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Editorial

Advanced Oxidation Processes for Water and Wastewater Treatment

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Technical and scientific developments have facilitated an increase in human life expectancy and quality, which is reflected in a large growth of global population. This process has been accompanied by economic development and an immense urbanisation level. This growth has been followed by over-exploitation of water resources and an increase in environmental pollution. Therefore, the rising demand for clean and safe water is a major challenge. Water scarcity, elimination of emerging contaminants and escalating need for water reuse allied to limited treatment capacity of conventional water and wastewater plants are major barriers that need to be appropriately addressed.

Water and wastewater treatment with Advanced oxidation processes (AOPs) have received a great deal of attention in recent years, since these processes are known for their capacity to mineralize a wide range of pollutants into CO_2, H_2O and mineral acids.

In this Special Issue, the application of AOPs as an effective solution for the treatment of drinking water and urban/industrial wastewater was addressed. The removal of pharmaceuticals and organic pollutants through electrochemical oxidation processes ([1–5]), combined coagulation and UV/O_3 ([6]), UV/H_2O_2 system ([7]) and heterogeneous catalysis ([8,9]) are the main topics covered in this issue. In addition, the degradation of an agro-industrial wastewater through heterogeneous photocatalysis using Zr on clay-based materials ([10]) is also part of this special issue.

Since the call for papers was announced in March 2020 and after a rigorous peer-review process, ten articles were accepted for publication (52% of total submitted papers). This Special Issue of Water comprises contributions from over fifty authors and from five countries (China, Germany, India, Portugal and Spain). To gain a better insight into the essence of the Special Issue, we offer brief highlights of the published papers below.

1. Recent Trends in Removal Pharmaceuticals and Personal Care Products by Electrochemical Oxidation and Combined Systems

This review paper [1] focuses on the removal efficiency of pharmaceuticals and personal care products through electrochemical oxidation, alone or in combination with other treatment processes, in the last 10 years. The influence of reactor designs and configurations as well as electrode materials and operational conditions (e.g., initial concentration, electrolytes, current density, temperature, pH, stirring rate, electrode spacing, and fluid velocity) are also explored.

2. A Comparison of the Mechanism of TOC and COD Degradation in Rhodamine B Wastewater by a Recycling-Flow Two- and Three-dimensional Electro-Reactor System

This research article [3] designs a recycling-flow 3D electro-reactor system for the degradation of a dye wastewater. The mechanism of TOC and COD degradation of Rhodamine B wastewater was analysed in terms of mass transfer, electrochemically active surface area of electrodes, instant concentration of hydroxyl radicals, current efficiency and energy consumption in comparison to the recycling-flow 2D electro-reactor system.

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3. Comparing the Effects of Types of Electrode on the Removal of Multiple Pharmaceuticals from Water by Electrochemical Methods

This work [2] investigates the effect of laboratory-scale electrochemical treatments on removing multiple pharmaceuticals (diclofenac, sulfamethoxazole and atenolol) from synthetic water and spiked wastewater by electro-coagulation and electro-oxidation using aluminium and graphite electrodes. The pharmaceutical removal with electro-oxidation was higher than those with the electro-coagulation process, which was obtained from a five-cell graphite electrode system, while the removal of pharmaceuticals with aluminium electrodes was about 20% (20 μM).

4. Removal Characteristics of Effluent Organic Matter (EfOM) in Pharmaceutical Tailwater by a Combined Coagulation and UV/O_3 Process

Coagulation and UV/O_3 processes are combined to remove the effluent organic matter from a biotreated pharmaceutical wastewater [6]. The removal behaviour of effluent organic matter by UV/O_3 process was characterized by synchronous fluorescence spectroscopy (SFS) integrating two-dimensional correlation (2D-COS) and principal component analysis technology. Five main components of pharmaceutical tail wastewater were identified by SFS. Spectral analysis revealed that UV/O_3 was selective for the removal of different fluorescent components, especially fulvic acid-like fluorescent (FLF) and humus-like fluorescent (HLF) components. The coagulation-UV/O_3 processes proven to be an attractive way to reduce the environmental risks of pharmaceutical tail wastewater.

5. Heterogeneous Fenton-Like Catalytic Degradation of 2,4-Dichlorophenoxyacetic Acid by Nanoscale Zero-Valent Iron Assembled on Magnetite Nanoparticles

Fe^0@Fe_3O_4 nanoparticles were synthesized in this study [9] and combined with hydrogen peroxide to obtain a heterogeneous Fenton-like system, which was further applied into the degradation of the 2,4-dichlorophenoxyacetic acid. The effect of different experimental conditions was assessed on the removal of 2,4-D, such as pH, hydrogen peroxide concentration, temperature and catalyst dosage. In addition, the possible mechanism of the Fe^0@Fe_3O_4 activated Fenton-like system was proposed.

6. Degradation of Ketamine and Methamphetamine by the UV/H_2O_2 System: Kinetics, Mechanisms and Comparison

The reaction kinetics and degradation mechanisms of ketamine (KET) and methamphetamine (METH) by UV/H_2O_2 are studied in this paper [7]. The influence of various operational parameters on KET and METH removal was evaluated: initial H_2O_2 dosage, pH and water background components. KET and METH degradation is inhibited by the presence of some anions (HCO_3^-, Cl^-, NO_3^-) and humic acid. The degradation products were analysed by UPLC-MS/MS, and potential transformation paths are proposed.

7. Oxidation of Selected Trace Organic Compounds through the Combination of Inline Electro-Chlorination with UV Radiation (UV/ECl_2) as Alternative AOP for Decentralized Drinking Water Treatment

In this study [4], a UV/ECl_2 system is tested in lab-scale conditions to assess chlorine production and radical formation changing chloride concentrations, pH, cell currents and UV energy input applied. Afterwards, a UV/ECl_2 pilot setting was tested under real conditions treating Elbe river water. The combination of ECl_2 with UV can be a feasible alternative to reduce Trace Organic Compounds without the need for any external chemicals and electricity supply.

8. Effect of Zr Impregnation on Clay-Based Materials for H_2O_2-Assisted Photocatalytic Wet Oxidation of Winery Wastewater

This work [10] successfully produced UV-activated Zr-doped composites through the impregnation of Zr on the crystal lattice of different clay materials (Zr-MT, (Zr)Al-PILC and (Zr)AlCu-PILC). The ((Zr)Al-Cu-PILC) photocatalyst was tested in the photodegradation of

a real winery wastewater under UV-C irradiation, and the influence of Zr immobilization on the properties and photoactivity of the heterogeneous catalysts was assessed.

9. Heterogeneous Catalytic Ozonation of Aniline-Contaminated Waters: A Three-Phase Modelling Approach Using TiO_2/GAC

In this publication [8], the catalytic ozonation of aniline promoted by granular active carbon doped with TiO_2 is modelled. A three-phase modelling approach is proposed including ozone mass transfer parameters and rate constants (pseudo-first order kinetics) from both surface and liquid bulk reactions involving the adsorption process, oxidation in the liquid and the solid catalyst.

10. Erythromycin Abatement from Water by Electro-Fenton and Peroxyelectrocoagulation Treatments

In this final work [5], electro-Fenton and peroxyelectrocoagulation processes were investigated to mineralize erythromycin from ultrapure water, assessing the influence of some operational conditions, such as the anode material (BDD and Fe), current density (5 mA cm^{-2} and 10 mA cm^{-2}), oxygen flowrate injected to the cathode (0.8 L min^{-1} O_2 and 2.0 L min^{-1} O_2), pH (2.8, 5.0 and 7.0) and electricity costs.

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