Photolytic and photocatalytic treatment of organic pollutants in water and wastewater systems

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ABSTRACT

The reduction of environmental pollution caused by conventional and emerging pollutants from human activities is a vital need for new environmental friendly (green) purification technologies. The presence of a great number of organic toxic compounds (pesticides, industrial chemicals, heavy metals, pharmaceuticals etc.) has been documented especially in water environments due to surface runoff or incomplete municipal or industrial wastewater treatment.

Photochemical degradation is considered to be one of the most important transformation processes for many organic pollutants in aquatic environment. In general, photodegradation can be either direct or indirect. In direct photodegradation, pollutants absorb sunlight radiation while the indirect process includes the absorption of sunlight by chemical entities of the water or soil matrix other than the target compound and the subsequent formation of transient reactive oxygen species (ROS) such as singlet oxygen, hydroxyl radicals, peroxyl radicals which in turn react with the target molecule. In addition to direct or indirect photolysis, organic pollutants can also undergo self-sensitized photo-oxidation, i.e. the excited state of the pollutant induces the formation of ROS which in turn oxidize the pollutant. Photolytic reactions are often complex and lead to multiple TPs which can be more toxic and persistent than the parent compound.

The use of conventional water and wastewater treatment technologies (i.e. biotreatment, flocculation, filtration etc.) usually leads to low removal efficiencies. On the contrary, photocatalysis, involves the breakdown of the pollutants to non-hazardous substances while no secondary treatment is needed. Thus, it is considered as an important green technology since it operates effectively under sunlight, ambient conditions, and environmental friendly reactants while the formation of toxic by-products is avoided.

Considering the relevance and importance of photochemical processes in the environmental fate and protection technologies for organic micropollutants, the lecture focus on: a) the design and development of efficient photocatalysts working under sunlight irradiation, b) the optimization of processes by using chemometric methodologies and green oxidants; c) kinetic and mechanistic aspects of photolytic-photocatalytic degradation processes for selected organic micropollutants frequently detected in aqueous media and d) the integrative assessment of the processes through advanced analytical techniques.