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Repetition Property of Chemical Compound Adsorption by Charcoal Board Adhered with Superfine Natural Fibers

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We newly developed charcoal board by adhering charcoal powders with superfine natural fibers as binder. Charcoal board as a building interior material was prepared from charcoal powders adhered with superfine cellulose and collagen fibers. Since natural fibers was used as a binder for the charcoal board, adsorbability of the charcoal was maintained, because superfine natural fibers do not cover micropores on the charcoal surface. Repetition property of the adsorption of ammonia and formaldehyde was measured, which leaded to estimation of saturated adsorption amount. The saturated adsorption amount depended on the kind of gas and circumstantial relative humidity (RH). The middle RH of about 53%, the saturated adsorption amounts for ammonia and formaldehyde were 5.9 mg/g and 3.9 mg/g, respectively.It was found that relative humidity affected the adsorbability of chemical compounds. In high humidity RH of 81% and the middle RH of 53%, the adsorption rate and the adsorption amount for the ammonia were larger than those in the low RH of 31%.

Key words: Charcoal, Superfine natural fibers, Adsorption, Relative humidity

1. INTRODUCTION

Adsorption property of the charcoal has been applied so far for a deodorizer and cleansing materials. The adsorption property depends on both of the surface area and superficial active group of the carbon. We have proposed charcoal board, one of the new materials which are conscious of our environment[1]. This material composes of carbonized material powders and superfine natural fibers as binder. One of the characteristics of the charcoal board is to use industrial waste as raw materials. And charcoal board does not contain harmful chemical compounds and does not generate them during the production process either. Furthermore, when the charcoal board is disposed, it returns to charcoal powder without polluting environment, because the binder is biodegraded by natural microbiological activities and the charcoal is never rotten and oxidized in the natural state.

We have studied on the biodegradation property, the chemicals adsorption property and the humidity controllability of the charcoal board, and the availability of the charcoal board as building materials was discussed[2]. The charcoal board can be expected to application for building materials of Healthy Housing [3].

In this paper, we report on the repetition property of chemical compound adsorption by the charcoal board and the effect of the humidity on the adsorption property.

2. EXPERIMENTAL

2.1 Sample preparation

The flowchart of sample preparation method is shown in Fig. 1. The charcoal board was made from cellulose and collagen as binder and charcoal powder. The superfine natural fibers were made by mixing the superfine cellulose and collagen fibers [4]-[6]. The charcoal wood was carbonized at 750℃. Then, charcoal powder was mixed with the superfine fibers, pressed and dried at 105°C for 24 hr. The composition ratio of charcoal/superfine fiber in the charcoal board was adjusted to 8/2, and the composition ratio of cellulose fibers/ collagen fibers in the superfine fibers was 8/2 . And the specific gravity was 0.4.

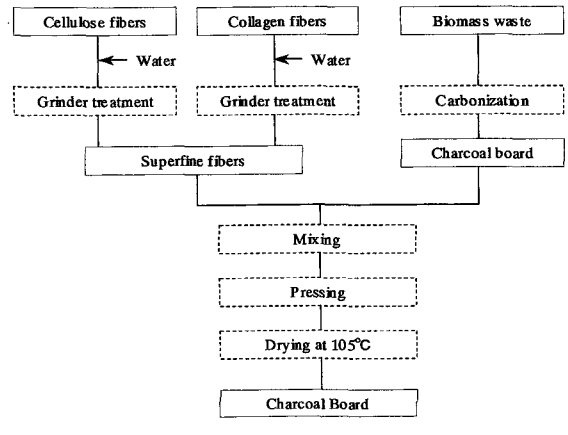
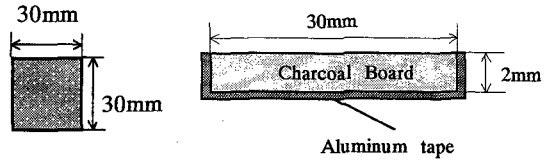


Fig. 1 Flowchart of sample preparation method

(a)shape of sample



(b)position of sample

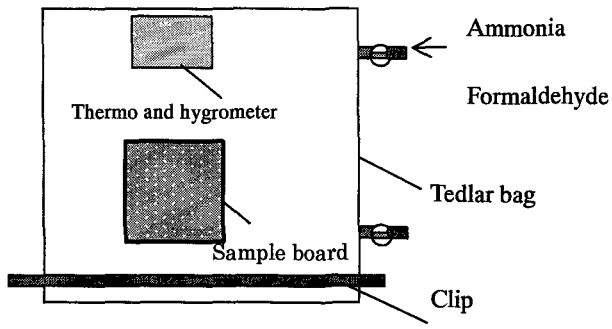


Fig.2 Layout for adsorption measurement.

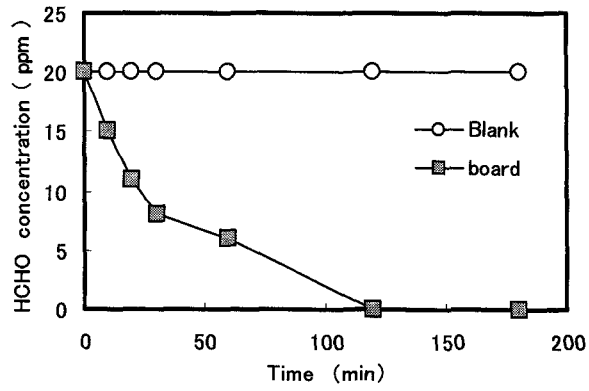


Fig.3 Formaldehyde adsorption by the charcoal board.

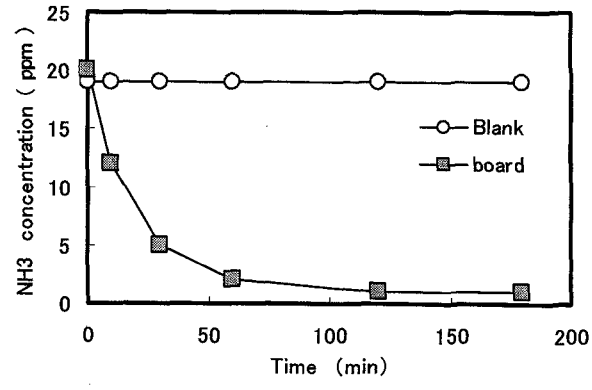


Fig.4 Ammonia adsorption by the charcoal board.

2.2 Chemical compound adsoption test method

Chemical compound adsoption test method is shown in Fig. 2. The test sample was 30 mm x 30 mm and 2 mm in thickness. The test sample was dryed at 105°C for 12 hours. The sample surface except the front surface (30 mm x 30 mm) was covered by aluminum tape in order to prevent adsorption of gas from the back surface and the side surface.

The Tedlarbag was used for a chamber. Detector tube was used for measurement of chemical compound concentration in the chamber. Formaldehyde (HCHO) and ammonia (NH_3) were selected as adsorbed gas. The initial gas concentration were 20 and 100 ppm in a chamber. The adsoption test measured at 23°C.

Circumstantial relative humidity (RH) for testing adsorption/desorption efficiency for building materials is defined for three regions low RH of 13~33%, middle RH of 34~74% and high RH of 75~98%[8]. In this experiment, about 31%, 53% and 81% were adopted as the low, middle and high RH, respectively.

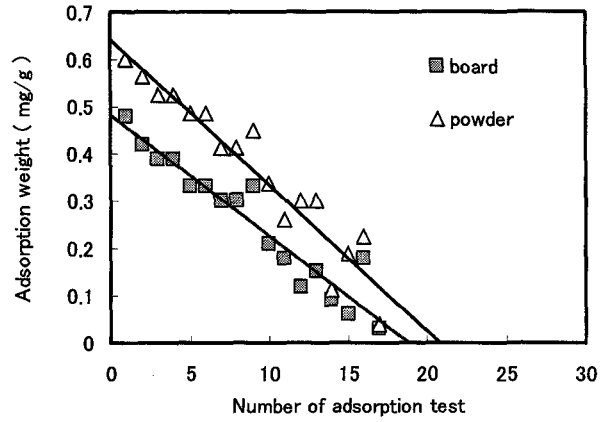


Fig.5 Reduction of formaldehyde adsorption weight in repetition of formaldehyde adsorption test in the middle humidity by charcoal board. Initial gas concentration is 20ppm.

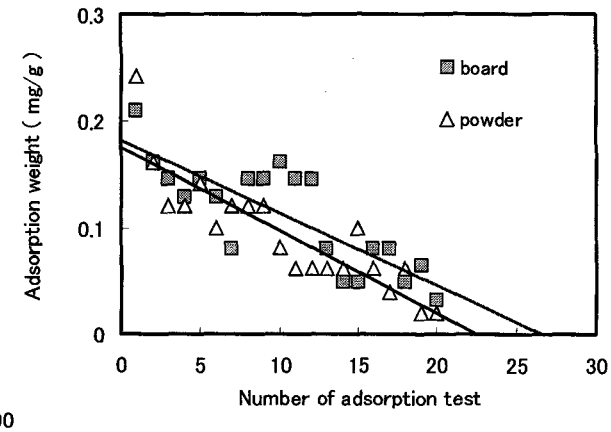


Fig.6 Reduction of ammonia adsorption weight in repetition of ammonia adsorption test in the middle humidity by charcoal board. Initial gas concentration is 20ppm.

3. RESULTS AND DISCUSSION

3.1 Chemical compound adsorption

As charcoal has porous structure, chemical compounds can be adsorbed into the pore surface. Before adsorption test, the test sample was placed in RH=53% until adsorption equilibrium was reached. Figs. 3 and 4 show the results of formaldehyde and ammonia adsorption by the charcoal board in the middle humidity, respectively. The initial gas concentration was adjust to 20 ppm in a chamber. The gas concentration decreased with increasing adsorption time. After 200 minutes the charcoal board adsorbs almost amount of gas. The final adsoption amount by the chacoal board is almost same as that by the charcoal powder, but the adsorption velocity is different between them. This means that using superfine natural fibers as a binder, adsorbabilits of the charcoal is maintained, because superfine natural fibers dose not cover micropore on the charcoal surface. In the case of using polymer resin as a binder the adsorbability of the charcoal should decrease, because polymer covers the micropores of the charcoal.

The adsorption amount was decreased gradually when the adsorption test was repeated. Finally the charcoal board adsorbed no gas. Saturated adsorption amount of gas in the charcoal board was estimated by integrating of the adsorption amount in repetition of the adsorption test.

Figure 5 shows reduction of formaldehyde adsorption weight in repetition of formaldehyde adsorption in the middle humidity by the charcoal board and powder. The lines in the figure were calculated with the least square method. Both samples hardly adsorb ammonia after the fifteenth tests. As a result, the saturated adsorption amount were 6.7 mg/g of charcoal powder, 4.7 mg/g of the charcoal board, respectively. It was confirmed that charcoal board show similar saturated adsorption amount of the charcoal powder.

Figure 6 shows reduction of ammonia adsorption weight in repetition of ammonia adsorption test in the middle humidity. In the same manner, the saturated adsorption amount were 1.9 mg/g of the charcoal powder, 3.1 mg/g of the charcoal board.

3.2 Effect of humidity

The adsorption test was carried out under different humidity condition, because the charcoal board as building interior material is exposed to the circumstantial under various humid conditions. Before the adsorption test, moisture content of the charcoal board was pre-equilibrated by placing the board in the respective relative humidity for two weeks. Fig.7 shows equilibrium moisture content of the charcoal board. The moisture content of 5.8%, 12.5% and 15.0% is obtained in the board equilibrated in the RH of 31%, 53% and 81%, respectively.

Figure 8 shows reduction of ammonia adsorption weight in repetition of ammonia adsorption by the charcoal board in the high, middle and low RH.,It was confirmed in the high and middle humidity that saturated ammonia adsorption weight is larger than that in the low humidity. The lines in the figure were calculated with the least square method.

The saturated adsorption amount were estimated to 3.9 mg/g in the high humidity, 3.7 mg/g in the middle

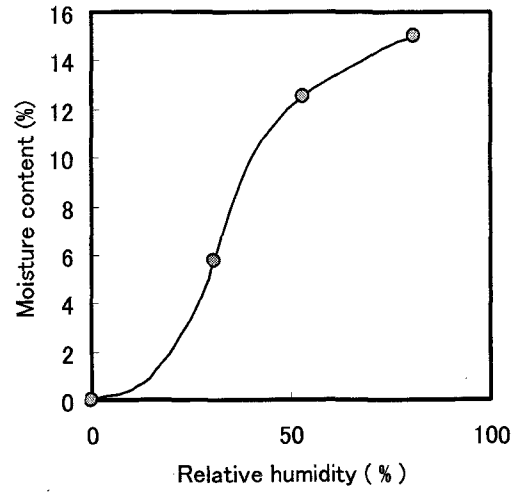


Fig.7 Relationship between relative humidity and moisture content of the charcoal board.

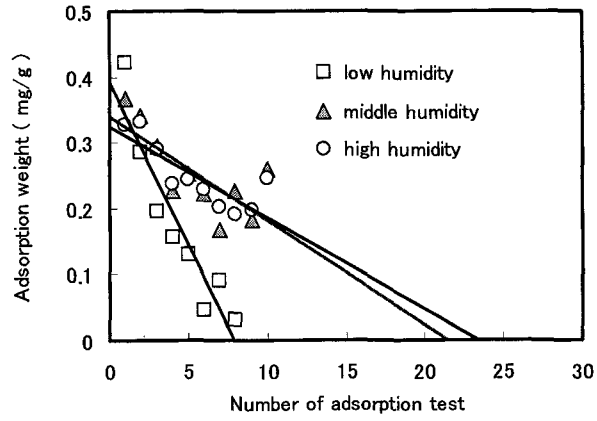


Fig.8 Reduction of ammonia adsorption weight in repetition of ammonia adsorption test by the charcoal board. Initial gas concentration is 100ppm.

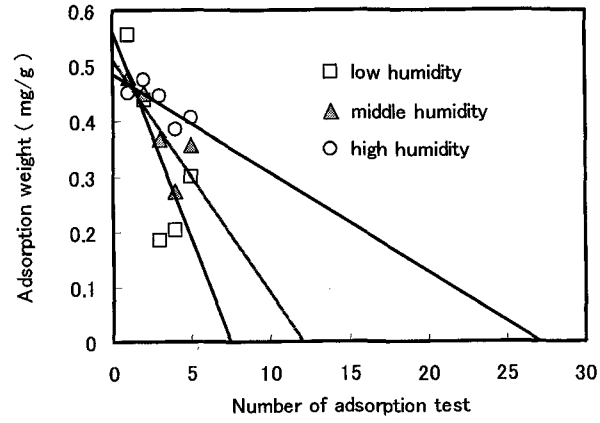


Fig.9 Reduction of ammonia adsorption weight in repetition of ammonia adsorption test by the charcoal powder. Initial gas concentration is 100ppm.

humidity, 1.3 mg/g in the low humidity.

Figure 9 shows reduction of ammonia adsorption weight in repetition of ammonia adsorption by the charcoal powder in the high, middle and low RH. The saturated adsorption amount by charcoal powder were 7.2 mg/g in the high humidity, 3.4 mg/g in the middle humidity, 2.3 mg/g in the low humidity.

From these results, it is suggested that adsorption sites were increased by swelling in the high humidity, and therefore, the saturated adsorption amount of the charcoal board and the charcoal powder increase.

4. CONCLUSIONS

The charcoal board was prepared from carbonized material powders with superfine natural fibers. It was confirmed that the charcoal board adsorbed formaldehyde and ammonia. When charcoal powder was adhered with the superfine fibers, the ability of the performance of charcoal was maintained in the charcoal board.

It was found that relative humidity in the atmosphere around of the board affected the adsorbability of chemical compounds. In the high relative humidity (RH=81%), the ammonia adsorption amount was increased compared with that in the low relative humidity. The saturated ammonia adsorption amount by the charcoal board was estimated to 3.9 mg/g in the high humidity.

5.ACKNOWLEGEMENT

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