# PHYSICAL SCIENCES

## THE EFFECT OF A NUMBER OF INORGANIC SALTS ON THE PHYSICAL-CHEMICAL CHARACTERISTICS OF THE PEG-DEXTRAN-WATER BIPHASIC SYSTEM

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**Abstract**
The presented work is dedicated to the exploration, acquisition, and investigation of two-phase water-polymer systems possessing specific characteristics relevant to concrete application areas. The study examines the impact of several inorganic salts (NiSO4, CoSO4, and MnSO4) on phase separation processes in PEG-dextran-water two-phase systems. Additionally, the structural temperatures of these salts in water have been determined.

**Keywords:** Polyethylene glycol, dextran, water-polymer two-phase system, binodal curve, critical point, structural temperature.

As known [1], when two different polymers are dissolved in water, at values greater than certain concentrations of these polymers, the homogeneous solution separates into two phases, a homogeneous-heterogeneous phase transition occurs. When any substance is introduced into such a system, the added substance distributes unequally between the phases of the system [2]. Such non-equilibrium distribution allows for separating biological particles (such as viruses, bacteria, cells, etc.) from each other, creating opportunities for individual study and analysis. Due to its simplicity, cheapness and practical importance, the application areas of this method have expanded significantly in recent times [3].

The presented work investigates the effect of adding inorganic salts ($NiSO_4$, $CoSO_4$, and $MnSO_4$) at various concentrations to the PEG-dextran-water two-phase system, while keeping the anion constant. A phase diagram is used to characterize two-phase water-polymer systems. The phase diagram is defined by several parameters, namely the binodal curve, the critical point, the tie line, and the slope angle of the tie line. The "binodal curve" is the specific locus on the phase diagram that marks the points separating the homogeneous and heterogeneous regions of the system. Another characteristic of two-phase systems is the critical point, which is the point where the volumes and concentrations of phases in the two-phase system are equal.

Research has determined that increasing the concentrations of inorganic salts (NiSO4, CoSO4, and MnSO4) causes the binodal curve of the PEG-dextran-water two-phase system to move away from the origin coordinates. Increasing the concentration of salt and expanding the area of the homogeneous region has made the dissolution of polymers together in water easier. On the other hand, the concentrations of the components corresponding to the critical points of the binodal increase depending on the total salt concentration (weight concentration). This indicates the dispersing effect of added salt on the two-phase PEG-dextran-water system. To restore the phase separation process, it is necessary to add structuring polymers (both PEG and dextran are water structuring polymers) to the system. The obtained results can be easily explained by Samoylov's theory [4].

Additionally, the influence of the inorganic salts on the structure of water has been investigated. For this purpose, the viscometric method has been used to determine the structural temperature (Tstr) of water and solutions. As known [5], if the structural temperature of the solution is greater than that of pure water, the solute structures water; conversely, it disrupts the water structure. Using optimization methods, the structural temperatures of solutions with salts in water have been determined, and the results are presented in Table 1.

| **Solutions** | **$T_{str}$ (K)** |
|---|---|
| Pure water | 139 |
| $CoSO_4$ | 125 |
| $MnSO_4$ | 80 |
| $NiSO_4$ | 59 |

Since the structural temperature of pure water is Tstr = 139K, and the structural temperatures of all three salts (NiSO4, CoSO4, MnSO4) in water are lower than that of pure water, it follows that the solutes, namely the added salts NiSO4, CoSO4, and MnSO4, disrupt the structure of water.

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