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Photocatalytic Treatment of Hospital Secondary Wastewater in a Pilot Scale for the Removal of Residual Pharmaceuticals

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Abstract The present study deals with the application of heterogeneous photocatalysis in pilot compound parabolic solar (CPC) reactor for the advanced treatment of hospital secondary wastewater effluent treatment using TiO_2 and g-C_3N_4 catalysts. Degradation followed first order kinetics with the corresponding rates ranging from 0.018 and 0.013 LkJ^{-1} for citalopram and O-des-Venlafaxine to 0.039 and 0.044 LkJ^{-1} for venlafaxine and amisulpride, respectively. The treatment was followed also by EEM-fluorescence as well as toxicity (Microtox) and risk assessment.

Keywords: TiO_2, g-C_3N_4, Pharmaceuticals, Photocatalysis

1. Study-Results

Pharmaceutical compounds (PhCs) are partially removed in conventional wastewater treatment plants and consequently they are detected in environmentally relevant concentrations in effluents and aquatic systems. Therefore, advanced treatment technologies should be applied for their efficient removal. Photocatalytic processes were performed using a compound parabolic collector (CPC) pilot plant reactor established at the University hospital WWTP of Ioannina. The collector consists of 24 borosilicate glass tubes (total volume 85 L, irradiated surface area 12 m^2). The wastewater samples were subjected to solid phase extraction (SPE) procedure (Oasis HLB cartridges (200 mg) and sample analysis was performed by a UHPLC Accela LC system, connected with a hybrid LTQ-FT Orbitrap XL mass spectrometer as well as by EEM-fluorescence as described in previous works [1]. In general, faster kinetics were recorded using TiO_2 in comparison to g-C_3N_4 catalysts. Pharmaceutical removal percentages are higher than 50 and 70% for g-C_3N_4 and TiO_2 respectively, while toxicity percentages were also reduced to low bioluminescence inhibition percentages or hormesis effect. Photocatalytic treatment resulted also in the amelioration of the effluent quality physicochemical characteristics such as COD, BOD and biodegradability index [2]. EEM-fluorescence analysis before and after the treatment also shows a decrease in the corresponding organic fluorophores (DOM). Risk quotients >1 were recorded before treatment for some compounds and target organisms however after treatment the correspond risks were reduced to low or negligible levels.

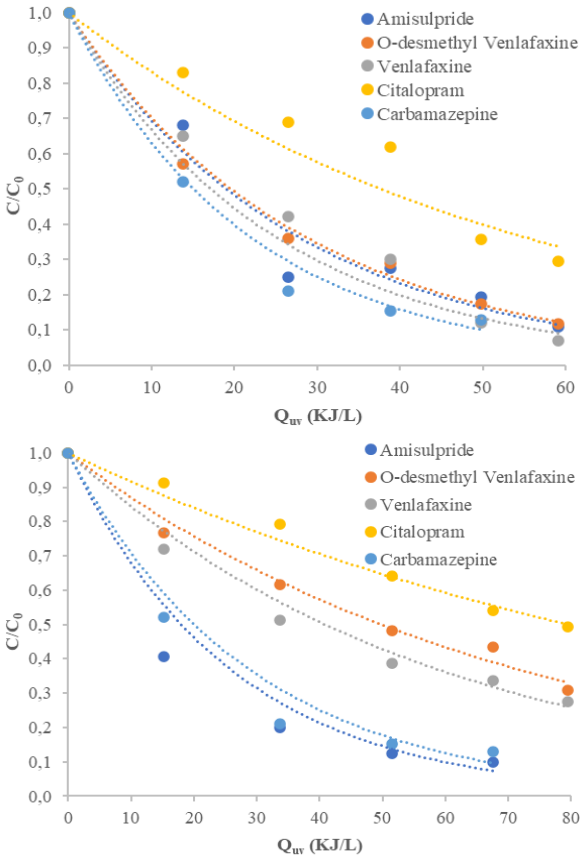

Figure 1. Photocatalytic degradation kinetics of PhCs in hospital wastewaters (200 mgL^{-1} of catalyst TiO_2, g-C_3N_4).

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