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APPLICATION OF ADVANCED OXIDATION PROCESSES FOR THE TREATMENT OF MICROPOLLUTANTS IN WASTEWATER

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INTRODUCTION

The presence of micropollutants and/or toxic compounds in effluents supposes an important problem due to their final disposal into environment. Consequently, to achieve a satisfactory level of environmental protection, the removal of potentially hazardous substances should be attempted. In the last decades, "emerging contaminants" represent an additional concern to our society, due to the lack of information about its effects on human beings and environment as well as its interference in biological water treatments.

Advanced Oxidation Processes (AOPs) are alternative methods to treat waters, which use the oxidation power of the hydroxyl radical ($OH^{\bullet}$) to degrade organic compounds, providing pollutants transformation and disinfection. Among these processes, ozonation, UV/H_2O_2, UV/H_2O_2/Fe, wet oxidation and UV/TiO_2 have been tested for the abatement of diverse micropollutants previously identified in municipal effluents such as pesticides, pharmaceuticals and endocrine disruptors.

In general, results indicate that a first step of oxidation leads to a complete degradation of micropollutants. Afterwards, a slight COD and TOC removal is observed. The biodegradability and toxicity of the effluent behave in a more complex way; generally, an increment of biodegradability accompanied by a toxicity reduction is observed. However, in some cases, the first step of oxidation favors the formation of more toxic compounds, indicating that the oxidation reaction time is an important factor to be taken into account during wastewater treatment by AOP.

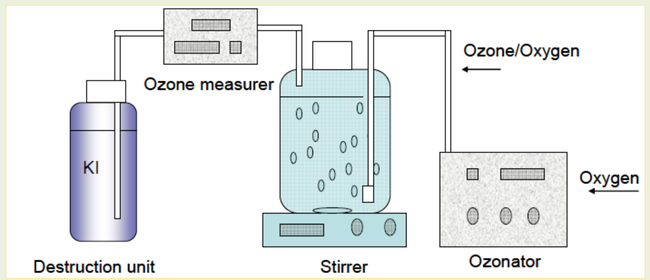
In this document different AOPs; **ozonation, UV/H_2O_2 and heterogeneous photocatalysis (UV/TiO_2)** are described, as well as its influence on different micropollutants.

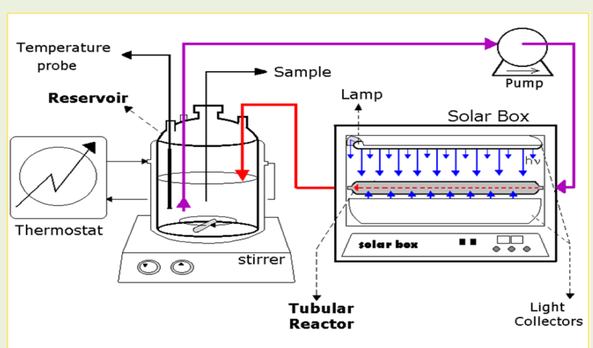
MATERIALS AND METHODS

OZONATION: Ozonation experiments have been carried out in a 2-L reactor with an ozone flow rate of 0.87 g h^{-1} (≈0.85 mg L^{-1} of ozone concentration). The effluent was collected from the wastewater treatment plant (WWTP) of Gava-Viladecans (Barcelona, Spain). Samples were preliminary filtrated and stored at 4 °C. Afterwards, the SE was spiked with 0.09 mmol L^{-1} of atrazine (ATZ) (20 mg L^{-1} initial concentration) and treated by the proposed methods. During experimentation, the temperature was kept at 25 °C and no pH adjustment was carried out. ATZ was chosen in this study as a model compound. It is a water-soluble pesticide included in the European list of priority substances which represents a significant risk to the aquatic environment .

UV/H_2O_2: Experiments with real effluents were performed and compared with other ones with milli-Q water to know the effect of the organic matter on the degradation of an emergent contaminant. This was 4-tert-butylohenol (TBF) considered an endocrine disruptor, which is an antioxidant of the alkylphenol family, included in the European priority list of substances. The effluents were treated by means of UV/H_2O_2 in a jacketed 2-L reactor at 25 ºC, equipped with three mercury low pressure lamps (254 nm), with nominal power of 8 W each. The initial concentrations of H_2O_2 and TBF were 100 mg L^{-1} and 20 mg L^{-1} respectively. The organic content of the secondary effluent coming form de same WWTP cited before was: 60 mgO_2 L^{-1} (COD) and 18 mgC L^{-1} (TOC).

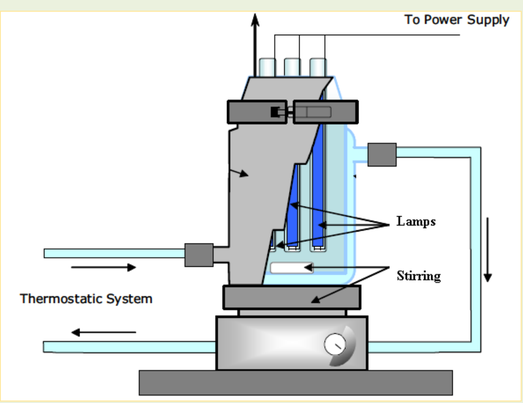
PHOTOCATALYSIS: Experiments have been developed in a stirred reservoir tank (1.0 L) which was filled with the pharmaceutical and the catalyst TiO_2 suspended in aqueous solution. The aqueous suspension was continuously pumped into the Solarbox (Co.fo.me.gra 220 V 50 Hz) and recirculated to the reservoir tank with a flow of 0.65 L min^{-1}. In the Solarbox, the Duran tubular photoreactor (0.078 L) was irradiated by a Xe-OP lamp (Phillips 1 kW). In order to keep the solution at 25 ºC, the jacket temperature of the stirred tank was controlled with an ultra-thermostat bath. Pollutants studied have been two β-blockers Metoprolol tartrate salt (MET) and propranolol hydrochloride (PRO), which may be considered as emerging contaminants.



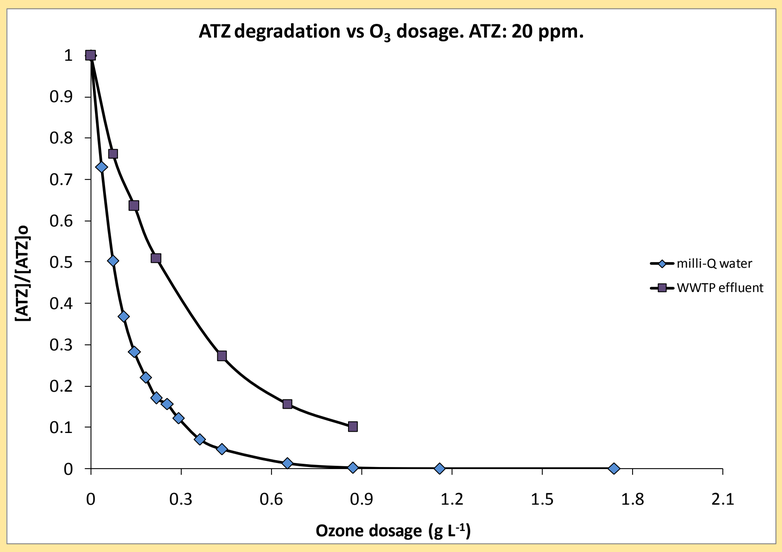


KEYWORDS

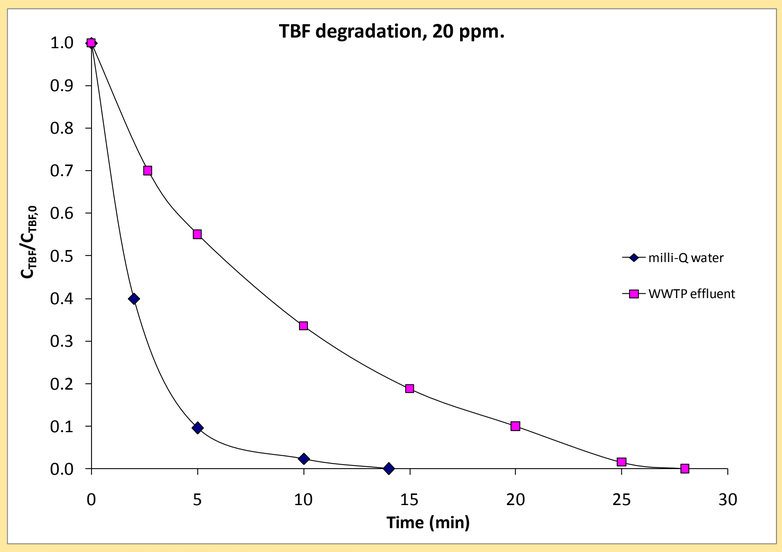
Water treatment, environmental protection, effluent discharge, AOP.



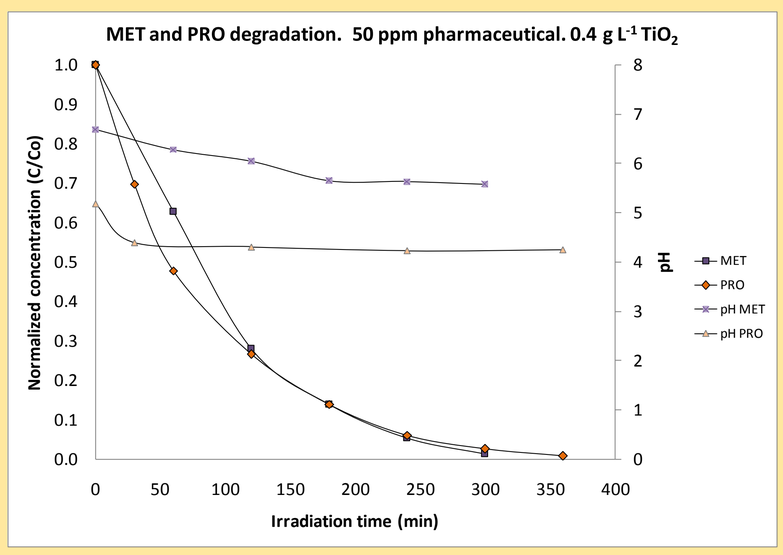
RESULTS – OZONATION



RESULTS - UV/H_2O_2



RESULTS – PHOTOCATALYSIS



CONCLUSIONS

- The preliminary assessment of the ATZ treatment in secondary effluents proved the efficiency of **ozone** to remove specific micro-contaminants.
- The presence of effluent organic matter can reduce the effectiveness of the methods to remove ATZ due to the competition of EfOM and inorganic components to react with radicals and/or molecular **ozone**.
- The **UV/H_2O_2** process seems to be an appropriate technique for the degradation of emerging contaminants. As it can be observed, the degradation in a matrix without organic matter was faster than the other one. The COD, TOC, DOC, turbidity and aromaticity were also reduced. The AOP improve the biodegradability.
- At the used experimental conditions, **photocatalytic treatment** was proved to be an effective method to achieve mineralization degrees in the vicinity of 55% for waters containing β-blockers MET and PRO.
- The tested compounds presented similar removal rate by **photocatalysis**. After 360 minutes of treatment, with 0.4 g L^{-1} of catalyst, both compounds were totally removed.
- 360 minutes of irradiation in **photocatalysis** promoted a slight decrease of the overall toxicity of the β-blockers samples .

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