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Wastewater chemical contaminants: Remediation by advanced oxidation processes

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Abstract

Approximately 70% of the terrestrial area is covered with water, but only a small water fraction is compatible with terrestrial life forms. Due to the increment in human consumption (Fig 1), the need for water resources is increasing, and it is estimated that more than 40% of the population worldwide will face water stress/scarcity within the next few decades. Water recycling and reuse may offer the opportunity to expand water resources. For that, the wastewater treatment paradigm should be changed and adequately treated wastewater should be seen as a valuable resource instead of a waste product.

The exact composition and elements concentration of wastewater vary according to its different origin sources, such as industrial, agricultural, urban usage of water, etc. (Fig 1). Thus, a variety of known and emerging pollutants like heavy metals, antibiotics, pesticides, phthalates, polyaromatic hydrocarbons, halogenated compounds and endocrine disruptors have been found in natural water reservoirs and it might also be due to the limited effectiveness of conventional wastewater treatment. The conventional approaches consist of a combination of physical, chemical and biological processes, aiming the removal of large sediments such as heavier solids, scum and grease and of organic content to avoid the growth of microorganisms and eutrophication of the receiving water bodies. However, this approach does not seem enough to reduce the chemical pollutants and much less the emerging chemical pollutants.

In this work, after some considerations concerning chemical pollutants and the problematic efficiency of their removal by conventional methods, an update is presented on the successes and challenges of novel approaches for wastewater remediation based on advanced oxidation processes. An insight into wastewater remediation involving the photodynamic approach mediated by tetrapyrrolic derivatives is underlined.

Among the advanced oxidation processes, heterogeneous photocatalysis has proven its efficiency to degrade recalcitrant organic compounds. The great hope in this technology lies in its ability for water decontamination and, in addition, the killing of pathogenic microorganisms. In addition to this potential, there is the possibility of immobilization of the photocatalyst on solid matrices and thus to be easily removed, recovered, and reused, making it an effective, less expensive and even environmentally friendly technology. Additionally, solar-driven processes can be considered as a green technology once they can employ sunlight as the irradiation source, thus circumventing the use of very high energy consuming UV-lamps.

After our analysis and with the data at hand, we think that photodynamic wastewater treatment may be worth drawing the attention from the scientific community and of political decision-makers. This approach has the potential to become a very robust solution to overcome the increasing need for water and wastewater treatment. We expect that the information compiled in this review can motivate the research community to put in more efforts in photodynamic wastewater treatment in order to gain progressive recognition.