# Activation and *n*-butane adsorption properties of activated carbons from cokes

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## Introduction

Activated carbons shows an ability to adsorbe hydrocarbons of the gas phase. Activated carbons are used in the purification of many kinds of gas phases like hexane, benzene, toluene, gasoline, phenol etc.[1] In this study, cokes from bitminous coal were activated for the purpose of preparing the activated carbons by steam activation. The effect of the activation temperature, time, steam concentration and flow rate on the *n*-butane adsorption, burn off, surface area and average pore size of the activated carbons, were investigated. The adsorption characteristics of the activated carbons for gasoline are indirectly estimated by *n*-butane adsorption.

## Experiment

The cokes used in this study were obtained from bitminous coal. The result of elemental analysis is summerized in Table 1. Cokes were activated in a tube furnace. Steams with concentration of 25~75%, flow rate of 1~3 ℓ/min, was supplied to the tube furnace through gas mixing apparatus which was preheated at 450℃. Activation was performed for 10~250 minutes at the temperture between 800~1000℃. Adsorption of *n*-butane on activated carbon was evaluated by the weight change after adsorption and desorption at 25℃. The flow rate of *n*-butane was 105㎖/min in adsorption, and that of air was 230㎖/min in desorption. Adsorption and desorption were kept for 20 minutes respectively. Effective adsorption($W_E$) was determined by the following

$$W_E = (M_1 - M_2)/V \times 100$$

where $M_1$ is the weight of the sample after adsorption, $M_2$ is the weight of the sample after desorption, V is volume of the samples.

## Results and discussion

Oxydation of carbons by steams is a endothermic reaction. The oxydation, therefore, is affected by activation temperture and time. The steam concentration in carrier gas and the gas flow rate through the reactor is important, too.

Fig. 1 shows burn offs of the cokes which were activated at various temperature and time. At the beginning of activation, the rapid increment of burn off was thought to be due to the volatile matters which were still remained in the cokes after carbonization. It can be seen that burn offs of the cokes were considerably influenced by the activation temperature.

The volumes of micropores, BET surface area of the carbons obtained by the activation of 30 minutes, are shown in Table 1. It was known that micorpores and mesopores were well developed in the activated carbon obtained at 600~900℃ and micropores were homogeneously developed in the carbons obtained at above 1000℃.[2] Table 1 shows that average pore size below 900℃ increase with elevated activation temperatures and decrease above 950℃, which was thought that exhaustion of carbons by oxydation was very serious at higher temperature above 950℃.

In Fig. 2, *n*-Butane adsorption of activated carbons is plotted versus activation temperature and time. It was observed that the amount of *n*-butane adsorbed increased considerably with activation time and dereased in the carbons obtained at 1000℃. There was not a sharp difference in average pore sizes of the activated carbons prepared at various temperatures in Table 1. This indicates that the amount of *n*-butane adsorbed is directly influenced by surface area and total pore volume rather than by average pore size. The surface area of the activated carbons which is related to the burn offs, needed to be increased in order to increase the amount of *n*-butane adsorbed.

The relationship of the amount of *n*-butane adsorbed and burn off for all the samples prepared in this study, is illustrated in Fig. 3. It is interesting that without regard to activation temperature and time, the amount of *n*-butane adsorbed is directly proportional to the burn off.

## Conclusion

*n*-Butane adsorption and surface area of the activated carbons obtained by steam activation from cokes, gradually increased up to 950℃, but decreased above 950℃. The amount of *n*-butane adsorbed on the activated carbons was directly related to the burn off.

## Reference


1. Kirk-Othmer, Encyclopedia of Chemical Technology, Vol. 3, p561, published by Wilely Interscience, 1978
2. Ermolenko, I., Morozova, A. A., Fridman, L. I., Savel'ev, G. G., Stas, N. F. and Gorina, T. S., Vesti Akd. Navuk, BSSR, Ser. Khim. Navuk, 5, 20(1975)


Table 1 Adsorption characteristics for the activated carbons

| Activation Temp. (50min) | BET Surface area($m^2$/g) by nitrogen | Total Pore Volume (cc/g) | Average Pore Size(Å) |
|---|---|---|---|
| 800℃ | 309 | 0.16 | 10.2 |
| 850℃ | 326 | 0.17 | 10.3 |
| 900℃ | 426 | 0.22 | 10.4 |
| 950℃ | 566 | 0.28 | 10.0 |
| 1000℃ | 530 | 0.26 | 9.8 |

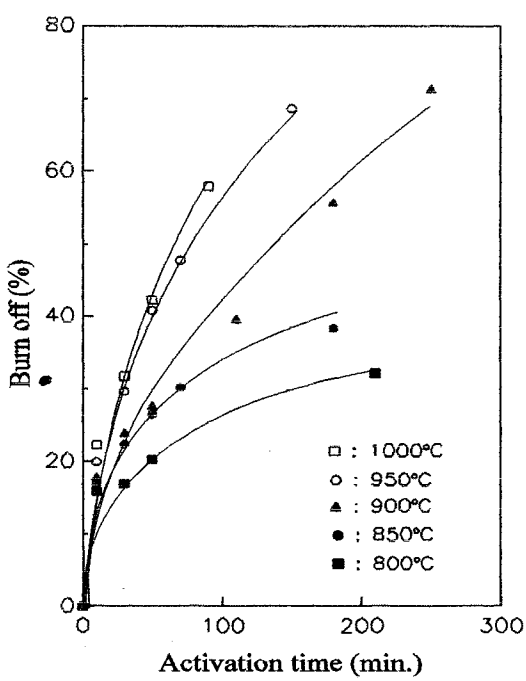


Fig. 1 Burn offs of activated carbons obtained from cokes

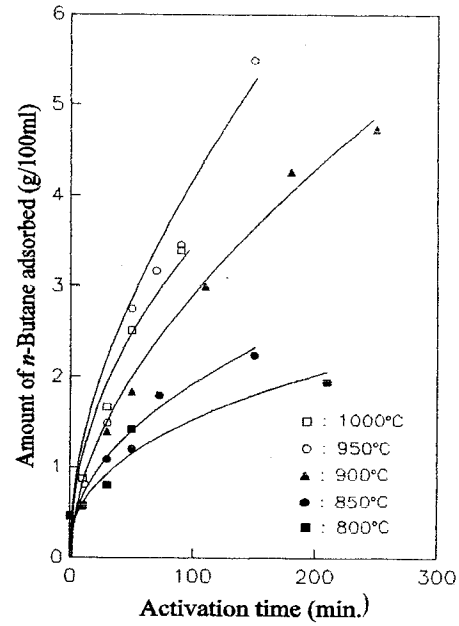


Fig. 2 *n*-Butane adsorption of the activated carbons obtained from cokes

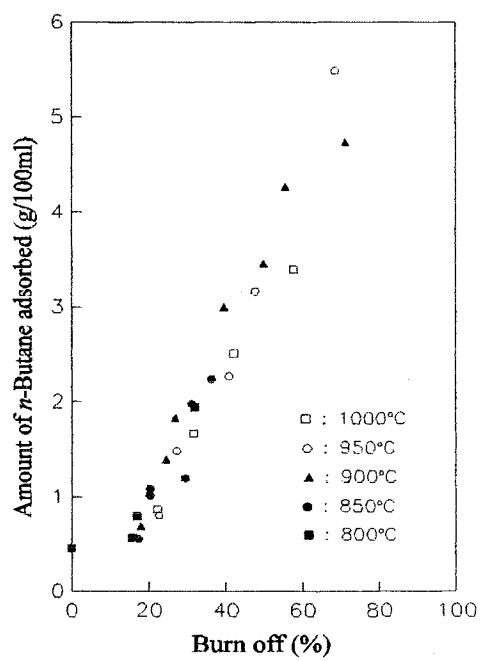


Fig. 3 The relationship of burn off and *n*-butane adsorption for the activated carbon from cokes