INFLUENCE OF VOLATILES ON THE PRODUCTION OF ACTIVATED CARBONS FROM PINE GASIFICATION CHARS

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1. Introduction

Since chars and fly ashes from gasification of different fuels usually have high carbon content and low toxicity levels [1], the residues produced by coal and pine gasification have been successfully used as activated carbon precursors [2]. However it was observed that some of the activated carbons produced still have high amounts of volatile matter ($\approx 40 \% \text{ w/w}$) that, according to Pastor-Villegas and Durán-Valle [3], may be formed by the condensation of tars on the char’s surface during the gasification process. The reduction of volatile matter in the precursor can thus be determinant for the production of high quality adsorbents.

The main objective of the present study was the optimization of the pretreatment conditions needed to minimize the volatile matter of chars produced by pine gasification. A selected sample was used to prepare an activated carbon whose textural properties and performance for the removal of acetaminophen from liquid phase, were compared with the carbon produced from the untreated char, using the same experimental conditions.

2. Experimental

The chars were produced by pine fluidized bed gasification as described in ref 1. The ash and the carbon content of this residue were determined according to the procedure described also in ref 1.

The pine char (Pi) was submitted to heat treatments (600 – 900 °C) during 1 h, under N$_2$ flow (10 cm$^3$ s$^{-1}$), in a horizontal furnace. To determine the volatile matter content, overnight dried samples at 100 °C were heated (15 °C min$^{-1}$) up to 900 °C, and kept for 10 min, under N$_2$ flow (10 cm$^3$ s$^{-1}$). After cooling, under N$_2$ flow, the samples were weighted and the procedure was repeated until constant weight. The textural characterization of the materials was made by N$_2$ adsorption isotherms at -196 °C measured in an automatic apparatus Micromeritics ASAP 2010. Before the isotherms acquisition the samples ($\approx 50$ mg) were outgassed overnight at 120 °C under vacuum better than 10$^{-2}$ Pa.
A selected heat treated sample was chemically activated with $K_2CO_3$ using the following conditions: char:$K_2CO_3$ of 1:3 (w/w); temperature 800 ºC; time 2 h. The carbon obtained was assayed as adsorbent of acetaminophen (120 mg dm$^{-3}$) from aqueous phase at 30 ºC and dissolution pH.

3. Results and discussion

The pine char considered in this study, presents high carbon content (72 %), reason why it was used as activated carbon precursor, although it’s somewhat high ash amount (23 %).

The $N_2$ adsorption isotherms obtained in all the materials (Fig.1) revealed that the heat treatment made over sample Pi lead, in general, to the development of a micro and mesopore network. The highest apparent surface area (≈ 240 m$^2$ g$^{-1}$) was observed for sample treated at 600 ºC. Further increase of the temperature, up to 800 ºC, lead to the decrease of the adsorption capacity of the samples. This is most likely due to the release of volatile matter leading to the appearance of larger pores that were previously blocked. In fact, higher temperatures leaded to a progressively decrease in volatile matter content of the heat treated samples. The heat treatment at 900 ºC promoted a somewhat unexpected increase of the adsorption capacity. This was probably the result of the sintering accompanied by the shrinkage of the char particle, which lead to the realignment of char structure, narrowing some pores.

Sample heated at 900 ºC was used as activated carbon precursor (hereinafter called Pi-t). The material obtained presented an apparent surface area of 750 m$^2$ g$^{-1}$, i.e. a value half of that obtained for the sample prepared from the untreated char using the same experimental conditions ($A_{BET} \approx 1500$ m$^2$ g$^{-1}$ for Pi/1:3/800/2). These results seem to indicate that the volatile matter present in the pristine char has no negative effect in the porosity development.

The liquid phase results show that after 24 h of contact time, the carbons obtained from the treated and untreated char have similar performance (between 58 e 68 %).

A deeper characterization of sample Pi-t is foreseen to allow a better interpretation of the kinetic and equilibrium liquid phase results, also planned.

4. References