Electrochemical Investigations of Benzanthrone

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1. Abstract
- Cyclic Voltammetry (CV) and differential pulse voltammetry (DPV) of benzanthrone, an environmental pollutant, was studied in an acetonitrile solution with a 0.15 M tetrabutylammonium hexafluorophosphate as the background electrolyte.
- Benzanthrone concentrations of 0.5, 1.0, 1.5, and 2.0 mM were studied at 50, 100, 200, 500, 1000 and 2000 mV/s scan rates, or n.
- With increase in scan rates up to 200 mV/s the reversibility of benzanthone began shifting, indicating a change in the electron transfer rate constants for low concentration solutions.
- At higher scan rates (500 - 2000 mV/s), quasi-reversible reactions, i.e., $I_p / I_{sp} > 1.5$, were observed.
- For the 0.5 and 1.0 mM benzanthone concentrations and higher scan rates, the reductive reaction at the surface of the electrode is not diffusion-controlled alone.
- At higher concentrations (1.5 and 2.0 mM), the cathodic peak/ anodic peak current ratio ($I_{pa} / I_{pa}$) stays close to one, with average $I_{pa} / I_{pa}$ ratios of 0.986 and 1.161 respectively, indicating a diffusion controlled, reversible reaction at the electrode surface.

2. Reasons for Study
1. Polycyclic aromatic hydrocarbons, PAHs, contain multiple fused aromatic rings such as benzene.

Naphthalene  Benzo(a)pyrene
2. PAH form from the incomplete combustion of solid and liquid fuels such as coal, kerosene, and wood, as well as other organic matter.
3. These compounds are found everywhere and many people are at risk of exposure.

3. Materials and Methods
3.A. Methods
1. Cyclic Voltammetry
2. Differential Pulse Voltammetry

3.B. Materials
1. Benzanthrene, Sigma Aldrich, 98.0% purity
2. Acetonitrile, EM Science, 99.93% HPLC grade
3. Tetrabutylammonium hexafluorophosphate, Fluka Analytical, 99.0%

4. Results /Data
4.A. Cyclic Voltammetry

4.B. Differential Pulse Voltammetry (D.P.V.)

4.C. Shifting Reversibility

1.5 mM Benzanthrene at Various Scan Rates

2.0 mM Benzanthrene at Various Scan Rates

Linearity up to 200 mV/s is consistent with all of the concentrations, showing a reversible reaction until the scan rate exceeds beyond 200 mV/s.

5. Conclusion
- As concentration increased, the peak values of $I_{pc}$ and $I_{pa}$ increase as expected for all of the concentrations tested, 0.5, 1.0, 1.5, and 2.0 mM of benzanthone.
- The shift in linearity of $I_{pc}$ and $I_{pa}$ vs. square root of scan rate above 100 mV/s indicates a shift in the reversibility of the reduction/oxidation.
- The lowest limit of detection was determined to be 0.169 mM, confirming that the concentrations used in this study would be electrochemically active using D.P.V.
- Overall, the electron transfer that occurs in benzanthrene when potential is applied begins shifts as scan rate increases. This could be a change in the mechanism of the electron transfer. The higher scan rates, $500$ mV/s, produced irreversible electron behavior.

References

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