Original

Formaldehyde Reduction in Indoor Environments by Wood Charcoals*[1]

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Abstract——The effect of carbonization temperature of wood charcoal on the reduction ability of gaseous formaldehyde was studied for a basic study on air purification in indoor environments. The ability to remove formaldehyde was maximum when using wood charcoal carbonized at a temperature of 600°C, which was greatly influenced by the chemical factors.

Keywords: wood charcoal, formaldehyde, reduction, carbonization

1. Introduction

In recent years, considerable attention has been focused on wood charcoal applications especially based on its adsorption properties, such as removal of NOx[1)] or oil, adsorption of organic pollutants and heavy metals[2)], and production of pure water in the electric parts industries. Since air-tight room environments, rationality in the building process and variation in the building materials used have lead to an increase in indoor environmental pollutants involving harmful materials such as aldehydes or ketons released from housing materials, adhesives or paint. This has caused health problems such as allergy or "sick house syndrome". In order to solve health problems related to air-pollution in indoor environments on a global scale, activated charcoal to reduce air pollutants is becoming more widely used. However, the capability of wood-based charcoal materials is not yet fully known. In this study, the effect of carbonization temperature of wood charcoal on the reduction of formaldehyde was investigated for the basic study on the air purification in room environment.

2. Materials and Methods

Wood powder of Japanese cedar (*Cryptomeria japonica* D. Don ; 20 mesh pass) was dried at 105°C for 24 hours, and then carbonized in an electric furnace at specific temperatures ranging from 200°C to 1,000°C. The temperature was increased at the rate of 4°C/min , and then kept constant for 1 hour after reaching the target temperature. Wood charcoal was removed from the furnace after natural cooling. A gaseous sample of formaldehyde was prepared by putting a specific amount of formalin and purified air consisting of 79% of N_2 and of 21% of O_2 in a tetra pack and storing at room temperature for a few days.

A gaseous sample with 600 to 700 ppm of formaldehyde was passed through a reaction tube with wood charcoal powder at a rate of 100 ml/min. The concentration of formaldehyde was measured by a gas detecting tube. Original wood powder of sugi and activated charcoal of coconut shell powder provided from Nakalai tesque, Japan, code 079-31, were used for controls.

The initial removal ability of formaldehyde was determined while sucking for 1.5 min, and the total removal ability of formaldehyde was measured periodically, while passing the gas through the tube for 1 hour.

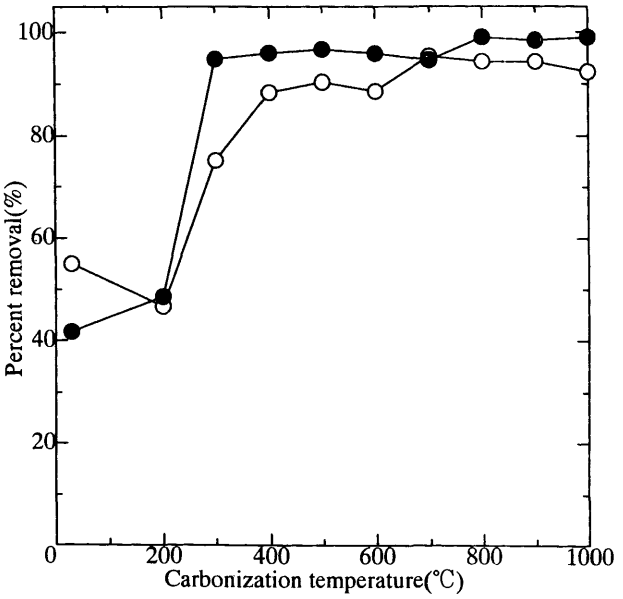

Fig. 1. Relationship between initial percent of formaldehyde removal after passage through wood charcoal powder and carbonization temperature. Legend : —○— charcoal from sapwood, —●— charcoal from heartwood. Note: Activated charcoal showed 99.7% of percent removal.

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3. Results and Discussion

3.1 Initial ability to remove formaldehyde

Fig. 1 shows the relationship between carbonization temperature and percentage of formaldehyde removal on the first passage through wood charcoal powder for 1.5 min. The percent of formaldehyde removal by wood charcoal made from sapwood was slightly lower than that from heartwood at a carbonization temperature range from 200°C to 1,000°C. The percent removal was improved drastically at a carbonization temperature of around 200°C to 400°C and showed about 90% removal over 500°C. A similar percent removal, which only slightly differed from values obtained with activated charcoal, was obtained for sapwood and heartwood over 700°C.

3.2 Removal ability of formaldehyde after passing through charcoal

Fig. 2 and Fig. 3 show the relationship between the time and percent removal of formaldehyde after passing through wood powder and charcoal for sapwood and heartwood, respectively. Similar trends were observed for sapwood and heartwood. The powder made from the original wood and wood charcoal carbonized at 200°C removed less formaldehyde than other specimens. Wood charcoal carbonized at 600°C demonstrates the best ability to remove formaldehyde, especially in the first 30 minutes. Its ability was superior to activated charcoal in this period of time. In the case of using wood charcoal carbonized at higher temperature than 600°C, removal ability of formaldehyde was not improved. The effect of carbonization temperatures on the ability of formaldehyde reduction was considered to be affected by the amount of specific surface area and distribution of pore diameter on size, as well as chemical factors such as the kinds and distribution of functional groups on the material.

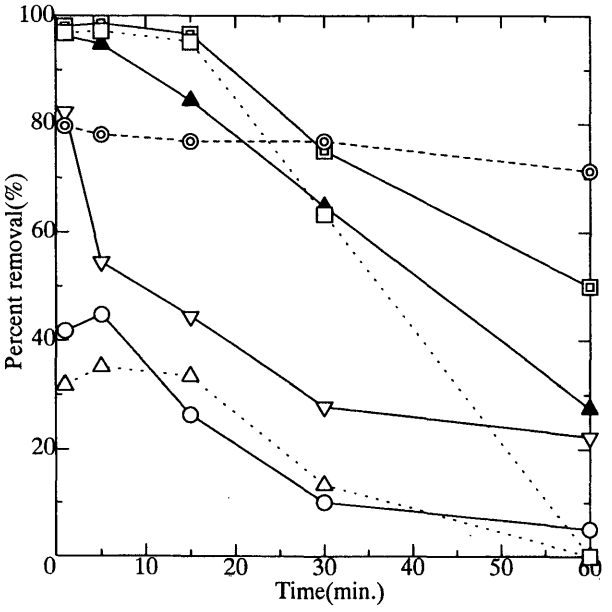

Fig. 2. Relationship between time and percent of formaldehyde removal passing through wood and charcoal powder made from sapwood. Legend: —○— wood powder, —▲— charcoal (800°C), ···△··· charcoal (200°C), ···□··· charcoal (1,000°C), —▽— charcoal (400°C), ···◎··· activated charcoal, —▣— charcoal (600°C).

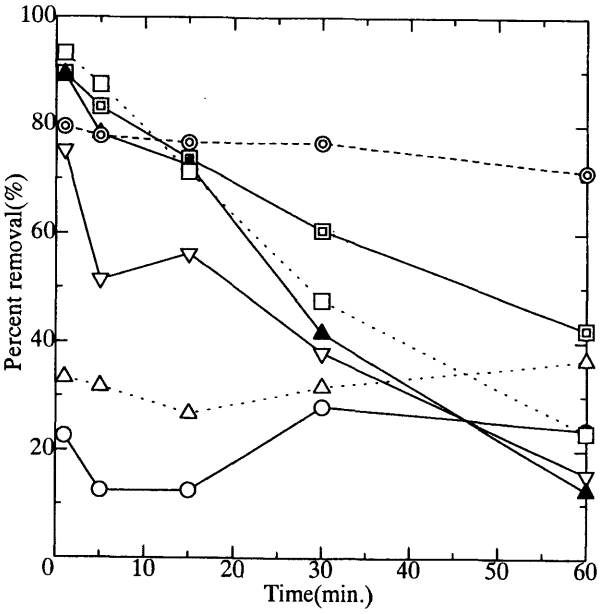

Fig. 3. Relationship between time and percent of formaldehyde removal passing through wood and charcoal powder made from heartwood. Legend: —○— wood powder, —▲— charcoal (800°C), ···△··· charcoal (200°C), ···□··· charcoal (1,000°C), —▽— charcoal (400°C), ···◎··· activated charcoal, —▣— charcoal (600°C).

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