

# PREPARATION OF ACTIVATED CARBONS FROM SISAL BY CHEMICAL ACTIVATION

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## Introduction

Activated carbon can be produced from a variety of raw materials. Among them, lignocellulosic materials are very commonly used precursors due to its low cost and large supply [1]. Chemical activation has some advantages over physical activation such as: it is a single step process, it produces a less weight loss of carbon and needs lower process temperature. The study of the effect of some process variables such as carbonization time, temperature, heating rate [2,3] allows a better preparation of the activated carbons.

## Experimental

Different series of carbons prepared from sisal, impregnated and non impregnated, were obtained. The raw material was impregnated with KOH 1:1 ratio. All the samples were carbonized at 800 C in a N<sub>2</sub> flow of 100 cm<sup>3</sup> min<sup>-1</sup>. The carbonization time was varied from 30 min to 240 min, and the heating rate from 5 C min<sup>-1</sup> to 20 C min<sup>-1</sup>. The non impregnated carbons were denoted as S and the impregnated ones as SI. When carbonization time is varied a T followed by time in minutes is added to the sample name. When the heating rate is varied a R followed by the heating rate value is added to the sample name. The specific surface areas were determined by N<sub>2</sub> adsorption at 77 K (Micromeritics ASAP 2010) and using the B.E.T. and t-plot methods. The pore size distribution of the samples were calculated by DFT (Density Functional Theory) method.

## Results and Discussion

Chemical activation of sisal with KOH improves the surface areas of the obtained carbons from few hundred to several thousand square meters per gram.

The variations in surface areas for activated and non activated carbons versus the carbonization time are shown in Figure 1. As it may be observed it was not possible to find any trend for the non activated carbons. The higher surface area obtained was 320 m<sup>2</sup>g<sup>-1</sup>. In the case of activated carbons a decrease of surface areas with

the increase of carbonization time was detected. Thus, pore destruction is produced with the increase of the

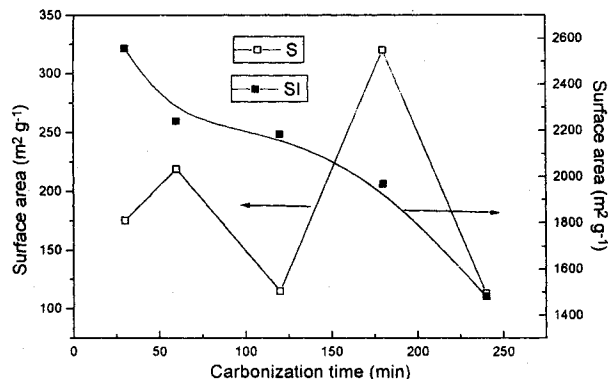


Figure 1. Effect of carbonization time

carbonization time.

The heating rate also affects in different way to the activated and non activated carbons (Figure 2). When the rate increases from 5 to 20 C min<sup>-1</sup>, the surface areas of non activated carbons also increase. However, in the case of activated carbons a maximum of surface area was obtained when the heating rate was 10 C min<sup>-1</sup>.

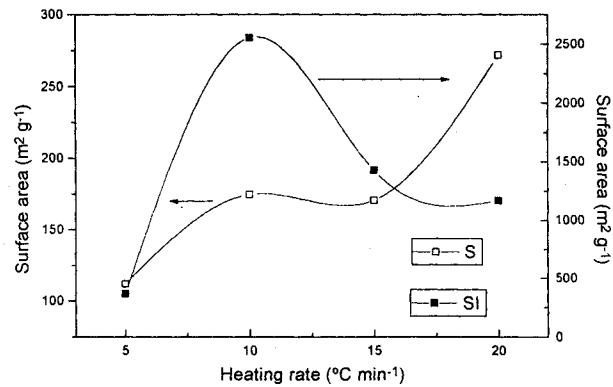


Figure 2. Effect of heating rate

Too slow or too high heating rates affect negatively to the activation process of KOH.

Figures 3 and 4 show the effect of carbonization time on the porosity of the obtained carbons. All the carbons are essentially microporous. When the carbonization time increases the pore size of not activated carbons shifts from 16 Å (ST30) to 10 Å (ST240), appearing a bimodal

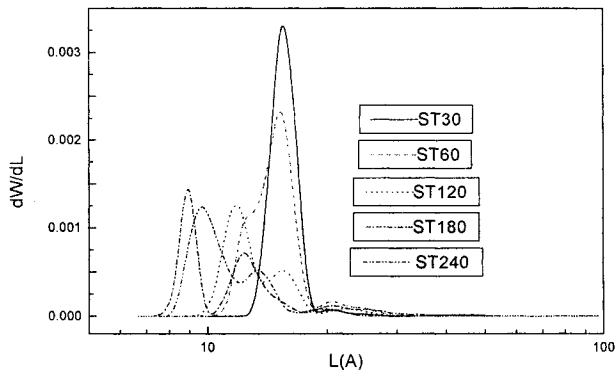


Figure 3. Effect of carbonization time on pore size distribution of non activated carbons

distribution.

When the carbons were activated their pore size distribution changes in a similar way. The mean pore size is at around 7.5 Å although, pores of 11.5, 15 and 20 Å are also present.

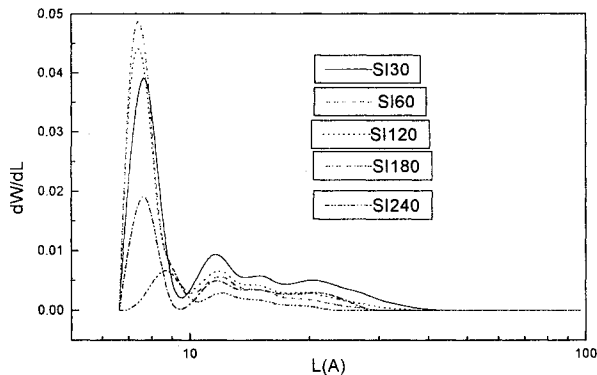


Figure 4. Effect of carbonization time on pore size distribution of activated carbons

The heating rate of 5 C min<sup>-1</sup> produces mesopores of 320 Å and micropores of 15 Å. The higher rates used produce only micropores of 15 Å (Figure 5) in the non activated carbons.

The effect of heating rate on the pore size distribution of activated carbons may be observed in the Figure 6. The size of the pores does not vary with the heating rate and their distribution is very similar to that obtained when the carbonization time was varied. This signify that the carbonization time has a higher influence that the heating rate on the pore development of the activated carbons.

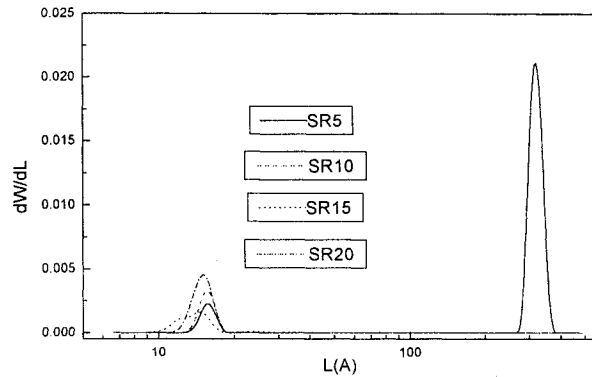


Figure 5. Effect of heating rate on pore size distribution of not activated carbons

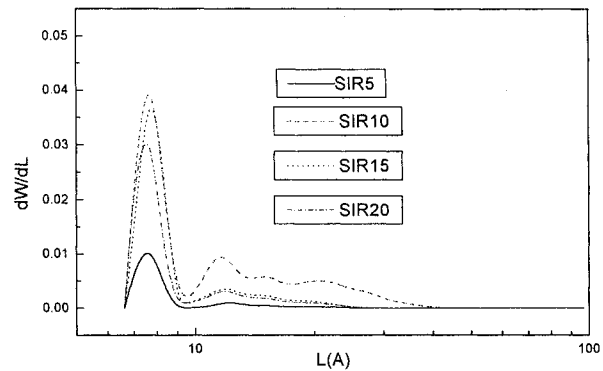


Figure 6. Effect of heating rate on pore size distribution of activated carbons

## Conclusions

The activation of sisal with KOH produces activated carbons of high surface area. At lower carbonization time the surface areas of activated carbons were higher. However, the lower the carbonization time, more mesopore contribution was found in the activated carbons. Excessively slow or high heating rates affect to the increase of surface area with the KOH treatment, negatively.

## References

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