

Simultaneous degradation of 30 pharmaceuticals by anodic oxidation: Main intermediaries and by-products

Calzadilla, W.
Espinoza, L.C.
Diaz-Cruz, M.S.
Sunyer, A.
Aranda, M.
Peña-Farfal, C.
Salazar, R.

Abstract

The anodic oxidation (AO) of 30 pharmaceuticals including antibiotics, hormones, antihistaminics, anti-inflammatories, antidepressants, antihypertensives, and antiulcer agents, in solutions containing different supporting electrolytes media (0.05 M Na₂SO₄, 0.05 M NaCl, and 0.05 M Na₂SO₄ + 0.05 M NaCl) at natural pH was studied. A boron-doped diamond (BDD) electrode and a stainless-steel electrode were used as anode and cathode, respectively, and three current densities of 6, 20, and 40 mA cm⁻² were applied. The results showed high mineralization rates, above 85%, in all the tested electrolytic media. 25 intermediaries produced during the electrooxidation were identified, depending on the supporting electrolyte together with the formation of carboxylic acids, NO₃⁻, SO₄²⁻ and NH₄⁺ ions. The formation of intermediates in chloride medium produced an increase in absorbance. Finally, a real secondary effluent spiked with the 30 pharmaceuticals was treated by AO applying 6 mA cm⁻² at natural pH and without addition of supporting electrolyte, reaching c.a. 90% mineralization after 300 min, with an energy consumption of 18.95 kW h m⁻³ equivalent to 2.90 USD m⁻³. A degradation scheme for the mixture of emerging contaminants in both electrolytic media is proposed. Thus, the application of anodic oxidation generates a high concentration of hydroxyl radicals that favors the mineralization of the pharmaceuticals present in the spiked secondary effluent sample.

Author keywords

Anodic oxidation
Boron-doped diamond electrode
Hydroxyl radical
Pharmaceuticals
Secondary effluent