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Application of a novel plasma-based advanced oxidation process for efficient and cost-effective destruction of refractory organics in tertiary effluents and contaminated groundwater

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ABSTRACT

Corona discharge is emerging as a promising advanced oxidation process (AOP) for the treatment of a variety of organic contaminants, including compounds that are not effectively destroyed by more common AOPs. This paper presents laboratory and field results describing the destruction of regulated and Contaminant Candidate List (CCL) compounds in tertiary treated wastewater effluent and contaminated groundwater during the operation of a novel hydro-non-thermal-plasma (HNTP) AOP system. The system generates a plasma discharge above the target water matrix, which emits an "electron wind", ultraviolet (UV) irradiation, $O_{3(g)}$ and hydroxyl radicals (•OH) into a relatively thin water layer. The synergism between these oxidizing agents results in efficient degradation of refractory organics (typically >95%) rendering further chemical dosage unnecessary. Batch experiments revealed the dominating kinetics to be first order for MTBE ($k = 7.5\times10^{-4}$ s^{-1}) and TCE ($k = 4.8\times10^{-4}$ s^{-1}). This study is the first report of pilot-scale HNTP destruction of (mainly) TCE, 1,4-dioxane and NDMA from a contaminated water source (groundwater in California). The pilot-scale HNTP reactor showed high removal efficiencies of 95.3%, 91.7% and 95.3%, for these three contaminants, along with energy efficiency (EEO) values comparable to other AOP systems.

Keywords: AOP; Non-thermal plasma; MTBE; TCE; NDMA

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