

The effect of anionic surfactant on the fluorescence of polyvinylpyrrolidone in water



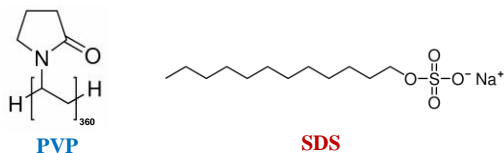
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Introduction

Polyvinylpyrrolidone (PVP) is a nonionic synthetic polymer often employed in drug formulations. Due to its hydrophilicity, it is often found in aqueous solutions where it can act as a solubilizing agent for organic molecules with poor water solubility.¹ Interestingly, **PVP** also exhibits fluorescence in water.^{2,3} In this poster, we examine the effect of an anionic surfactant, **sodium dodecyl sulfate (SDS)**, on **PVP** fluorescence. We found that **SDS** anions bind to **PVP** chains and increase **PVP** fluorescence intensity as we increase **SDS** concentration.



Results and Discussion

Fluorescence of PVP

PVP is observed to exhibit significant fluorescence, with maximum intensity at 384 nm, when the excitation wavelength is 310 nm. Fluorescence intensity increases linearly with PVP concentration (see **Fig 1**).

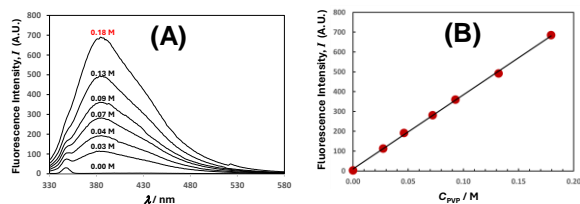


Figure 1. (A) Fluorescence intensity spectra of PVP in water at room temperature (excitation wavelength, 310 nm; width of slits, 5 nm). (B) Fluorescence intensity, I , as a function of PVP molar concentration, C_{PVP} (based on monomer molecular weight). Solid line is a linear fit through the data.

PVP fluorescence intensity increases with SDS concentration

Fluorescence intensity of PVP was measured at $C_{PVP} = 0.18$ M as a function of SDS concentration (see **Fig 2**). At low SDS concentration (C_{SDS}), I linearly increases with C_{SDS} . However, I becomes approximately constant at high C_{SDS} . The observed transition concentration was found to be somewhat higher than SDS critical micelle concentration (**CMC**).⁴ This behavior is consistent with SDS-PVP binding competing with SDS micellization.

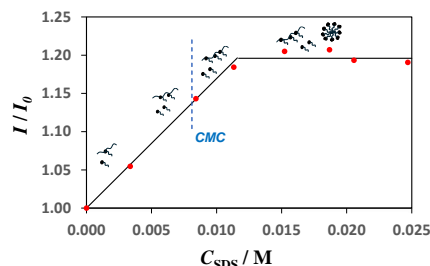


Figure 2. Normalized fluorescence intensity, I/I_0 , as a function of SDS concentration, C_{SDS} , at $C_{PVP} = 0.18$ M, where I_0 is I at $C_{SDS} = 0$. Values of I were obtained after removing residual fluorescence from corresponding SDS-water samples. The solid lines are I guides. The vertical dashed line identifies CMC of SDS.

Effect of PVP on SDS crystallization

SDS crystallization can be observed in water at 2 °C (below Krafft point). However, addition of PVP dramatically reduces SDS crystallization (see **Fig 3A**). Addition of NaNO_3 induces SDS crystallization at room temperature due to the common ionic effect. Addition of PVP also dramatically reduces SDS crystallization at room temperature (see **Fig 3A** and **3B**).

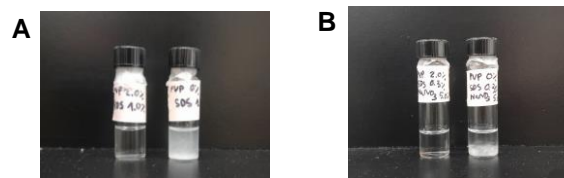


Figure 3. (A) Comparison between PVP-SDS-water (left), and SDS-water (right) samples at 2 °C. (B) Comparison between PVP-SDS-water (left), and SDS-water (right) samples in the presence of NaNO_3 0.60 M at room temperature.

Effect of NaNO_3 on PVP fluorescence

PVP fluorescence intensity dramatically decreases as NaNO_3 concentration, C_{NaNO_3} , increases. In the presence of SDS 0.010 M, the effect of C_{NaNO_3} on PVP fluorescence intensity is slightly reduced. This could be attributed to a competitive binding between NO_3^- and SDS anions.

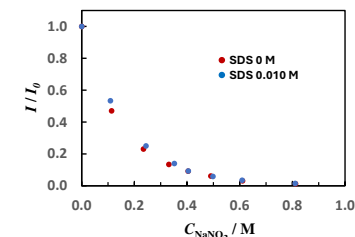


Figure 4. Normalized fluorescence intensity, I/I_0 , as a function of NaNO_3 concentration, C_{NaNO_3} , at $C_{PVP} = 0.18$ M and room temperature in the absence of SDS (●) and in the presence of SDS (0.010 M, ●).

Conclusion

- Fluorescence of PVP is found to increase with SDS concentration below CMC.
- Fluorescence behavior, crystallization assays, and related experiments with NaNO_3 support the hypothesis that SDS anions bind to PVP polymeric chains.
- Our results indicate that PVP fluorescence could be used to determine concentration of anionic surfactants in water below CMC.
- These studies will be extended to other types of anionic surfactants, including perfluoroalkyl substances (PFAS), which are relevant environmental chemistry.⁵

References

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