Electrochemical Degradation of Acetaminophen in the Presence of Different Redox Mediator Systems

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doi: 10.20964/2019.12.80

Received: 12 August 2019 / Accepted: 8 October 2019 / Published: 29 October 2019

This study focuses on the electrochemical degradation of acetaminophen (AP) in the presence of individual redox mediators. The oxidation peaks of Fe(II), Ag(I), and sulfate were detected on a Windsor boron-doped diamond (BDD) electrode in 1 M Na₂SO₄. The AP degradation performance using a single mediator was in the following order: Ce(IV) (from Ce(SO₄)₂) > Fe(III) (from Fe(NO₃)₃ or FeCl₃) > Co(II) (from CoCl₂) ≈ Ag(I) (from AgNO₃). *p*-BQ due to AP degradation was observed in 1 M Na₂SO₄ in the presence of Ce(IV) and Fe(III), while the former exhibited more and faster *p*-benzoquinone (*p*-BQ) generation than the latter. In the presence of individual mediators in 1 M Na₂SO₄ or NaNO₃, the performance of electrochemical AP degradation, *p*-BQ removal, and TOC mineralization on a Diachem BDD anode occurred in the following order: Fe(III) > Ce(IV) > Fe(II) ≈ Co(II) > Ag(I), but the performance decreased when replacing Na₂SO₄ with NaNO₃ as the electrolyte. The Cl₂/Cl⁻ redox mediator could also enhance AP degradation and TOC mineralization. The apparent pseudo first-order rate constants for AP electrochemical degradation in these solutions ranged from 2.92×10⁻⁴–4.34×10⁻² 1/s. An Fe(III) dosage of 100 ppm (Fe(III)/AP mole ratio = 2.7) at 0.25 A/cm² is suggested for this electrochemical process although Fe(III) dosage in the range of 50–500 ppm could be considered. Fe(III) has good potential for use in the electrochemical advanced oxidation process (EAOP) to significantly improve organic pollutant degradation performance.

Keywords: electrochemical degradation; acetaminophen (AP); *p*-benzoquinone (*p*-BQ); redox mediator; boron-doped diamond (BDD) electrode

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