#745 / Poster
TOPIC : Waste and side streams valorization

Activated Carbons from Organosolv Lignin for the Degradation of Organic Pollutants

AUTHORS
Konstantinos Kalogiannis / University of Western Macedonia - Department of Chemical Engineering
Stylianos Stefanidis / Chemical Process & Energy Resources Institute, Centre for Research and Technology-Hellas
Stamatia Karakoula / Chemical Process & Energy Resources Institute, Centre for Research and Technology-Hellas
Angelos Lappas / Chemical Process & Energy Resources Institute, Centre for Research and Technology-Hellas
Zacharias Frontistis / Department of Chemical Engineering, University of Western Macedonia

PURPOSE OF THE ABSTRACT
The key step to the successful valorization of lignocellulosic biomass lies in its fractionation towards its three main building blocks, cellulose, hemicellulose and lignin. These fractions can then be converted to valuable intermediate and end products, in the framework of the biorefinery concept.
In this work we present the production of activated carbons (ACs) from the lignin fraction of lignocellulosic biomass. The lignin fraction is retrieved from a novel organosolv pretreatment that replaces the commonly used inorganic acids, with O2 gas. Both the lignin fraction and the initial lignocellulosic feedstock (beechwood) were subjected to slow pyrolysis over a range of temperatures and holding times to evaluate the effect of these parameters. In addition, the lignocellulosic material was subjected to deashing prior to its carbonization.

Acid washing of beech wood slightly increased the surface area of the biochar produced at 600 °C by removing inorganic elements that could react with the pyrolysis vapors and lead to the condensation of heavy molecules and partial blockage of micropores. However, acid washing reduced the surface area of the biochar produced at 900 °C. At higher pyrolysis temperatures, inorganic species in untreated beech wood decomposed, enhancing the surface area. Acid washing mitigated this effect by removing a significant portion of these inorganic species before pyrolysis. Interestingly, the biochar produced from lignin exhibited textural properties similar to that derived from beech wood, including a high specific surface area (SSA) of 462 m^2/g, attributed primarily to micropores (374 m^2/g). This suggests that lignin from organosolv processes is a promising feedstock for producing high-surface-area carbon materials.

The synthesized carbon materials were evaluated for (i) the adsorption and (ii) the degradation, in the presence of persulfate ions, of the endocrine disruptor Bisphenol S (BPS). The experimental conditions used were: inherent pH (6.5), 500 μg/L of BPS, 500 mg/L of carbon materials, and 500 mg/L of sodium persulfate (SPS). BPS concentrations were measured using a Waters Alliance HPLC system equipped with a PDA detector and a Kinetex C18 column (Phenomenex). According to the obtained results, several carbon materials exhibited significant BPS removal, either

through degradation (in the presence of persulfate) or through adsorption (in the absence of oxidant). The Beech 900°C/6h sample demonstrated the highest efficiency, achieving more than 98% BPS degradation and nearly 85% BPS adsorption within 60 minutes.
On the other hand, the BeechW 900°C/1h sample showed significantly higher catalytic activity than adsorption (96% degradation and 20% adsorption in 60 minutes). Regarding the Lignin 600°C sample, although adsorption was almost negligible (2% after 180 minutes), it demonstrated moderate catalytic activity (59% degradation after 180 minutes).

These results highlight the significant influence of (i) biomass source and (ii) preparation conditions on the efficiency of both adsorption and oxidation of persistent pollutants. Therefore, further research is warranted to tailor carbon materials for specific environmental applications.

Acknowledgements
This project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0, funded by the European Union – NextGenerationEU (Implementation body: HFRI).
Key words: biorefinery; lignin; activated carbons; adsorbents

FIGURES

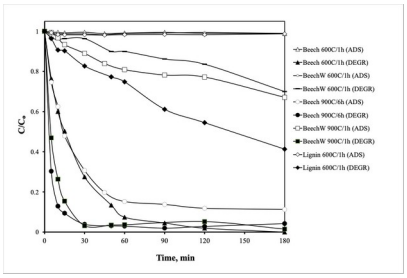

FIGURE 1

Figure 1. Normalized concentration of BPS (500 μg/L) versus time in 120 mL of ultrapure water containing 500 mg/L of carbon materials, in the presence or absence of persulfate. ADS: Adsorption; DEG: Degradation experiment.

FIGURE 2

KEYWORDS
biorefinery | lignin | activated carbons | adsorbents

BIBLIOGRAPHY