



Preparation and characterization of a biochar from pistachio hull biomass and its catalytic potential for ozonation of water recalcitrant contaminants

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HIGHLIGHTS

- ▶ This work demonstrates the preparation of a biochar from pistachio hull biomass.
- ▶ The prepared catalyst was very active in catalyzing the dye ozonation process.
- ▶ The COP mineralized RR198 to a much greater extent than does single ozonation.

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ABSTRACT

This work introduces a biochar as novel catalyst prepared from the pistachio hull, and demonstrates its catalytic potential for degrading the reactive red 198 (RR198) dye in catalytic ozonation processes (COPs). The prepared pistachio hull biochar (PHB) was a macroporous, basic material with low specific surface area. PHB had the greatest catalytic potential at an optimal alkaline pH of 10. Significant catalytic potential was observed when PHB was added to the ozonation reactor; a 58.4% catalytic potential was obtained in the decolorization of RR198 in the COP with 0.2 g of catalyst after a reaction time of 60 min. A 71% mineralization (TOC reduction) of the dye solution was observed in the COP after a reaction time of 60 min. Overall, it can be concluded from the experimental results that the PHB is a promising and affordable catalyst for use in COPs for treatment of resistant organic compounds.

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1. Introduction

Several classes of synthetic organic chemicals (SOCs), which are increasingly produced and used worldwide, are present in the industrial (chemical, petrochemical, pharmaceutical, textile, etc.) effluents and municipal wastewaters that end up in receiving waters. Many of the SOC are toxic to human and aquatic life (Crittenden et al., 2005). Moreover, most of these SOC are biorecalcitrant and resistant to biodegradation, and they may be toxic to microorganisms. This means that conventional biological treatment systems are inefficient in removing recalcitrants. To exploit the unique feature of biological processes for treating biorecalcitrants, the biological processes must be supplemented with a process capable of efficiently degrading these compounds into simple and biodegradable intermediates (Tabrizi and Mehrvar, 2004).

Advanced oxidation processes (AOPs) are among the most attractive and promising techniques considered for the degradation of biorecalcitrant compounds. Many studies are available

regarding the successful use of AOPs for the degradation and mineralization of different classes of organic compounds (e.g., Klammer et al., 2010; Byun et al., 2011; Méndez-Arriaga et al., 2011). Among the AOPs, those associated with ozone are more attractive than UV-based processes for full-scale wastewater treatment because there is less interference from turbidity and colorant with O₃ than with UV. A recent ozone-based AOP is known as the catalytic ozonation process (COP). In the COP, a solid material is added to the ozonation process as a catalyst for the decomposition of O₃ and thereby generates reactive radicals (Lv et al., 2010). These radicals result in more degradation and mineralization of the organic contaminants compared to single ozonation (Moussavi et al., 2010). Based on the type of catalyst used, the COPs are divided into homogeneous and heterogeneous processes. The heterogeneous COPs have a higher efficacy for the degradation and mineralization of recalcitrants, and the catalyst can be separated more easily at the end of the reaction resulting in lower residuals in the treated stream (Yang et al., 2010).

According to the literature, which has been recently reviewed by Nawrocki and Kasprzyk-Hordern (2010) the catalytic effectiveness of several types of materials, including activated carbon, me-

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