Transforming low value coal tar derived products into chemical activated carbons

M. Villanueva-Gutiérrez*, A. Castro-Muñiz, S. González-Martínez, F. Suárez-García, J. I. Paredes

Instituto de Ciencia y Tecnología del Carbono, INCAR-CSIC, C/Francisco Pintado Fe, 26, 33011 Oviedo.

Miguel.Villanueva@incar.csic.es

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Introducción

The potential of low value coal tar-derived products (CTPs) has been exploited by using them as precursors for the synthesis of hypercrosslinked polymers (HCPs), high added-value materials. The obtained HCPs were carbonised and chemically activated with KOH. These activated carbons (ACs) will be used for the treatment of underground coal gasification (UCG) wastewaters [1] because of their specific surface areas, variety of surface chemistry and pore sizes mainly in the micropore range [2]. These features are interesting and may have a strong effect on their ability to remove pollutants.

Experimental

HCPs were obtained by the one-pot Friedel-Crafts alkylation, using different CTPs as precursors (see Table 1), $FeCl_3$ as catalyst and formaldehyde dimethyl acetal as crosslinking agent. The obtained HCPs were carbonised in a horizontal furnace at a temperature of 850 °C for one hour in an inert atmosphere. The resulting carbonised materials were chemically activated with KOH at a temperature of 850 °C for one hour in an inert atmosphere, using a mixing ratio of 2:1 (KOH:char) by weight. Afterwards, the samples were thoroughly washed with HCl 1M and distilled water to eliminate remnants of the activating agent and/or its decomposition products.

The porous texture of the activated carbons was characterized by gas physisorption of N_2 at −196 °C and CO_2 at 0 °C. The total pollutants adsorption capacity (q_{ads}) of the ACs was obtained by shaking the samples in a concentrated phenol aqueous solution for 24 h at 25 °C. The final concentration of the pollutant was measured by UV-vis spectroscopy.

Resultados y discusión

The activation yields obtained after the chemical activation showed a high dependence on the nature of the CTP precursor used, obtaining values from 30 wt.% to up to 82 wt.% (Table 1). This dependence was also reflected on the porous textures of the activated carbons. The N_2 adsorption/desorption isotherms of the obtained ACs (see Figure 1a) were all of type I according to the IUPAC classification, but with a rather significant contribution of type IV plus an H4 hysteresis loop. All the samples are therefore essentially microporous, but they also incorporate a certain contribution of mesopores. The BET specific surface areas (S_{BET}) ranged from 934 m^2/g up to than 1776 m^2/g (see Table 1). The carbonization and activation conditions were the same for all of the activated carbons obtained with this method, so the difference in their porous textures and yields could only be attributed to the HCPs different characteristics.

Tabla 1. Porous textural parameters derived from N_2 and CO_2 adsorption isotherms, activation yield and amount of adsorbed phenol

CTP	Activation yield (wt.%)	S_{BET} (m^2/g)	V_{CO2} (cm^3/g)	Adsorbed phenol (mg/g)
Distilled coal tar pitch (DCTP)	58	1620	0.50	314
Wash oil (WO)	31	1758	0.45	263
Chrysene oil (CO)	37	1642	0.43	200
Phenolic oil (PO)	74	1463	0.54	367
Creosote B (CreoB)	52	1604	0.45	288
Naphthalene oil (NO)	56	1776	0.54	307
Depleted naphthalene oil (DNO)	56	1647	0.52	250
Distilled coal tar (DCT)	77	934	0.39	239
Anthracene oil (AO)	82	991	0.42	201

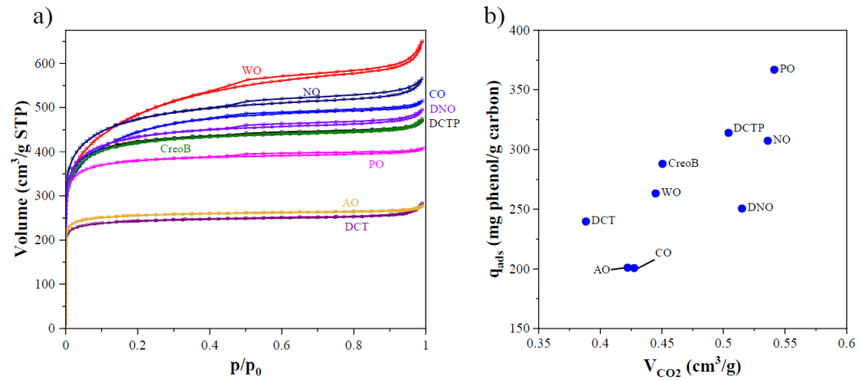

Figura 1. (a) N_2 adsorption/desorption isotherms and (b) amount of adsorbed phenol vs. micropore volume

The carbons were tested as adsorbents for water remediation to remove organic compounds from UCG wastewaters using phenol as model pollutant (initial concentration 2 g/l). As shown in Figure 1b and Table 1, the larger the narrow micropore volume, obtained from the CO_2 adsorption (V_{CO2}) the more phenol the activated carbons adsorbed.

Conclusiones

Chemical activation of HCPs obtained from low value products from the coal distillation provided ACs with different porous textures depending on the CTP used as precursor. The amount of phenol adsorbed on the ACs was as high as 367 mg/g, shown by the AC obtained from PO.

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