Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2020.25772

193 (2020) 369–380
July

Photocatalytic degradation of metronidazole (MNZ) antibiotic in aqueous media using copper oxide nanoparticles activated by H_2O_2/UV process: biodegradability and kinetic studies

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Received 26 August 2019; Accepted 1 March 2020

ABSTRACT

Metronidazole (MNZ) has identified as a remarkable environmental pollutant since it is highly consumed and is resistant to biological degradation. This study was accomplished to assess the photocatalytic degradation of MNZ in aqueous media using copper oxide nanoparticles (CuO-NPs) activated by H_2O_2 in the presence of UV irradiation (UV/H_2O_2/CuO-NPs process). For this purpose, the laboratory-scale experiments were carried out in the 2.5 L batch reactor. The effect of operational parameters, that is, initial pH (3–11), the concentration of MNZ (25–100 mg/L), the concentration of H_2O_2 (10–40 mg/L), the concentration of CuO-NPs (2–8 mg/L), and reaction time (0–60 min) were also assessed. The results of this study clarified that under optimum conditions (pH = 3, H_2O_2 = 10 mg/L, $[MNZ]_0$ = 50 mg/L, CuO-NPs = 8 mg/L, and reaction time = 60 min), the removal efficiencies of MNZ, chemical oxygen demand (COD), and total organic carbon (TOC) using the UV/H_2O_2/CuO-NPs process were 98.36%, 73.0%, and 56.52%, respectively. According to the results, by increasing reaction time from 0 to 60 min, the AOS in the effluent was increased from 1.39 to 2.38, and the COD/TOC ratio was decreased from 1.74 to 0.8. The results related to parameters of the kinetics showed that the removal of MNZ antibiotic using the studied system conforms to the pseudo-first-order kinetics (R^2 = 0.983), and kinetics rate constant (k) was 0.0624 min^{-1}. This study provides UV/H_2O_2/CuO-NPs process as an innovative method to degrade the MNZ antibiotic and enhance its biodegradability. We concluded that the studied process can be used as an effective and eco-friendly method in the removal of MNZ antibiotics.

Keywords: Advanced oxidation processes (AOPs); Metronidazole antibiotic; Copper oxide nanoparticles; Hydrogen peroxide; Kinetic studies; Biodegradability

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