Electrochemical Degradation of Acetaminophen in the Absence/Presence of Ce(IV)

Kuo-Lin Huang^{*}, Tzu-Ying Tang

Department of Environmental Science and Engineering, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan (ROC)

^{*}E-mail: huangkl@mail.npust.edu.tw

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This study investigates the degradation of acetaminophen (AP) using Ce(IV) oxidation with/without the aid of electrolysis on a Ti/PbO₂ anode in Na₂SO₄+H₂SO₄ solutions under different operating conditions. The results show that *p*-benzoquinone (*p*-BQ) is an intermediate generated from AP degradation. Increases in temperature (25–80°C) did not accelerate the degradation of AP but increased the rate of *p*-BQ degradation. The AP degradation efficiencies all achieved 100% within 2 min despite the difference in Ce(IV) concentration (100–4000 ppm) and initial AP concentration (AP₀ = 10–100 ppm). The *p*-BQ degradation was noticeably quicker at higher Ce(IV) concentrations than at lower ones at AP₀ = 10 ppm, while the optimal Ce(IV) concentration range was 375–500 ppm, which showed better *p*-BQ degradation rates than the other Ce(IV) concentrations at AP₀ = 100 ppm. At AP₀ = 10 mg/L, the increase in the current density without the addition of Ce(IV) increased the rate of AP degradation (pseudo-first-order rate constant (k) = 1.55×10^{-3} – 6.04×10^{-3} s⁻¹) and *p*-BQ formation/degradation at 0.5–1.5 A/cm² and 25°C, but the electrochemical degradation efficiency of AP decreased with an increase in temperature (20–80°C) (k = 1.55×10^{-3} – 3.58×10^{-4} s⁻¹). The AP degradation efficiency was lower using electrolysis alone at 0.5–1.5 A/cm² and 20–80°C than when using only Ce(IV) oxidation at 80°C. Compared with the Ce(IV) oxidation method (without electrolysis), the electrochemical plus Ce(IV)-mediated (E+Ce(IV)) process achieved faster *p*-BQ degradation at lower temperatures. This E+Ce(IV) process was also more efficient for AP degradation and *p*-BQ formation/degradation than electrolysis alone. At AP₀ = 100 ppm, 25°C, and 0.5 A/cm², the TOC removal (k = 8.83×10^{-5} – 1.65×10^{-4} s⁻¹) increased with increases in Ce(IV) concentrations (200–375 ppm) using the E+Ce(IV) process for AP degradation. For AP and *p*-BQ degradation, the Ce(IV) electrochemically regenerated from a spent Cr-etching solution was as good as the purchased one.

Keywords: degradation; acetaminophen (AP); *p*-benzoquinone (*p*-BQ); Ce(IV); PbO₂ electrode

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