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Production of carbonaceous adsorbents from agricultural by-products and novolac resin under a continuous countercurrent flow type pyrolysis operation

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HIGHLIGHTS

▸ Olive stone biomass is precursor for adsorbents through continuous pyrolysis operation.
▸ Surface pyrolyzed specimens present maximum dye adsorption, highest weight losses.
▸ Pseudo-second order mechanism describes better methylene blue adsorption.
▸ Specific surface area values increase as follows: AC > N20B-cC > N40B-cC.
▸ Gross calorific values increase as follows: N100-c > N40B-cC > N20B-cC > B.

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ABSTRACT

Carbonaceous adsorbents based on novolac resin (N) and olive stone biomass (B) in a proportion of 20/80 and 40/60 w./w. N/O were produced. The specimens were cured (c) and pyrolyzed/carbonized (C) up to 1000 °C under a continuous countercurrent flow type pyrolysis operation (N20B-cC, N40B-cC). Commercial activated carbon (AC) was used for comparison reasons. Methylene blue adsorption from its aqueous solutions onto the adsorbents and kinetic analysis were investigated. The specific surface area of adsorbents and the gross calorific values (GCV) of cured materials were determined. The results show that N40B-cC presents lower weight loss and shrinkage but higher methylene blue adsorption than N20B-cC. Pseudo-second order mechanism describes better methylene blue adsorption onto all adsorbents. The specific surface area of carbonaceous and the gross calorific values of cured materials follow the order: AC > N20B-cC > N40B-cC and N100-c > N40B-c > N20B-c > B respectively. Olive stone biomass may constitute a suitable precursor for the production of carbonaceous materials.

1. Introduction

The sustainable management of agricultural by-products, with regard to economical and environmental parameters, is a critical issue of the last decades. The quantities of agricultural biomass are rapidly increased last years without solving the problem of their disposal and the legislation of the European Union to be stricter concerning solid agricultural wastes (Braguglia et al., 2011). Agricultural by-products such as sugarcane bagasse (Orlando et al., 2003) peanut hull (Gong et al., 2005), apple pomace (Robinson et al., 2002), coconut husk (Manju et al., 1998) and olive stones (Simitzis and Ioannou, 2011; Ioannou and Simitzis, 2009) are lignocellulosic wastes that can be used as an inexpensive and renewable additional source of carbonaceous materials (Ahmedna et al., 2000; Xu et al., 2010). Moreover, the conversion of biomass to energy adds no additional greenhouse gases to the atmosphere. The CO_2 emission from the use of biomass equals to CO_2 derived from photosynthesis during the lifetime of a plant. If biomass remains unused, methane could potentially be emitted through natural decomposition (Strezov et al., 2007).

Several technologies for the conversion of biomass to energy are currently emerging. They can be categorized to thermal, biochemical and physical processing. The first category consists of combustion, gasification, pyrolysis and liquefaction, the second category consists of anaerobic digestion and fermentation and the third category considers biofuel extraction through esterification as the physical method of biomass conversion (Strezov et al., 2007; McKendry, 2002). The selected best technology depends primarily on the final application.

In wastewater treatment technology, various techniques have been used for the removal of organic and inorganic pollutants. Among these, physicochemical and biosorption methods, such as precipitation, ion exchange, membrane filtration and reverse

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