



# Enhancement of mineralization of metronidazole by the electro-Fenton process with a Ce/SnO<sub>2</sub>–Sb coated titanium anode

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## HIGHLIGHTS

- The electro-Fenton process effectively enhanced the mineralization of metronidazole.
- The optimum conditions for the electro-Fenton process were identified.
- A comparative analysis of MNZ toxicity and biodegradability between the EF and EC was assessed.
- EF process increased the biodegradability and decreased the toxicity of MNZ wastewater.

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## ABSTRACT

We compared the degradation behavior of metronidazole (MNZ) under advanced oxidation processes with the aim of enhancing the mineralization of MNZ. Among the advanced processes used, that is, Ce/SnO<sub>2</sub>–Sb/Ti electrochemical/anode oxidation (EC/AO), the Fenton and the electro-Fenton (EF) processes, the EF process was the most effective. Different input variables, including catalyst concentration, [H<sub>2</sub>O<sub>2</sub>]/[Fe<sup>2+</sup>] molar ratio, and pH level were evaluated to find the optimum condition for mineralization by EF treatment. The total organic carbon was optimally diminished by up to 37% by applying a Fe<sup>2+</sup> concentration of 2.0 mM, a [H<sub>2</sub>O<sub>2</sub>]/[Fe<sup>2+</sup>] molar ratio of 10:1, and a pH of 2.0. The change in biodegradation was investigated on the basis of the BOD<sub>5</sub>/COD<sub>cr</sub> ratio. The ratio of BOD<sub>5</sub>/COD<sub>cr</sub> of raw MNZ aqueous (0.227) was increased to 0.252 and 0.345 by the EC and EF systems, respectively. The general toxicity resulting from the different treatments for MNZ aqueous solution was assessed by the Photobacterium bioassay. The toxicity of the EF-treated solution decreased 63%, falling to an effectively non-toxic level, indicating that the EF process can decontaminate and mineralize MNZ into a non-toxic product. According to the BOD<sub>5</sub>/COD<sub>cr</sub> ratio, the EF process is a sufficiently powerful pretreatment technology that can increase the biodegradability and decrease the toxicity of wastewater containing MNZ, providing a favorable condition for subsequent biochemical treatment.

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## 1. Introduction

Metronidazole (MNZ) is a kind of nitromidazole antibiotic that has antibacterial and anti-inflammatory properties. MNZ has been widely used clinically to treat infectious diseases caused by anaerobic bacteria and protozoans, and it has also been used as an additive in poultry and fish feed to eliminate parasites. Residual concentrations in the high microgram per liter range have been found in hospital effluent and in the several tens of nanograms

per liter of municipal wastewater, surface water, and groundwater [1,2]. Because of the non-degradability, toxicity, potential mutagenicity, and carcinogenicity of MNZ [3], wastewaters originating from the production of MNZ and from industrial activities pose a major threat to the surrounding ecosystems and human health. Lanzky and Haning-Snrensen [4] reported that acute toxicity of MNZ was observed when it was tested on freshwater and marine organisms. Therefore, the elimination of MNZ from wastewater is of significant environmental, technical, and commercial importance.

Removal of MNZ from water is difficult due to its high solubility and refractory character, but removal can be achieved through methods such as sorption [5], photolysis [6], heterogeneous

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