DIURON, METHOMYL AND MCPA ADSORPTION BY ACTIVATED CARBONS FROM ANGOLAN LIGNOCELLULOSIC PRECURSORS

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Introduction

This work reports the production of activated carbons from novel precursors, namely wood produced in Angola (Benguela region), and its application to remove pollutants from aqueous solutions, namely Diuron, Methomyl and MCPA. At present, Angola has a considerable amount of waste of wood, either from the cutting of trees for residential areas, factory, mining, oil and gas, which are abandoned, suffering a slow degradation.

Materials and Methods

The precursors were crushed into pieces of size up to 3 mm in one dimension and dried before its pre-washing with an acid aqueous solution of 20 % in H_2SO_4 by a period of 24 h. The suspension was filtrated and the solid material washed with distilled water and oven dry at 110 ºC. The production of activated carbons was done in a horizontal tubular furnace. The first step was the carbonisation of the precursor done at 800 ºC for 30 min. The gas was then switched to CO_2 for the activation step at 800 ºC for different times namely for Njiiliti,180 min, Nuati 240 min, Baobab wood 300 min, and Candeia 360 min. Samples were cooled to room temperature under an inert atmosphere and then removed from the furnace. The samples nomenclature is (Wood Name) (% of burn-off). The precursors were characterized by thermogravimetric analysis and helium pycnometry. The content of cellulose and lignin was done by Agroleico (Porto Salvo, Portugal), using the Portuguese Standards NP2029 and ME-414, respectively. Nitrogen adsorption isotherms at 77 K were determined using a Quantachrome Instruments Quadrasorb *SI* after outgassing the samples at 573 K for a period of 3 h in a Quantachrome Master Prep Unit. The point of zero charge was determined by mass titrations [1]. X-ray diffraction (XRD) patterns were determined on a Bruker AXS D8 Advance diffractometer using CuKα radiation, 40 kV and 30 mA, with a step size of 0.020º between 5.000 and 60.020º. Elemental analysis was carried out for carbon, hydrogen, sulfur and nitrogen using a Eurovector EuroEA elemental analyzer.

Results and Discussion

In this work we present the results of four different precursors, **N**uati presents the higher content in cellulose and lignin, respectively 46.4 and 24.6 %, whereas the lowest value of cellulose is 36.9 % for Boabad wood, which have the smaller content in hemicellulose 9.2 % and lignin, 7,4 %. The nitrogen isotherms indicate that all activated carbons, prepared by physical activation with CO_2, are essential microporous. As can be seen in table1.The samples presents apparent surface areas between 603 and 801 m^2g^{-1}, pore volume from 0.26 to 0.36 cm^3g^{-1}, mean pore width from 0.68 to 0.98 nm, and low external surface areas, less than 47 m^2g^{-1}. All samples have similar burn-off but dissimilar porous development. Sample Candeia-47, with a burn-off of 47 %, shows the highest apparent surface

area (875 m^2g^{-1}) and sample Njiliti-40, with a burn-off of 40%, the smallest (603 m^2g^{-1})

Table1.Textural and chemical characterisation of the carbon materials. (dI-detection limit)

Sample	Burn off (%)	A_{BET} (m^2/g)	A_S (m^2/g)	V_S (cm^3/g)	Vo (cm^3/g)	Lo (nm)	N (%)	C (%)	S (%)	pzc
Boabab-42	42	875	44	0.40	0.34	0.74	0.37	79.04	<dL	8.33
Nuati-33	33	801	22	0.36	0.31	0.74	0.19	88.45	0.29	8.75
Njiliti-40	40	603	27	0.26	0.23	0.68	0.25	98.90	<dL	9.89
Candeia-47	47	838	24	0.36	0.33	0.71	0.42	80.11	<dL	8.58

Regarding the surface chemistry, all samples have more or less the same absorption bands, as observed by FTIR, but with different intensities. It is possible to identify characteristic bands of the following surface functional groups: alcohol (R-CH2-OH, HO-R-OH, at 3429 and 1442 cm^{-1}), alkane and alkene (R-CH2-R, at 2923, 2851, 875 cm^{-1}) and amide (NH, R-CO-NH2, at 720, 1800 cm^{-1}). The intense absorption band around 1430 cm^{-1}, present in all samples, could be assigned to CH3, CH2 and CH groups and to C=C bonds associated with the typical aromatic structure of the ACs. The small amount of sulphur probably can justify the sulfone bands, C-SO2-OH, of low intensity in the interval 1165-1150 cm^{-1}. All samples are of basic nature, with pzc values in the range between 8.33 and 9.89. Samples Njiliti-40 and Nuati-33 show the highest pzc value, 8.75 and 9.89, respectively. The samples tested in the liquid phase show different maximum adsorption capacity for Diuron, Baobab-42 with 275 mgg^{-1}g and Nuati-33 with 250mgg^{-1}. In relation to the Methomyl solutions in the analyzed samples, the maximum adsorption capacity was 160mgg^{-1} for the Baobab 42, and for the MCPA solutions, the maximum adsorption capacity was achieved by Candeia-47 sample, with a value of 300 mgg^{-1}. It should be noted that the Njiliti-40 sample present a value close to 60 mgg^{-1}.

Conclusions

The results presented in this work allow us to conclude that the materials tested are good precursors for the production of activated carbon by activation with carbon dioxide. The ACs produced are primordially microporous with BET apparent surface area and pore volume up to 875 m^2g^{-1} and 0.34 cm^3g^{-1}, respectively, for sample Baobab-42. Regarding the surface chemistry, ACs are of basic nature as indicated by the pzc, FTIR and elemental analysis. The Methomyl, MCPA and Diuron adsorption studies shown that the ACs presents interesting results for the removal of pesticides. The maximum adsorption capacities were 275 and 250, 300 mg/g for MCPA, Methomyl and Diuron, respectively, which can be particularly interesting and an asset in countries like Angola where the pesticides has been vastly and carelessly used with soil and water contamination as a consequence. The interesting potential of the wood wastes from Candeia, Baobab, Njiliti and Nuati trees as precursors for the AC production.

Acknowledgment

The authors gratefully acknowledge the funding by Fundação para a Ciência e a Tecnologia (project UID/QUI/0619/2016) with National (OE) funds. Emílio Tchikuala is thankful to Fundação Calouste Gulbenkian (Doctoral Grant nº 146128-"Bolsas de apoio à investigação para estudantes de doutoramento dos PALOP"). Angolan government for the opportunity

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