

# THE CATALYTIC ACTIVATION OF PHENOL-RESIN BASED CARBON FIBER USING POTASSIUM

H. Jin, J. M. Lee, and P. Ehrburger \*

Korea Research Institute of Chem. Tech., P.O.Box 107, YUSUNG, Taejon 305-606, South Korea

\*Institut de Chimie des Surfaces et Interfaces, 15 rue Jean Starcky, B.P. 2488, 68057 Mulhouse Cedex, France

## Introduction

The conventional activated carbon fiber (abbreviation: ACF) is manufactured by two steps; carbonization and activation. Carbonization results in an elementary pore structure, and activation is to enlarge the radius of the pores, which were created during the carbonization process, and to increase some new porosity. In this work, the preparation of ACF was attempted by catalytic activation using potassium, which is known to activate carbon materials chemically.

## Experimental

Kynol fiber was impregnated in KOH ethanol solution. The ethanol was removed from the fiber by drying at 120°C for 1 hr. The resulting fiber was heated to 700 ~ 900°C at a rate of 10°C/min in argon atmosphere and kept for 15 minutes ~ 2 hrs to prepare carbon fiber (abbreviation: CF). Two CFs with potassium contents of 6.6 % (CF1), 0.2 % (CF2) were prepared together with the CF without potassium (CF0) as a reference. The CF was activated in carbon dioxide at 700 ~ 900°C. The number following these symbols, such as 700 and 900, means the activation temperature(°C). The potassium content in the fiber was measured by atomic absorption spectroscopy. The adsorption of nitrogen at -196°C and carbon dioxide at 0°C were performed in a volumetric apparatus in order to characterize the pore structure.

## Result and Discussion

Fig. 1 shows the relationship between activation time and burn-off. The activation rate of CF0 was very slow at 700°C, but those of CF1 and CF2 were fast. The potassium accelerated the activation process remarkably. The activation rates increased according to the contents of potassium. Activation began at temperatures slightly in excess of 700°C, and the reaction was accompanied by some vaporization of alkali metal into the gas stream.

Fig. 2 shows the relationship between total pore volume and burn-off. The total pore volume of CF0 increased remarkably with the extent of the activation. The two potassium impregnated series have lower total pore

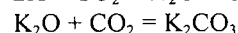
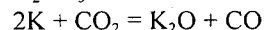
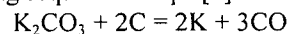
volumes and higher activation rates than unimpregnated CF0.

Fig. 3 shows change of mean pore radius with the proceeding of activation. The activation in CF0 increased the radius of micropores. A narrower micropores formed in potassium impregnated CF than in unimpregnated CF.

From the above results, It may be thought that potassium catalyzes gasification reaction similar to that described previously[1]. The gasification of metallurgical cokes by CO<sub>2</sub> at 900°C has recently been shown to be strongly catalyzed by potassium salts. Potassium plays an important role in the activation rate and in controlling the porous texture development of the activated carbon samples. The potassium influenced favorably narrow micropore formation as also found by coal activation [3].

Fig. 4 shows change of total micropore volume with the proceeding of activation. The size of total micropore volume in CF2 was kept unchanged in spite of proceeding of activation in contrast to the increase in CF0. This phenomenon is thought to be as follows: the formed micropores are removed by the burn-off, but simultaneously the micropores reform. No change of the size and volume of micropores means an equilibrium state between both processes.

The catalysis mechanism is thought as follows. The potassium hydroxide reacts with carbon dioxide resulting in potassium carbonate. The fact that vaporization of alkali metal has often been observed to accompany the C-CO<sub>2</sub> reaction when catalyzed by alkali metal carbonates, suggests that an oxidation-reduction cycle involving the intermediate formation of free alkali metal might be occurring. A possible cycle might consist of the following sequential steps [2]:



## Conclusions

Phenol-based activated carbon fiber could be made at 700°C by catalytic activation. The potassium accelerated activation of the fiber in carbon dioxide catalytically to form narrow micropore preferentially. The total pore volume of 0.3 ~ 0.9 cc/g, for mean pore width of 0.6 ~ 0.65 nm was obtained.

## References

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- [3] F. Krahenbuehl, H. F. Stoeckli, A. Addoun, P. Ehrburger and J. B. Donnet. The use of immersion calorimetry in the determination of

micropore distribution of carbons in the course of activation. Carbon, 1986; 24(4), 483-486.

## Acknowledgements

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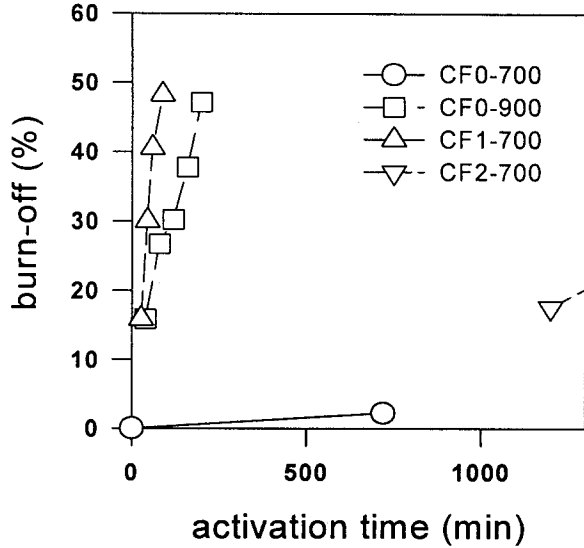


Fig. 1. Relationship between activation time and burn-off.

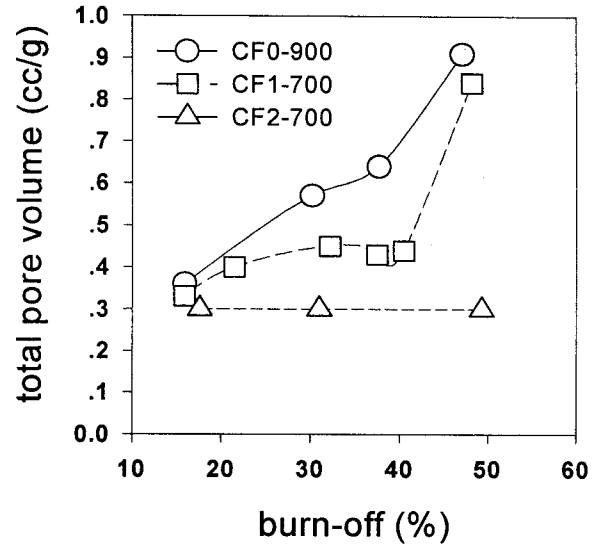


Fig. 2. Relationship between total pore volume and burn-off.

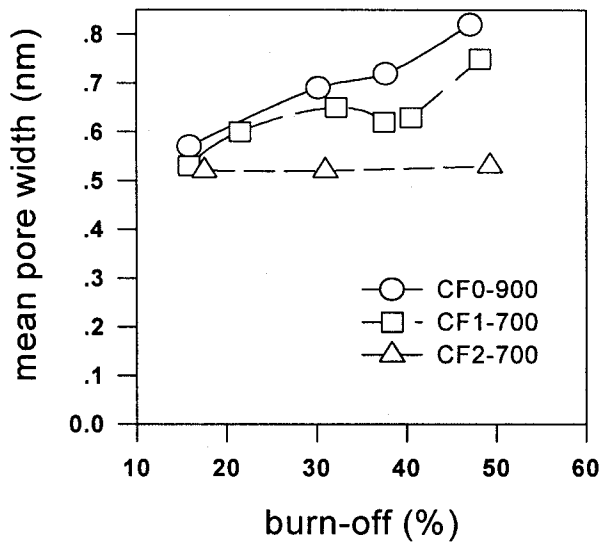


Fig. 3. Relationship between mean pore width and burn-off.

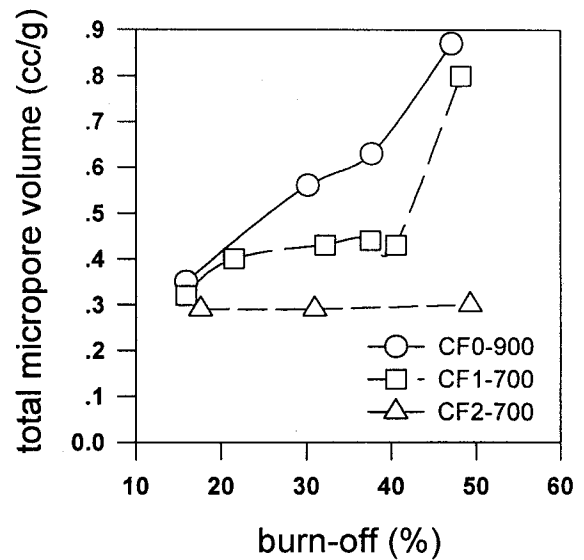


Fig. 4. Relationship between total micropore volume and burn-off.