PRODUCTION AND CHARACTERIZATION OF ACTIVATED CARBONS MADE FROM SUNFLOWER STEMS

J.M.V. Nabais, C. Laginhas, P.J.M. Carrott, M.M.L. Ribeiro Carrott*

Centro de Química de Évora and Departamento de Química, Universidade de Évora, Colégio Luís António Verney, 7000-671 Évora, Portugal

** corresponding author: jvn@uevora.pt*

Introduction

Activated carbons (ACs) are artificial materials, prepared from natural or synthetic precursors that are worldwide extensively used. The ACs main characteristics are the noticeable adsorption capabilities provided by the highly developed porous structure and the rich surface chemistry. Because of their versatility and properties the final material can be tailored to have specific properties suitable for a wide range of applications such as medical uses, gas storage, removal of pollutants and odours, gas separation and purification as well as in catalysis. With the increase of activated carbon demand, one of the main challenges lies in the attempt to find new precursors, which are cheap and accessible with good valorisation potential, like industrial and agricultural residues.

In the present work we report the production of ACs from sunflower stems, an agricultural by-product, through a physical activation process by CO_2 and H_2O, using a single step carbonisation at 400ºC, which as far as it came to our knowledge was never made for this precursor.

Methods

The precursor was first crushed and sieved in order to obtain a regular and homogeneous shape. From the selected fraction (2-4mm) 30 g of precursor was weighed and placed in a suitable container made of stainless steel, which was inserted into a horizontal furnace. The carbonization took place at 400ºC during 1 h under a constant N_2 flow of 85 cm^3min^{-1} followed by physical activation at 700 and 800ºC in a constant CO_2 or H_2O flow of 85 cm^3min^{-1} during different periods ranged between 0.25 and 7 h, in order to obtain burn-off within the range 15-80 wt%. After activation, all samples were washed with 1000 mL of distilled water for 24h at room temperature and oven dried at 100 ºC for another 24h.

All samples were characterized by N_2 adsorption at 77 K using a Quantachrome Instruments Quadrasorb SI, infrared analysis (FTIR) carried out in a Perkin Elmer model Paragon 1000PC spectrophotometer using the KBr disc method, elemental analysis (EA) performed in an Elemental Analyzer, Euro Vector Instruments and X-ray diffraction (XRD) using a Bruker AXS-D8 Advance Powder Diffractometer equipped with a CuKα radiation (40 kV, 30 mA). The nitrogen adsorption

isotherms were analysed using the Brunauer-Emmett-Teller (BET), Dubinin-Radushkevich (DR) and α_s methods. The point of zero charge (pzc) was determined as well by mass titrations according to the procedure described elsewhere [1].

Results and Discussion

According to IUPAC classification all N_2 isotherms were found to be of Type I, which indicates activated carbons with porous structures composed essentially by micropores. The isotherms also show the presence of a small hysteresis due to the presence of mesoporos. All samples exhibit low external areas and non-significant mesoporosity, as can be seen by the overall agreement between the calculated values of V_s and V_0, shown in table 1.

All samples have basic properties with pH corresponding to the point of zero charge varying from 9.40 to 11.16. Due to their basic properties, these ACs show good potential to be used in the adsorption of substances with acidic properties, which assumes a negative charge at the working pH. The surface chemistry was evaluated by FTIR, and the spectra analysis showed the presence of several functional groups like hydroxyl and carbonyl bonds, quinones, lactones and pyrones.

All XRD patterns showed two typical broad bands, related to reflections from (002) and (10*l*) planes. By the application of Bragg's Law it was possible to estimate the interplanar spacing (d_{002}), which ranged between 0.32 and 0.36 nm. The use of Debye-Scherer's equation also allowed to estimate the height and width of the microcrystallites, these were between 1.00-2.78 nm and 2.76-7.76 nm, respectively.

Sample	BET	α_s		DR
	A_{BET} / m^2g^{-1}	V_s / cm^3g^{-1}	A_{ext} / m^2g^{-1}	V_0 / cm^3g^{-1}
G715	329	0.16	26	0.13
G742	618	0.30	71	0.27
G751	717	0.38	81	0.30
G819	308	0.15	25	0.13
G847	680	0.33	41	0.30
G880	563	0.26	41	0.21
G716-H2O	113	0.06	19	0.05
G733-H2O	594	0.28	26	0.25
G824-H2O	429	0.22	24	0.20
G838-H2O	737	0.35	37	0.32

Acknowledgements

The authors would like to thank to Fundação para a Ciência e Tecnologia (FCT) for financial support though Project FCOMP-01-0124-FEDER-007142.

References

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