6 Aqueous Thermodynamics Oli Systems Budget-Friendly Options
6. Navigating Chapter 6 Aqueous Thermodynamics Oli Systems eBook Formats
  - ePub, PDF, MOBI, and More
  - Chapter 6 Aqueous Thermodynamics Oli Systems Compatibility with Devices
  - Chapter 6 Aqueous Thermodynamics Oli Systems Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Chapter 6 Aqueous Thermodynamics Oli Systems
  - Highlighting and Note-Taking Chapter 6 Aqueous Thermodynamics Oli Systems
  - Interactive Elements Chapter 6 Aqueous Thermodynamics Oli Systems

8. Staying Engaged with Chapter 6 Aqueous Thermodynamics Oli Systems
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Chapter 6 Aqueous Thermodynamics Oli Systems
9. Balancing eBooks and Physical Books Chapter 6 Aqueous Thermodynamics Oli Systems
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Chapter 6 Aqueous Thermodynamics Oli Systems
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Chapter 6 Aqueous Thermodynamics Oli Systems
  - Setting Reading Goals Chapter 6 Aqueous Thermodynamics Oli Systems
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Chapter 6 Aqueous Thermodynamics Oli Systems
  - Fact-Checking eBook Content of Chapter 6 Aqueous Thermodynamics Oli Systems
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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