

Removal of Antibiotics from Hospital Wastewater Using TiO₂-Catalyzed Ozonation

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Abstract

This research examined the efficacy of ozonation and TiO₂-catalyzed ozonation for removing residual antibiotics from hospital wastewater. The wastewater samples were sourced from the centralized treatment system at Phranangklao Hospital, located in Nonthaburi Province, Thailand. Synthetic wastewater containing sulfamethoxazole (SMX) at an initial concentration of 5,000 ng/L was prepared as a representative antibiotic solution based on a previous SMX ozonation study by Guo et al. (2015), and was used to evaluate the effect of ozone dose on antibiotic degradation. Specifically, ozone concentrations of 2.8, 4.2, 5.6, and 7.0 mg/L were tested under a consistent contact period of 5 minutes. Following this, hospital wastewater, collected after undergoing secondary clarification, was subjected to treatment under three distinct conditions: ozonation alone, TiO₂ alone, and combined O₃/TiO₂. Ozone was applied at 2.8 mg/L, while TiO₂ anatase powder was used at 0.56 mg/L, equivalent to 20% of the ozone concentration. To analyze the outcomes, SMX was measured using HPLC, while other target antibiotics present in the actual wastewater were quantified utilizing LC-MS/MS-QTOF techniques. The results clearly indicated that the degradation of SMX was positively correlated with the ozone dose applied. In samples processed through solid-phase extraction (SPE), the residual SMX concentration reduced significantly from 76.3% to 23.5% as the ozone concentration increased from 2.8 mg/L to 7.0 mg/L, while the non-ozonated control retained 99.3%. In the context of hospital wastewater, ozonation proved effective in reducing various antibiotics, most notably ceftriaxone and quinolones. TiO₂ alone showed limited or negative removal, indicating low standalone effectiveness. Compared with ozonation alone, the combined O₃/TiO₂ process increased the removal efficiencies of ofloxacin, levofloxacin, trimethoprim, sulfamethoxazole, ampicillin, and ceftriaxone to 72.11%, 69.75%, 69.20%, 68.00%, 65.79%, and 62.12%, respectively. These findings indicate that TiO₂-catalyzed ozonation can enhance the removal of selected antibiotics from hospital wastewater.

Keywords: hospital wastewater; antibiotics; ozonation; titanium dioxide