This thematic issue of Global Nest Journal is dedicated to the so-called advanced oxidation processes (AOPs), a family of similar but not identical technologies applied to the protection of the environment. Recent scientific and technological advances of AOPs are associated with the remediation of surface water, drinking water and groundwater, the treatment of municipal and industrial wastewaters, as well as the cleaning of air and soil contaminated with various recalcitrant compounds; these targets can usually be achieved using various AOPs either alone or in conjunction with other processes. The oxidative power of AOPs mainly, but not exclusively, arises from the generation of hydroxyl radicals (as well as other reactive species), which are strong, short-lived and non-selective oxidizers.

This special issue consists of thirteen research articles and a review. All of them were submitted following invitation by the guest editors, while a few were originally presented at the 13th International Conference on Environmental Science and Technology (CEST-2013), held in Athens, Greece between 5 and 7 September 2013. Photochemical AOPs have traditionally been a major player in the field with semiconductor photocatalysis based on titanium dioxide being undoubtedly the most widely investigated process. Carotenuto et al. study the UV/TiO$_2$ degradation of caffeine in water with emphasis on the effect of operating conditions on conversion and the post-treatment ecotoxicity of the samples. The work of Antonopoulou and Konstantinou deals with the effect of oxidants such as H$_2$O$_2$ and persulfate ions on the solar light/TiO$_2$ degradation kinetics of pesticide DEET; the authors also perform mechanistic experiments to elucidate the role of various radicals in the process. Karabelas et al. address a serious issue typically encountered in all AOPs, i.e. the role of actual water matrix on treatment performance; this effect is demonstrated investigating atrazine degradation in a pilot photocatalytic membrane reactor in the presence of humic acid and various cations, i.e. typical constituents of groundwater. In recent years, solar photocatalysis has also been tested as a disinfection method in wastewater treatment and this is addressed by two papers in this issue. Rizzo et al. demonstrate the efficiency of the process to inactivate two Enterococcus strains in secondary treated effluents, while Fanourgiakis et al. study the simultaneous removal of Escherichia coli and endocrine disruptors. Photo-Fenton processes based on iron salts, hydrogen peroxide and illumination (natural or artificial) constitute an attractive alternative to heterogeneous photocatalysis. A kinetic model capable of predicting the degradation of three pesticides in simulated secondary effluent and the consumption of hydrogen peroxide is developed and validated in the work of Carra et al. who conduct their research in a solar-Fenton pilot plant reactor. Miralles-Cuevas et al. address the question of optimizing the utilization of hydrogen peroxide in a compound parabolic collector since the treatment cost of Fenton processes is nearly exclusively due to the oxidant consumption. This is done testing various oxidant addition scenarios to treat a mixture of five pesticides.

Research in developing new or modifying existing photocatalytic and catalytic materials is of vital importance to the development of AOPs themselves. To this direction is the work of Rapsomanikis et al. and Pastrana-Martinez et al. who investigate the synthesis, characterization and performance of titania-clay composite films and iron oxides, respectively; the former can effectively decolorize an azodye, while the latter can mineralize diphenylhydramine in a heterogeneous photo-Fenton system. Shao et al. prepare, characterize and test Cu$_2$O nanocrystals as an alternative semiconductor photocatalyst. The catalyst exhibits substantial activity towards methylene blue degradation, good stability and limited ecotoxicity. Camara et al. test the stability and natural weathering of several commercial polymers that are typically employed as supports to immobilize titania for gas phase photocatalytic applications.

Electrochemical processes are dealt with by two papers of this special issue. Stergiopulos et al. compare three such processes, namely electrocoagulation on sacrificial iron electrodes, electro-oxidation on dimensionally stable anode (Ti/Pt) and electro-Fenton (i.e. iron electrodes and H$_2$O$_2$) to decolorize a model dye, indigo carmine. Comparison is made on the grounds of energy consumption
since the cost of electricity is a decisive (and usually prohibitive) factor for this kind of processes. Apaydin also uses electro-Fenton oxidation to treat an actual textile effluent achieving fast COD removal (i.e. 85% at 10 min and 313 mg l⁻¹ H₂O₂). Finally, Naddeo et al. review recent research in the area of disinfection by ultrasound irradiation. Low frequency, high power ultrasounds find several environmental applications including the killing of pathogens in waters and wastewaters; disinfection performance can be enhanced coupling sonochemical activity with other AOPs such as ozonation, electrochemical oxidation and UV irradiation.

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