Interaction between Polyvinylprrolidone and C.I. Basic Red 18
폴리비닐피롤리돈과 C.I. Basic Red 18의 상호작용

Sangchul Lee, Chonhee Jung, Tak Ko, Jinchul Hwang, Soomin Park

Pusan National University

1. Introduction

The interactions of water soluble bio and synthetic polymers with small molecules are important in the fields of biochemistry, pharmacology, dyeing chemistry and polymer science and technology. Studies on the interaction are ever increasing, and the knowledge in molecular level has reached to allow mankind to design certain molecules that interact with others as intended.

The author et al. had already reported the interaction of water soluble polymers with small molecules and interpreted cooperative binding mechanism by means of McGhee and von Hippel theory.

As an extension of a preceding work cooperative binding of C.I. Basic Red 18 with polyvinylpyrrolidone(PVP) in an acetate buffer solution was investigated at 25℃.

2. Experimental

Polyvinylpyrrolidone(PVP) sample was supplied by Dai-ichi Kogyo SeiyakuCo. and was purified by repeated precipitation from aqueous solution by ethanol. The dye used was C.I. Basic Red 18 kindly supplied by Hodogaya Chemical Co.. The dye was chosen for its high stability in boiling water in the pH range from 2-6. It was purified by recrystallized from dilute hydrochloric acid solution at 80℃.

The binding isotherm was determined by the dynamic dialysis technique. Dynamic dialysis experiments were carried out at 25℃. The dialyzed dye content was determined form absorbance measuring instrument using Shinadzu spectrophotometer with 1㎝ cell.

3. Results and Discussion

Isotherms of PVP-Red18 comprises data for the dynamic dialysis of Red 18 plotted as the total content of penetrant in cell(B), D_t against dialysis time, t. In the absence and presence of PVP polymer the plots are curvature over a wide range of concentration. The dialytic rate constant, K_f of Red 18 was determined from the plot, $-dD_t/dt$ versus t in the absence of polymer and the value of that was $7.00\times10^{-3}(\text{min}^{-1})$.

Dynamic dialysis of Dt vs t, PVP-Red18 system shows the results of the dynamic dialysis experiments in which Red 18 alone and in the presence of PVP was allowed to escape though the dialysis membrane. The shape of the isotherms is partition and suggests strongly that the binding involves a non-cooperative mode. The isotherms of PVP-Red18 is changed into Scatchared polt. To interpret the results MaGhee and Von Hippel's equation was applied. From the intercepts on the ordinate and abscissa, K was estimated. From the calculated data intrinsic binding constant was 63.4 l/basemol. In interaction system of PVP and Red 18, cooperative interaction was not seen .

The thermodynamic parameters for the complex formation of the dyes-polymer can be calculated from their temperature dependences of the intrinsic binding constant and the cooperative binding parameter. From the Van's Hoff plots of ln(K) versus the reciprocal absolute temperature thermodynamic parameters were obtained at 30℃.

The binding process is accompanied by an exothermic enthalpy change and an entropy gain. The main component of the free energy change of the polymer-dye binding is largely the negative enthalpy of the binding, predominating over a positive entropy contribution, negative value of ⊿G in the dye-dye interaction increased with increasing temperature.

This is characteristic of the hydrophobic interaction. All positive ⊿S is likely to the disruption of highly ordered water.

Table 1. Thermodynamic parameters for binding of Red 18 by PVP

Binding constant (l/basemol)	Temp (℃)				⊿G (KJ/mol)	⊿H (KJ/mol)	⊿S (J/deg)
K	20	30	40	50	-9.8	-8.0	4.2
	65.0	63.4	55	41			

Reference

1. I.M. Klotz, Ann. N. y. Acad. sci., 226, 18-35(1973)
2. J. steinhardt and J.A. Reymalds, "Multiple Equilibria in proteins", Academic P., (1969)