Production and CO_2 adsorption characteristics of activated carbon from bamboo by CO_2 activation method

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1. Summary

The activated carbon was produced from Sancheong bamboo by carbon dioxide gas activation methods. The carbonization of raw material was conducted at 900 ℃, and CO_2 activation reactions were conducted under various conditions: activation temperatures of 750□900 ℃, flow rates of carbon dioxide 5□30 cm^3/g-char·min, and activation time of 2□5 h. The yield, adsorption capacity of iodine and methylene blue, specific surface area and pore size distribution of the prepared activated carbons were measured. CO_2 adsoption characteristics for bamboo activated carbon were tested in the range of isothermal adsorption temperature of 20□80 ℃ and CO_2 concentration of 5□90%.

Keywords: bamboo, activated carbon, CO_2 activation method, CO_2 adsorption

2. Extended Abstract

Global warming, and the role of carbon dioxide in the greenhouse effect, are not widely recognized as urgent environmental problem. Many usual solution has been suggested to reduce these CO□emissions, including separating and capturing the CO□prior to emission into the environment. Adsorption processes to separate CO□gas from mixed flue gas are divided into high and low temperature process. Adsorbents for high temperature (MgO, CaO, alumina, etc.) are used in the high temperature adsorption process, and those for low temperature (activated carbon, zeolite, etc.) are used in the temperature below 250 ℃.

Activated carbons produce by using the various methods and from the various raw materials. In this study, bamboos cropped at Sancheong province in Korea were selected as raw materials by reason of the biomass, fast growth rate, and domestic resources. The

bamboos were previously pyrolyzed to bamboo chars at the 900 □ during 2 h under nitrogen gas stream, crashed to 0.5~3 mm size, and activated by CO□gas activation method. Then the bamboo activated carbons were characterized for physical properties and CO□adsorption properties.

The activation equipment was a stainless-steel tube reactor of 50 mm I.D. installed in a 3 kw three zone Lindberg tube furnace(LHTF322C) for which the temperature was controlled using a K-type thermocouple.

The BET surface area of bamboo char carbonized at 900 □ was 90~100 m^2/g. The adsorption capacity of iodine and methylene blue(MB) for activated carbon increased with activation time. After 4 h, bamboo activated carbon having Iodine No. above 1,400 mg/g were produced. But the yield of activated carbon decreased with the activation time to 68.9%(2 h), 59.7%(3 h), 53.7%(4 h), and 43.0%(5 h). The mean activation rates were 0.11~0.16 g/g·h.

The effect of reaction temperature was isothermally tested during 3 h in the range of 750~900 □ and in the CO□flowing of 7.8 $cm^3/g\text{-char}\cdot min$. The adsorption capacity of activated carbon increased with activation temperature. Iodine No. was 680.8 mg/g(750 □), 915.6 mg/g (800 □), 1135.1 mg/g(850 □), and 1183.8 mg/g(900 □). MB No. was 23.5 mg/g(750 □), 62.2 mg/g (800 □), 122.6 mg/g(850 □), and 127.3 mg/g(900 □). BET surface area was 666.1 m^2/g(750 □), 858.7 m^2/g (800 □), 1028.5 m^2/g(850 □), and 1072.0 m^2/g(900 □). Yield decreased with activation temperature to 83.4 %(750 □), 74.2 %(800 □), 59.6 %(850 □) and 47.6%(900 □).

In the test of the CO□amount effects on the MB No. and yield at 850 □ after 3 h reaction time, Yield decreased continuously in the range of 71.9~39.5% with CO□amount range of 5~30 $cm^3/g\text{-char}\cdot min$. But MB No. increased with CO□amount till 20 $cm^3/g\text{-char}\cdot min$, but held up steady state value.

Cumulative pore areas calculated by the BJH equation were 58.8 m^2/g (800 □), 77.9 m^2/g (850 □), and 100.2 m^2/g (900 □). N□adsorption method was used to characterize of micropore properties. In the test of characteristics of meso and macropore by mercury porosimetry, totally pores between 100~1000□ were well developed, pores below 100□ were especially contributed to the pore surface area. Pore surface area below 100□ increased with the activation temperature.

CO□adsorption on the bamboo activated carbon was completed within 1 min. CO□adsorption decreased with increasing the adsorption temperature in the range of 20~80 □. Adsorption weights percentage of CO□at 20 □ is 5% of bamboo activated carbon's weight.

Saturated CO_2adsorption amounts increased with CO_2partial pressure, but decreased with adsorption temperature to 106 mg CO_2/gA.C.(10.6% CO□of weight of activated carbon) at 684 mmHg of CO□ (90% of CO□concentration) and 20 □.