Three-dimensional Electro-Fenton Oxidation of Landfill Leachate Concentrates Using MnO₂-doped TiO₂-coated Granular Activated Carbon as Catalytic Particle Electrodes

Jinxiang Fu¹, Xiang He^{1,*}, Jinghai Zhu², Wenyi Gu¹, Xiaoxi Li¹

¹ School of Municipal and Environmental Engineering, Shenyang Jianzhu University, Shenyang 110168, China

² School of Public Health, China Medical University, Shenyang 110000, China

*E-mail: syjhxiang@163.com

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A composite catalytic particle electrode (CPE) consisting of granular activated carbon (GAC)-coated MnO₂-doped TiO₂ (Mn-Ti-GAC) was prepared and applied in a three-dimensional electro-Fenton (3DEF) system to treat nanofiltration concentrates (NFC) from a municipal landfill in northeast China. The CPE samples were characterized by XRD, SEM-EDS, BET, and XPS analyses. The stability, reusability, and generation of hydroxyl radicals ($\cdot\text{OH}$) on the Mn-Ti-GAC particles in the 3DEF system were compared with other reported CPEs. Following optimization of the reaction conditions, including a current density of 15 mA/cm², Fe²⁺ concentration of 1 mmol/L, CPE concentration of 200 g/L, and an initial pH of 3, the removal efficiencies of the chemical oxygen demand and ammonia nitrogen were 84.68 % and 81.3 %, respectively. The refractory organic (i.e., humic acid and fulvic acid) removal efficiency was higher than that of the hydrophilic fraction due to the type of pore distribution in the Mn-Ti-GAC particles. The 24h-LC₅₀ biotoxicity of the NFC to *Artemia salina* decreased rapidly following treatment, and the five-day biological oxygen demand (BOD₅)/COD increased from 0.002 to 0.296 at the end of the reaction.

Keywords: Landfill leachate concentrates; Three-dimensional electro-Fenton; Mn-doped TiO₂; Dissolved organic matter; Biototoxicity

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