Ultrasound-Assisted Advanced Oxidation Processes for Water Decontamination

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Dedicated to my Ph.D. students in the past and the present

Abstract. The study reflects a part of my experience in sonochemistry and ultrasound-assisted advanced oxidation processes (AOPs) acquired during the last fifteen years with my research team. The data discussed were selected from studies with azo dyes, endocrine disrupting compounds and analgesic/anti-inflammatory pharmaceuticals, which are all classified as "hazardous" or "emerging" contaminants. The research focused on their treatability by ultrasound (US) and AOPs with emphasis on the mineralization of organic carbon. Some of the highlights as pointed out in the manuscript are: i) ultrasound is capable of partially or completely oxidizing the above contaminant groups if the operating conditions are properly selected and optimized, but incapable of mineralizing them; ii) the mechanism of degradation in homogeneous solutions is •OH-mediated oxidation in the bulk solution or at the bubble-liquid interface, depending on the molecular properties of the contaminant, the applied frequency and pH; iii) US-assisted AOPs such as ozonation, UV/peroxide, Fenton and UV/Fenton are substantially more effective than ultrasound alone, particularly for the mineralization process; iv) catalytic processes involving TiO_2, alumina and zero-valent iron and assisted by ultrasound are promising options not only for the destruction of the parent compounds, but also for the mineralization of their oxidation byproducts. The degradation reactions in heterogeneous solutions take place mostly at the catalyst surface despite the high-water solubility of the compounds; v) sonolytic modification of the above catalysts to reduce their particle size (to nano-levels) or to decorate the surface with metallic nanoparticles increases the catalytic activity under sonolysis, photolysis and both, and improves the stability of the catalyst.

Keywords. AOPs; catalysis; nanocomposite; mineralization; •OH