Research exercise: Solution Structures of Amphiphiles

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Solution Structures of Amphiphiles
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**Goal**
To determine amphiphile solution structure(s) at very small concentrations using electrochemical and transport measurements.

**Introduction**
- A better understanding of the interaction and solubilizing properties of micelles before critical micelle concentration (cmc) is reached is important.
- The ionic radii of SDS structures yield insights about the types of interactions that occur between SDS molecules before cmc is reached.
- Critical Micelle Concentration (cmc): concentration of surfactants above which micelles form and almost all additional surfactants added to the system go into micelle.

- Ferrocene (Fc) was used as an electrochemical probe since it demonstrates good solubility, invariant redox potentials, and excellent chemical and electrochemical reversibility in organic electrolytes.
- Fc should interact with the hydrophobic portions of the amphiphilic structures.

**Experimental**
- 0.08mM Fc and 17mM SDS solution prepared in a 500ml volumetric flask.
- The ratio of SDS to Fc was kept around 210 to ensure there was no more than one Fc per SDS aggregate.
- The solution was diluted by a factor of 0.1; each concentration was tested.
- CV Technique used to obtain the peak current of the Fc-SDS dilutions.
- Scan rate set at 4 V/s.
- Viscosity measurements taken on each dilution using a 50 Canon Capillary Viscometer.

**Results**

**Conclusions**
1) Viscosity increases with concentration
2) Diffusion coefficient:
   - Most dilute concentrations, D increases with concentration until it reaches a maximum
   - D decreases with increasing concentration until cmc
   - Above cmc, D stays relatively constant
3) Ionic radii increases with concentration, at most dilute concentrations, implying more complex/larger structures

**Reactions**

\[ \text{Fc} \leftrightarrow \text{Fc}^+ + e^- \]
\[ \text{Fe}^{2+} \leftrightarrow \text{Fe}^{3+} + e^- \]

**Equations**
- **The Randles-Sevcik**: Cyclic Voltammetry (CV) Technique used to obtain the peak current of the SDS structures; the diffusion coefficient of the structures was then obtained.
  \[ I_p = 2.69 \times 10^9 n^{1/2} A D^{1/2} \sqrt{v} \]
- **Stokes-Einstein**: Computes ionic radii after obtaining measured solution viscosities and diffusion coefficients
  \[ a = k_B T/6 \pi \eta \]

**References**