Feasibility study of biochar/TiO_2 composites in heterogenous photocatalytic degradation

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1. Introduction

Biochar, a carbonaceous material derived from the pyrolysis of biomass, has emerged as a promising candidate in various environmental and technological applications (Cao *et al*, 2011). Photocatalysis has been extensively explored for the degradation of organic contaminants in wastewater and air purification (Marwah *et al.*, 2023). In recent years, considerable research has been conducted on the potential of biochar/TiO_2 composites to enhance the efficiency of photocatalysis (Mausomi *et al*, 2021). The resultant material favors the photodegradation activity through a synergistic effect since the carbonaceous structure acts as an electron sink, increasing the recombination time of the carrier's charge (Baca *et al*, 2020). These approaches have demonstrated significant impact on the efficiency of organic contaminant degradation as well as long-term stability of the material (Bhavani *et al*, 2022). In this work, the composite biochar/TiO_2 catalyst was prepared by the sol-gel method. The photocatalytic performance was evaluated by the degradation efficiency of ibuprofen drug.

2. Experimental activity.

2.1. Materials synthesis and characterization.

The organic matter used for the biochar synthesis consisted of vineyard branch residues. The precursor used for TiO_2 was titanium (IV) isopropoxide (TTiP) (fabricant). Biochar (BC) was prepared through pyrolysis under inert atmosphere. The crushed biomass was heated up to 350˚C at rate of 10 ˚C/min and hold for 90 min. TiO_2 was synthesized by a sol–gel method. Firstly, 4.3 g of TTiP and 25 mL of concentrated NH_4OH were mixed thoroughly by magnetic stirring. Subsequently, 25 mL isopropyl alcohol was added and continued stirred continuously for 1 h. TiO_2/BC composite was prepared by the soaking calcination method. 1 g of TiO_2 was added to biochar at difference ratio 1:0.1, 1:0.5, 1:1, 1:1.5. The prepared suspension was put in a oven and dried at 100˚C for 12h. Afterwards, the material was calcinated in a muffle furnace fulfilled with N_2 for 4h at 450˚C. Transmission electron microscope (TEM), Brunauer Electron Teller (BET) specific surface area, X-Ray diffraction (XRD), Fourier transform infrared (FTIR) and Ultraviolet visible diffuse reflectance spectrum (UV-vis DRS) spectroscopy were employed to characterize fabricated materials.

2.2. Photocatalytic evaluation.

The materials were evaluated by the photocatalytic degradation of 5 $mg.L^{-1}$ of ibuprofen, which is a pollutant listed for control in European waters (European Parliament, 2022). 0.5 $g.L^{-1}$ of photocatalyst were added in 100 ml of water and 5 $mg.L^{-1}$ of micropollutant. Blank tests were carried out for 3 hours in darkness to evaluate the adsorption. Reactions were conducted in a reactor under Solar light simulator of 765 $W.m^{-2}$ for 4 hours. Aliquots were extracted at 10-minute. Samples were analyzed using HPLC, and mineralization was analyzed through TOC.

3.- Results and discussion.

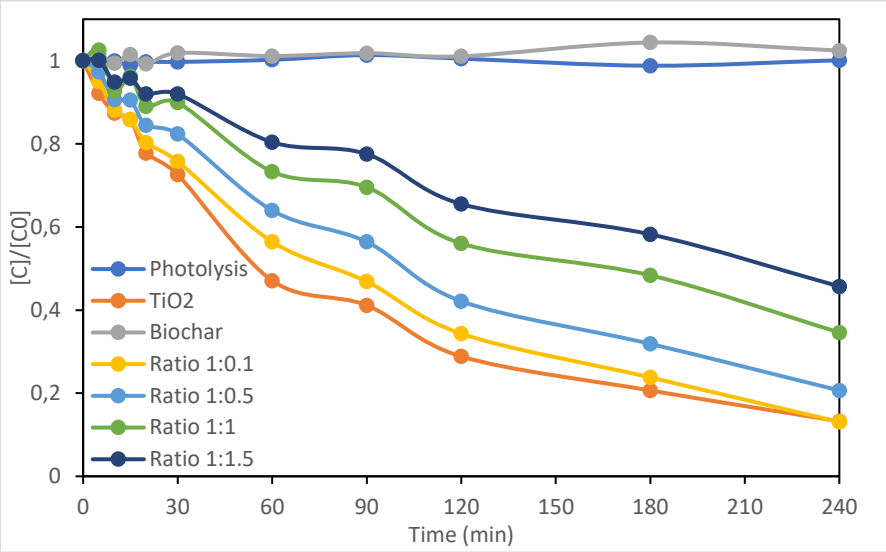

Figure 1. Ibuprofen degradation for different ratios of TiO_2:biochar.

As presented in figure 2, biochar or UV alone did not achieve to remove ibuprofen. However, Ibuprofen degradation was monitored once photocatalyst was added to the system. The best results of the biochar/TiO_2 have been achieved with ratios 1:0.1 and 1:0.5, showing degradations of 87% and 79%, respectively. These performances have been obtained with the addition of the lowest quantity of biochar (see Figure 1). Under photocatalytic conditions, the ratio 1:0.5 (TiO_2/BC) shows that can be used for removal organic pollutants. Moreover, active species, including ·OH and $\cdot O_2^-$ generated by TiO_2/BC played important roles during the process. Although results could not improve degradation achieved by TiO2, results are very promising as starting point to develop a new photocatalyst adequate for wastewater treatment and produced from agrowastes.

4.-References:

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