# POSTER

## ACTIVATION OF EUCALYPTUS WOOD CHAR: PYROLYSIS TEMPERATURE AND PREVIOUS OPERATION CONDITIONS INFLUENCE.

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### Introduction

The preparation of activated carbon from wood is an important subject from scientific and technologycal point of view. A lot of work have been done on the influence of operation conditions (1-3) and $CO_2$ reactivity (4) on lignocellulosic materials. However, still remains some unknown details about structural changes ocurrying during the process of heating and activation of chars. In this work, the pyrolysis and carbonization of Uruguayan eucalyptus wood, and properties of chars and related activated carbons, were studied using thermogravimetric analysis and gas adsorption. Chars have been obtained at three different temperatures, and some of them were preheated in $N_2$ or $CO_2$ up to 800°C, the activation temperature. In addition, activated carbons were prepared from the chars obtained, and $N_2$ (77 K) and $CO_2$ (273 K) isotherms of chars, preheated chars, and activated carbons were compared. Finally, gasifications of one of the chars were performed in two different gas atmosphere. In this way, the influence of preparation temperature and gas atmosphere on chars and activated carbons porosity and reactivity was studied.

### Experimental

Starting wood samples were reduced to sawdust. Thermogravimetric analysis was carry out in a CI Electronics modular system; the sample size was 10 - 20 mg. Pyrolysis was performed at 2°C/min in $N_2$ atmosphere. For $CO_2$ gasification the char samples were heated at 10°C/min up to 800°C, in $N_2$ or $CO_2$ atmosphere, maintaining constant this temperature until total conversion. When heating atmosphere was $N_2$, this was changed to $CO_2$ at 800°C.

Chars were prepared at 400, 600 and 800°C, in a horizontal tubular furnace, $N_2$ atmosphere, and 2h soaking time. They were named C400, C600 and C800.

For the preparation of preheated chars, C400, C600 and C800 were heated in a horizontal tubular furnace, in $N_2$ atmosphere, (preheated chars named C4N8, C6N8 and C8N8), or $CO_2$ atmosphere (products named C4C8, C6C8 and C8C8) up to 800°C, cooling later in $N_2$ atmosphere.

Finally, activated carbons were prepared in horizontal furnace under $CO_2$ atmosphere, heating at 10°C/min from ambient temperature up to 800°C, 1 h soaking time, and cooling in $N_2$. The products were named C418, C618 and C818.

### Results and discussion

*Pyrolysis.* Substantial devolatilation ocurred within the 220-350°C thermal range, and became less intense at increasing temperatures. For this reason, char preparation temperatures of 400, 600 and 800°C were chosen, for studying preparation temperature influence.

*Char Gasification.* The variation with conversion of $CO_2$ reactivity of chars at 800°C, shown in Fig. 1, indicates that reactivities increase in the order C400>C600>C800, according with the lower structure order at lower carbonization temperatures. When C800 was heated till 800°C in different atmospheres ($N_2$ or $CO_2$), the reactivity was improved in the case of $CO_2$ previous heating, as can be seen in the same figure.

*Porous structure and surface of chars.* Table 1 shows $N_2$ and $CO_2$ $V_{DR}$ and $N_2$ $S_{BET}$ for chars, preheated chars and activated carbons. Intends to obtain C400 and C600 $N_2$ isotherms revealed very low adsorption values most likely as a consequence of the narrow microporous structure of these chars. Char micropore volumes increased in the order C800>C600>C400; structure contraction for higher temperatures, resulting in decreasing pore diameters, as well as pore obstruction through pyrolytic carbon formation at lower temperatures, may explain these results, that seem to be opposite to reactivity order.

*Porous structure and surface of preheated chars.* The heating influence from ambient

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temperature up to the activation one is noticeable: the order of $CO_2$ $V_{DR}$ has changed, as a result of structure contraction, while $S_{BET}$ increased, being more important the heating influence when it was done from ambient temperature under $CO_2$. In this case, a partial gasification is performed, between 750 and 800°C.

*Porous structure and surface of activated carbons.* For 1h activation time, burnoffs increased with lower char preparation temperature, being 13% (C818), 26% (C618), and 50% (C418). Porosity parameters increased as well in the order C818<C618<C418, indicating that the gasification was improved as a consequence of char previous heating up to activation temperature. Fig. 2 shows the $CO_2$ isotherm evolution for C600 and derived preheated chars ($N_2$ and $CO_2$) and activated carbon.

## Conclusions

Low char preparation temperatures lead to chars with a very low microporosity. The previous heating up to a higher activation temperature produces structural changes that increases microporosity and enlarges pore diameters. As a consequence, $CO_2$ reactivity is increased for those chars prepared at lower temperatures


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Fig. 1. $CO_2$ reactivity of chars

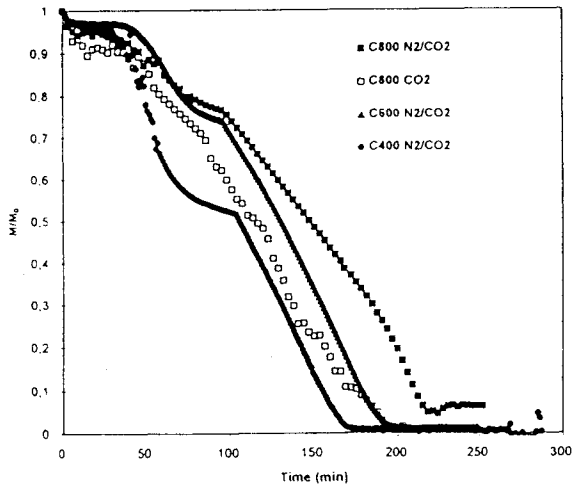


Fig. 2. $CO_2$ isotherms for C600 series

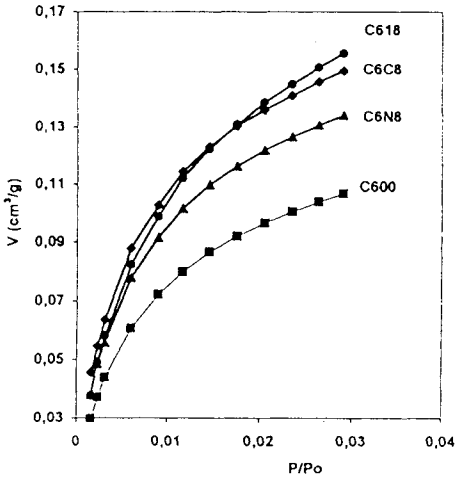


Table 1. Chars, $N_2$ preheated chars, $CO_2$ preheated chars, and activated carbons porous evolution

| | Chars | | | $N_2$ Preheated Chars | | | $CO_2$ Preheated chars | | | Activated Carbons | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C400 | C600 | C800 | C4N8 | C6N8 | C8N8 | C4C8 | C6C8 | C8C8 | C418 | C618 | C818 |
| $N_2$ $S_{BET}$ ($m^2/g$) | - | - | 490 | 580 | 530 | 600 | 620 | 570 | 600 | 1090 | 960 | 780 |
| $CO_2$ $V_{DR}$ ($cm^3/g$) | 0.13 | 0.19 | 0.26 | 0.26 | 0.24 | 0.25 | 0.27 | 0.25 | 0.26 | 0.36 | 0.32 | 0.30 |
| $N_2$ $V_{DR}$ ($cm^3/g$) | - | - | 0.21 | 0.24 | 0.14 | 0.24 | 0.26 | 0.24 | 0.25 | 0.45 | 0.41 | 0.31 |