Integrated Solar Photocatalytic Oxidation and Biodegradation for Degradation of Antibiotics and Endocrine Disrupting Compounds in Wastewater and Water

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Combination of solar light-driven photocatalytic oxidation with subsequent biodegradation demonstrates high potential for treating wastewater and water containing pharmaceutical and endocrine disrupting compounds. The long-term and low-dose exposures of aquatic organisms and humans to pharmaceutical and endocrine disrupting compounds in the environment can lead to adverse impacts such as endocrine disruption, toxicity, and antibiotic resistance.

Although various advanced oxidation processes have been applied to degradation various pharmaceutical and endocrine disrupting compounds in wastewater and water, these processes are usually expensive and may lead to more toxic intermediates and byproducts. Thus, combination of advanced oxidation with biological treatment is proposed as a cost-effective treatment option to achieve high removal and mineralization of these emerging contaminants. In this study the photocatalytic degradation of sulfamethoxazole (antibiotics, SMX) and bisphenol A (endocrine disruptor, BPA) were carried out in an aqueous suspension using a biochar-supported TiO_2 catalyst under solar light irradiation. The photocatalytic oxidation of SMX and BPA transformed these biocalcitrant contaminants into much more biodegradable products while eliminating toxic functional groups in these contaminants. Subsequently, the oxidative products of BPA and SMX were completely degraded by the bacteria isolated from different soils at University of Hawaii. Recent results showed that the solar photocatalytic oxidation of SMX and BPA showed the high removal of SMX and BPA (i.e., 93-98%) and their oxidative products (i.e., 40-80%) with 6-8 h irradiation of solar light. Besides, the following biodegradation by the isolated bacteria resulted in further degradation of the oxidative products of SMX and BPA to achieve complete mineralization of SMX and BPA in water. The biotoxicity tests also confirmed that the oxidative products of SMX and BPA had negligible toxicity and consisted of mostly nontoxic and biodegradable products.

Based on these results, combination of solar photocatalytic oxidation with biodegradation could be a sustainable and cost-effective technology for the remediation of biocalcitrant and emerging contaminants in wastewater and water.