REMOVAL OF NOx OR ITS CONVERSION INTO HARMLESS GASES BY CHARCOALS AND THEIR COMPOSITES OF TRANSITION METAL OXIDES OR ZEOLITE

S. Ishihara and T. Furutsuka
Wood Research Institute, Kyoto University
Uji Kyoto 611 Japan

Introduction

In recent years, much attention has been devoted to environmental problems such as acid rain, photochemical smog and water pollution [1]. In particular, NOx emissions from factories, automobiles, etc. in urban areas have become worse. In order to solve these problems on environmental pollution, the use of activated charcoal, oxides of transition metals, composites of noble metals and zeolites to reduce air pollutants is increasing. However, the capability of wood-based charcoal materials is not yet fully known. The removal of NOx or its conversion into harmless gases such as N_2 should be described [2]. In this study, the conversion or adsorption of NOx over wood charcoal and zeolites-dispersed ones were investigated.

Experimental

Wood powder of sugi (*Cryptomeria japonica* D. Don; 20 mesh pass) was dried at 105℃ for 24 hours, and then carbonized in electric furnace at the desired temperatures from 200 to 2400℃. The temperature was increased at the rate of 4℃/min., and then kept constant for 1 hour after reaching the target temperature. Wood charcoal was taken out of the furnace after natural cooling. Wood charcoals were soaked in solutions of metal alkoxide dissolved in 1-propanol. The charcoal was then ovendried at 105℃ for 24 hours and heated at 600℃ for 3 hours. In this way, metal oxide-dispersed wood charcoal was prepared. Zeolite-dispersed wood charcoal (Photograph 1) was prepared by a common process of zeolites preparation with wood charcoals. NOx gas of about 100 ppm was passed through the reaction tube with wood charcoal, metal oxide-dispersed wood charcoal, zeolite-dispersed one. The concentration of NOx gas was measured by gas detectors and GC. During the measurement, the reaction tube was radiated by monochromator or covered by black shield. The physical and chemical characteristics of charcoal were also evaluated.

Results and Discussion

Wood powder carbonized at 1000 and 1400℃, and activated charcoal had considerably larger specific surface areas compared to those carbonized at 200, 600, 1800 and 2200℃. No large difference was observed on the pore size distribution and specific surface areas between wood powder and wood powder carbonized at 200, 600, 1800 and 2200℃. Wood powder carbonized at 1000 and 1400℃ as well as activated charcoal created more micropores with radii below 10 nm. The formation and disappearance of micropores might have an effect on the similar tendency between pore size distribution and specific surface area.

When the carbonization temperature was 600℃, the concentration of NO was the lowest in all the samples of NOx after passing NO through wood charcoals and activated charcoal, that is, the wood powder carbonized at 600℃ indicated the best conversion or adsorption ability, even though the specific surface area and pore size distribution of wood powder carbonized at 600℃ were not remarkably large compared to wood powder carbonized at 1000 ℃ and activated charcoal. It seems that the conversion or the adsorption ability has nothing to do with physical properties. On the other hand, the concentration of NO_2 was not detected among every sample. It is clear that every charcoal except wood powder has good NO_2 conversion or adsorption ability. Very little concentration of NO was detected from every charcoal. It was observed that wood charcoal reduced NO_2 to NO (Figure 1).

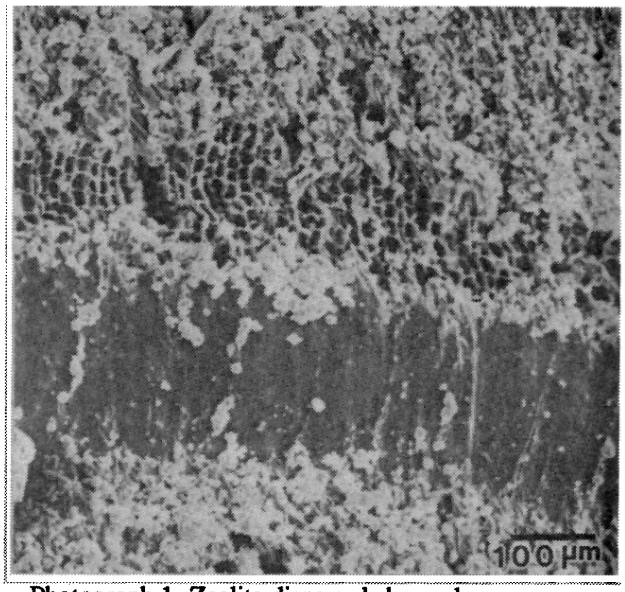
When metal oxide-dispersed wood charcoal was ovendried at 105℃, the NO conversion and the reduction efficiency from NO_2 to NO decreased compared to wood charcoal. However, the capacity to convert or adsorb NO was improved by heat treatment of the composite at 600℃. Particularly, vanadium oxide-dispersed wood charcoal showed the highest tendency to convert or adsorb greater amount of NO. When metal oxide-dispersed wood

charcoals were illuminated by monochromatic light with near wavelength of ultraviolet rays, titanium oxide-dispersed wood charcoal remarkably decreased the concentration of NO. The shorter the wavelength became, that is, as the light energy increased, the better the conversion or adsorption ability. From this result, it was found that oxide of transition metal performed as photocatalyst [3], since based from the result, vanadium or titanium oxide oxidizes or reduces NO by light energy.

Removal of NO or its conversion into NO or N_2 by the zeolite-dispersed wood charcoal were decreased with an increase in content of zeolite on the wood charcoal.

References

1. Kaneko, K. et. al., *Colloid & Polymer Sci.*, 265, 1987, p. 1018-1026.
2. Imai , J. et.al., *Catalysis Letters*, 20, 1993, p. 133-139.
3. Fujishima , A. et. al., *Nature*, 1972, 238, p. 37-38.



Photograph 1. Zeolite-dispersed charcoal.

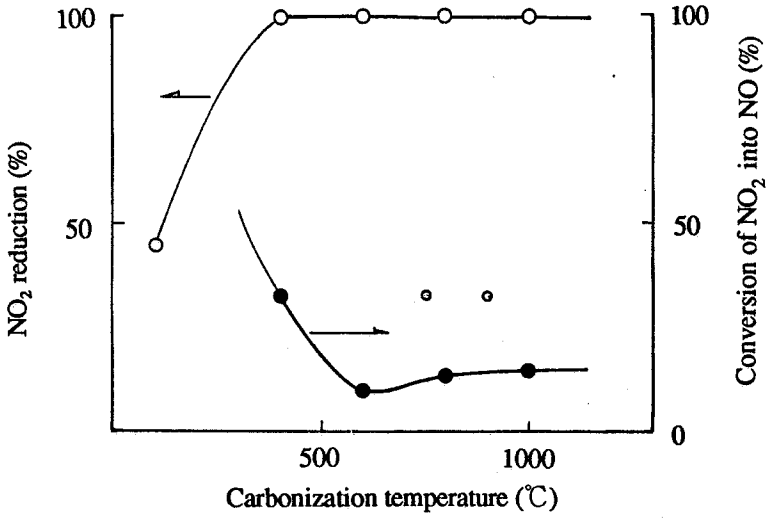


Figure 1. Relationship between carbonization temperature and NO_2 reduction, and conversion of NO_2 into NO.
○: commercial activated charcoal