World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:07, 2018

Ecotoxicological Test-Battery for Efficiency Assessment of TiO2 Assisted Photodegradation of Emerging Micropolluants

Authors : Ildiko Fekete-Kertesz, Jade Chaker, Sylvain Berthelot, Viktoria Feigl, Monika Molnar, Lidia Favier

Abstract : There has been growing concern about emerging micropollutants in recent years, because of the possible environmental and health risk posed by these substances, which are released into the environment as a consequence of anthropogenic activities. Among them pharmaceuticals are currently not considered under water quality regulations; however, their potential effect on the environment have become more frequent in recent years. Due to the fact that these compounds can be detected in natural water matrices, it can be concluded, that the currently applied water treatment processes are not efficient enough for their effective elimination. To date, advanced oxidation processes (AOPs) are considered as highly competitive water treatment technologies for the removal of those organic micropollutants not treatable by conventional techniques due to their high chemical stability and/or low biodegradability. AOPs such as (photo)chemical oxidation and heterogeneous photocatalysis have proven their potential in degrading harmful organic compounds from aqueous matrices. However, some of these technologies generate reaction by-products, which can even be more toxic to aquatic organisms than the parent compounds. Thus, target compound removal does not necessarily result in the removal of toxicity. Therefore, to evaluate process efficiency the determination of the toxicity and ecotoxicity of the reaction intermediates is crucial to estimate the environmental risk of such techniques. In this context, the present study investigates the effectiveness of TiO2 assisted photodegradation for the removal of emerging water contaminants. Two drugs named losartan (used in high blood pressure medication) and levetiracetam (used to treat epilepsy) were considered in this work. The photocatalytic reactions were carried out with a commercial catalyst usually employed in photocatalysis. Moreover, the toxicity of the by-products generated during the process was assessed with various ecotoxicological methods applying aquatic test organisms from different trophic levels. A series of experiments were performed to evaluate the toxicity of untreated and treated solutions applying the Aliivibrio fischeri bioluminescence inhibition test, the Tetrahymena pyriformis proliferation inhibition test, the Daphnia magna lethality and immobilization tests and the Lemna minor growth inhibition test. The applied ecotoxicological methodology indicated sensitively the toxic effects of the treated and untreated water samples, hence the applied test battery is suitable for the ecotoxicological characterization of TiO2 based photocatalytic water treatment technologies and the indication of the formation of toxic by-products from the parent chemical compounds. Obtained results clearly showed that the TiO2 assisted photodegradation was more efficient in the elimination of losartan than levetiracetam. It was also observed that the treated levetiracetam solutions had more severe effect on the applied test organisms. A possible explanation would be the production of levetiracetam by-products, which are more toxic than the parent compound. The increased toxicity and the risk of formation of toxic metabolites represent one possible limitation to the implementation of photocatalytic treatment using TiO2 for the removal of losartan and levetiracetam. Our results proved that, the battery of ecotoxicity tests used in this work can be a promising investigation tool for the environmental risk assessment of photocatalytic processes.

Keywords : aquatic micropollutants, ecotoxicology, nano titanium dioxide, photocatalysis, water treatment
Conference Title : ICECC 2018 : International Conference on Environment and Climate Change
Conference Location : Paris, France
Conference Dates : July 19-20, 2018

Open Science Index, Environmental and Ecological Engineering Vol:12, No:07, 2018 publications.waset.org/abstracts/91157.pdf