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Adsorption Properties of Porous Carbon Material Woodceramics

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It is able to expect to have the adsorption properties because Woodceramics are porous carbon materials. On the other hand, the high application of the added value is hoped more in material development. Thereupon, first of all, adsorption properties on Woodceramics were investigated. Secondly adsorption properties on Woodceramics coated with TiO_2 were investigated. The results are summarized as follows: Woodceramics are the carbon materials that have adsorption characteristic. Although the adsorption properties of Woodceramics will be inferior with time, Woodceramics coated with TiO_2 have an effective adsorption property. In other words, the method coated with TiO_2 seems to be one of the high usage of added values.

Key words: Woodceramics, Adsorption, Porous Carbon, TiO_2,

1. INTRODUCTION

In the materials field, there is a strong need to develop environmentally - friendly materials.

At present, there is a design of living space as the familiar example of consideration to environment. Environmental problems in the living space are contaminations such as molds, ticks, chemicals substances etc., and the development of new building materials is advanced as an environment countermeasure. There is charcoal with many porous structure as one of the new building materials*), and it is being used as building materials in living space.

By the way, there are porous carbon materials Woodceramics in the material with the same structure as charcoal. Woodceramics have characteristics of far infrared radiation effect, electromagnetic wave shield effect and humidity-regulating effect etc. And, because Woodceramics are materials with porous structure, it is able to expect to have characteristics of adsorption and heat insulation as charcoal. Then, the purpose of this research is to investigate about the adsorption characteristic of Woodceramics.

2.EXPERIMENTAL METHODS

2.1 Specimen

Specimens are Woodceramics that impregnated MDF (Medium Density Fiberboard, Density = 0.57Mg/m^3) with phenol resin (PX-1600) and burned at each burning temperature [600 ℃ (Density = 0.81Mg/m^3>,80 ℃ (Density = 0.88Mgm^3),1000 ℃ (Density = 0.80Mg/m^3))so that each specimen becomes all the same volume beforehand, Woodceramics were prepared.

To grasp the adsorption performance level of the Woodceramics, carbon materials as the materials of MDF (Thereafter, it claims to be it with MDF charcoal, Density = 0.54Mgm^3) and carbon materials as the material of bamboo material (Density=0.57Mg/m^3) were used as the comparative materials.

10% Ammonia water [NH_3] and 28% trimethylamine [$(CH_3)_3N$] were used as adsorption gas.

2.2 Woodceramics coated TiO_2

TiO_2 was coated on the entire surface of Woodceramics (Burning Temperature:800℃)

The method of the coating is as follows.

1) Under coating (once) (Undilution, for 3 hours drying), 2) Middle coating (twice) (15% dilution, for 3 hours drying), 3) Finish coating (once) (Undilution)

2.3 Adsorption properties of Woodceramics

Specimen and adsorption gas were inserted in a wit filtration device (capacity=10ℓ) made of glass and density of adsorption gas was measured at any time with a gas detection pipe (GASTEC SERVICE).

Furthermore, the early period density of adsorption gas was set up to 350ppm. Further, magnetic stirrer was set in the container bottom and the container filled with adsorption gas were unified by rotating the stirring stick inside the container so that adsorption gas inside the container becomes evenness.

Beforehand, specimens were heated for 3 hours at 180℃. And, the adsorption performance of a comparative material was similarly checked.

2.4 Adsorption properties testing on Woodceramics coated with TiO_2

Woodceramics coated with TiO_2 was exposed for 168 hours in the container (850 ml) with 10% of ammonia water (density 1%).

After that, adsorption performance of TiO_2 coating material was investigated under the following environment. Furthermore, to check the adsorption effect of TiO_2 coating on Woodceramics, Woodceramics (burning temperature: 800℃) was used as the comparative material of the adsorption effect by exposing during ammonia atmosphere.

(Environment condition)

A measurement device was put in the place of right under 160cm from a ceiling light (a fluorescent light) the part 270 cm, from the indoor window side to the back of a measurement room.

The measurement condition is as follows.

The illuminance of the source of light is 500lx.

The ultraviolet ray quantity that is radiating from the source of light is 0.3μ W/cm^2.

3. RESULTS AND DISCUSSION

3.1Adsorption properties to ammonia gas

Fig.1 shows the effect of concentration of ammonia on Woodceramics. MDF-charcoal and charcoal board were used as comparison material of Woodceramics.

As can be seen from Fig.1, concentration of Ammonia is decreasing with progress of time in an exponential function. It shows that Woodceramics is the material with adsorption characteristics.

The adsorption properties are inferior compared with a comparative material.

The followings are conceivable as the factor of adsorption properties.

Because Woodceramics are impregnated by phenol resin, the surface area of Woodceramics is smaller than comparative material. The degree of adsorption ability is due to the size of a surface area. Therefore, the adsorption ability of Woodceramics seems to be inferior compared with comparative materials.

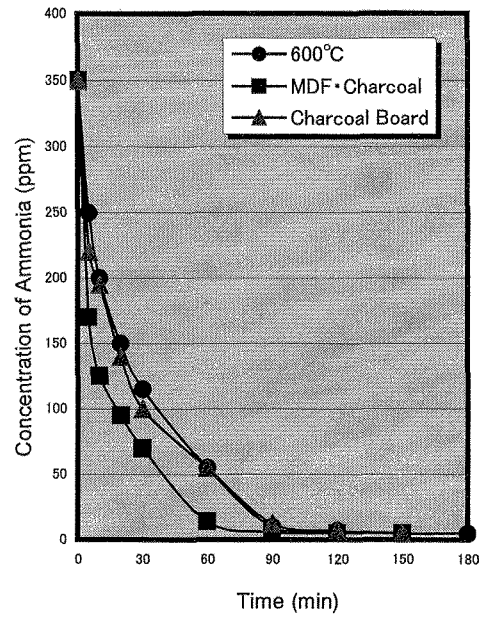

Fig1. Adosorption of Woodceramics

3.2 Burning temperature and density

Fig.2 shows the effect of concentration of ammonia on burning temperature.

As can be seen from Fig.2, Woodceramics at burning temperature 800℃ have a lower adsorption performance than ones at burning temperature 600℃ and also 1000℃.

The weight of specimens that used at this experiment were 27.6g at burning temperature 1000℃, 31.6g at burning temperature 800℃ and 27.7g at burning temperature 600℃.

In general, when density of Woodceramics is compared at burning temperature 600℃, 800℃ and 1000℃, Woodceramics burned at burning temperature 800℃ is the biggest[4].

The size of the density is related to the size of pore rate. In other words, the bigger the density, the smaller the pore rate.

In the case of the material that has a few pore rates, the size of surface area also becomes small simultaneously. Therefore, Woodceramics burned at burning temperature have a lower adsorption performance compared with each one burned at burning temperature 600℃ and 1000℃.

Fig.3 shows the effect of concentration of ammonia on volume of specimen.

As can be seen from Fig.3, difference of the size of specimens, in other words the lager the size of specimen, the more adsorption quantity increases.

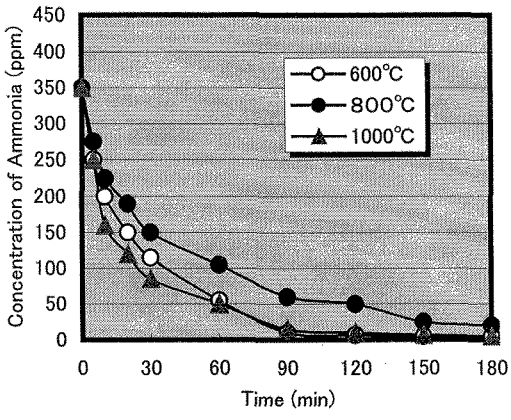

Fig.2 Efect of Concentration of Ammonia on Burning Temperature

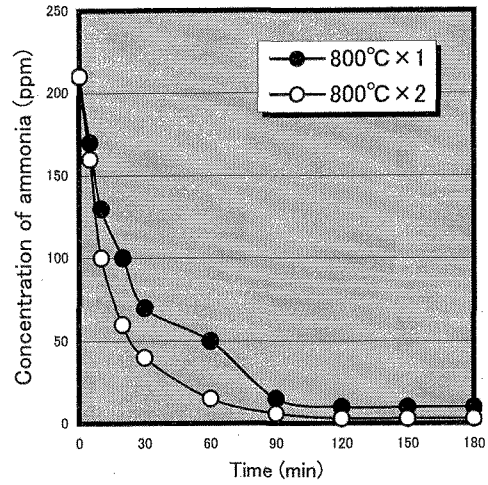

Fig.3 Effect of concentration of ammonia on volume (amount)

3.3 Trimethylamine adsorption properties

Fig.4 shows the effect of concentration of trimethylamine on Woodceramics.

As can be seen from Fig.4, any obvious adsorption effect is not appearing, although it is showing it even if the adsorption performance of Woodceramics corresponds to trimethylamine.

The followings are conceivable as the cause why any obvious adsorption effect does not appear. The size of the molecular weight of trimethylamine is considered to influence an adsorption effect.

The size of the molecular weight of the ammonia is 17 and that of trimethylamine is 59.11 and about 3.5 times of the size. In other words, the molecular weight of trimethylamine is bigger than ammonia.

The bigger the molecular weight, the bigger the intermolecular force, and the connection of an intermolecular becomes stronger. Therefore, to evaporates trimethylamine, many times needs to be spent.

As a result, it is probable that smell remains long time in a container, and a detection pipe reacts to this smell strongly.

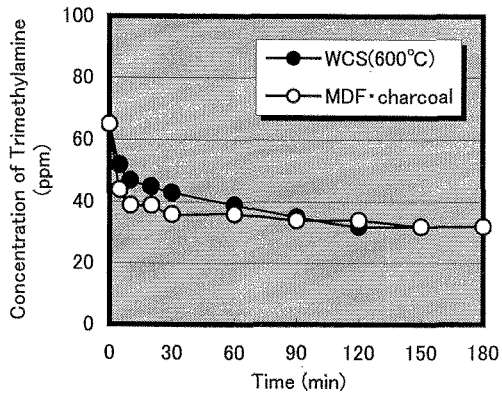

Fig4. Adsorption of trimethylamine by Woodceramics (600℃)

3.4 Adsorption performance by TiO_2 coating

Fig.5 shows Woodceramics surface coated with TiO_2.

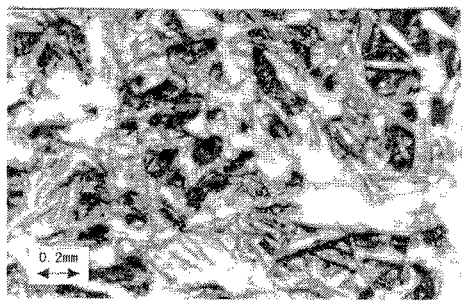

Fig.5 Macroscopic views of Woodceramics surface coated TiO_2

As can be seen from Fig.5, coated face is composed of porous parts and parts coated with TiO_2. Fig.6 shows the adsorption properties of Woodceramics coated with TiO_2. As can be seen from Fig.6 and Table 1, because the comparative material is absorbing ammonia sufficiently, it is not able to absorb the ammonia over this. In other words, the comparative material is saturatied condition. On the other hand, Woodceramics coated with TiO_2 absorbed the ammonia sufficiently. This cause seems to be the adsorption effect. This adsorption effect seems to depend on an adsorption and a disintegration that is the characteristic of TiO_2. The adsorption ability with Woodceramics coated with TiO_2 is smaller than the comparative material. The cause that this adsorption ability falls off is shown below. Because the impregnation rate of the phenol resin of workpiece that used this time was a high impregnation rate (68.9%), it seems that the impregnation rate becomes low and the surface area became small. From now on, we need to examine and need to compare with porous rate as a parameter.

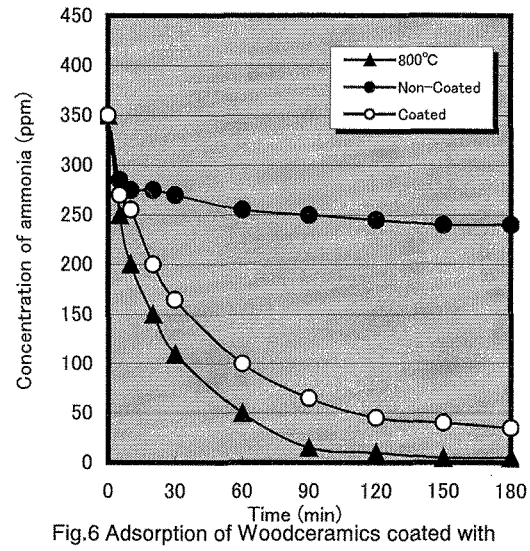

Fig.6 Adsorption of Woodceramics coated with TiO_2

Table 1. Change of weight on before and after experiments.

	Before expreiment	After Experiment (24hours after)
Non-coating	29.5g	32.9g
Coating	34.6g	35.5g

4. CONCLUSIONS

1) Woodceramics are porous carbon materials that have adsorption properties.

2) Adsorption properties will be inferior to the target when they pass.

3) The adsorption effect by TiO_2 that has dissolution ability is excellent in the target when it passes.

REFERENCES

(1) H.Tachimoto, The interesting stories of charcoal, Daily industry newspaper publishing company , (2000).

(2) S. Kishimoto, Charcoal , Sorin Ctd., (1998).

(3) S. Kishimoto, Natural history of charcoal, Integration science publication , (1984) .

(4) T. Okabe, Woodceramics, Uchida Rohkakkuho Press, Tokyo, (1996), pp.114.

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