Journal of Environmental Chemical Engineering
Volume 6, Issue 6, December 2018, Pages 7358-7367

Electrochemical oxidation of paracetamol in water by graphite anode: Effect of pH, electrolyte concentration and current density

Selvendiran Periyasamy [a], Muthukumar Muthuchamy [a, b]

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https://doi.org/10.1016/j.jece.2018.08.036

Highlights

- Degradation of paracetamol (>90%) by electrooxidation process using graphite electrode.
- Total degradation and mineralization (>82% COD removal & >65% TOC removal) at the end of 240 min of electrolysis.
- Effect of initial pH, electrolyte concentration (Na_2SO_4) and current density was a crucial parameters.
- Idendification of transformation products of paracetamol by HPLC.
- A pathway for paracetamol degrdation by hydroxyl radicals ($^{\bullet}OH$) based on reaction intermediates.

Abstract

Paracetamol is one of the micropollutant in water and most frequently used drugs as moderate pain reliever. These micropollutants are serious threat to human and environment. In the present investigation, we made attempt to degrade the electrochemical oxidation of paracetamol in water by graphite as anode. Electrooxidation behavior of paracetamol at graphite anode was tested by cyclic voltammetry technique performed in the potential range of -1.0 to +1.0 V versus Ag/AgCl. The optimized conditions were obtained by varying different factors, such as electrolyte concentration (0.02-0.1 M), current density (3.1–7.1 mA/cm^2), initial pH (4–8) and paracetamol concentration (20 mg L^{-1}). The results showed that the maximum removal of paracetamol concentration, chemical oxygen demand (COD) and total organic carbon (TOC) reached >90%, >82% and >65% after 240 min electrolysis at an initial pH 4, having paracetamol concentration of 20 mg L^{-1} at a constant current density of 5.1 mA/cm^2 with 0.1 M Na_2SO_4 supporting electrolyte. Different SO_4^{2-} concentrations in water promoted the electro generation of strong mediator oxidant species, such as $^{\bullet}OH$, $SO_4^{\bullet-}$ and $S_2O_8^{2-}$ increasing the removal efficiency of paracetamol. The degradation of paracetamol and its mineralization trend were monitored by UV–vis spectrophotometric method and total organic carbon (TOC) analyzer, respectively. FT-IR spectra confirmed that the functional group changes after electrolysis of paracetamol. HPLC studies revealed the byproduct (hydroquinone, benzoquinone and carboxylic acid) formation during the electrolysis process. On the other hand, researchers are actively involved in ozonation, photocatalysis, activated charcoal and biological treatments etc., to remove/degrade micropollutant, which are major drawbacks for the implications.

Graphical abstract