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REMOVAL OF ACETALDEHYDE BY SEPIOLITE-2-AMINOBENZOIC ACID COMPLEX MOM AMBIENT AIR

MASAHIRO SUGIURA and KAZUHIRO FUKUMOTO Toyota Central Res. and Develop. Labs., Inc.,
41-1 Yokomichi, Nagakute-cho, Aichi-gun, 480-11, Japan (Accepted July 10, 1992)

ABSTRACT

The removal of acetaldehyde by sepiolite combined with 2-aminobenzoic acid
(OABA) (sepiolite-OABA complex) from ambient air was studied in comparison with
that of the aldehyde by sepiolite, coconut-shell active carbon (carbon), 5A-zeolite,
13X-zeolite, diatomaceous earth, as well as these porous material-OABA complexes.
Experiments were done at 25•Ž in ambient air. The removal rate of the aldehyde by
these porous material-OABA (10%) complexes followed the order of sepiolite->>
carbon->13X-zeolite- >5A-zeolite->diatomaceous earth-OABA (10%) complexes. The
amount of the aldehyde removed by the sepiolite-OABA complex was much larger than
that by OABA and that by sepiolite itself. The larger removal rate of the aldehyde
by the sepiolite-OABA complex was thought to be caused through the reaction between
the aldehyde and OABA which is activated by sepiolite. The removal of the aldehyde
by the sepiolite-OABA complex was particularly remarkable when the aldehyde
concentration was low, e.g., such as 1-10 ppm. This complex was thought to be very
useful as the deodorant for acetaldehyde.

Key words: Sepiolite, Active carbon, 2-Aminobenzoic acid, Acetaldehyde, Reaction,
Adsorption

INTRODUCTION

Sepiolite adsorbs various gases and it could be used deodorant for various gases if adsorption capacity has increased. The adsorption capacity of sepiolite for acetaldehyde is less than that of active carbon and both are not satisfactory on many other aspects for the purpose (Sugiura et al., 1991). Therefore, the increasing the adsorption capacity of sepiolite seems necessary. Acetaldehyde is prescribed as one of the offensive odorants in the Offensive Odor Control Law of Japan (Environment Agency of Japan, 1976). Cigarette smoke, exhaust gas from heat engines, and rotten vegetables' odor contain more or less acetaldehyde, whose concentrations are in the range of about 0.01 to 100 ppm in ambient air, and are perceived in our daily life.
It is known that paraacetaldehyde can react with aminobenzoic acid to form methylquinoline derivative in a hydrochloric acid solution (Doebner and Miller, 1884). Also the formation of Schiff base from OABA and acetaldehyde is known (Niementowski and Orzechowski, 1895). These suggest the possibility of the removal of acetaldehyde by OABA or its derivatives. However, gaseous acetaldehyde is not reactive with, nor adsorbed by

258 M. Sugiura and K. Fukumoto

OABA in ambient air. Therefore, some activation of OABA is necessary. One possible way to activate OABA is to use some substrate for OABA, as suggested from the reaction in catalytic systems.
In our study sepiolite was found useful as the substrate for that purpose. The aim of this study is to disclose the mechanism on removal of acetaldehyde by sepiolite-OABA complexes, and to compare with that of the aldehyde by sepiolite, coconut-shell active carbon (carbon), 5A-zeolite, 13X-zeolite, diatomaceous earth, and these porous material-OABA complexes.

EXPERIMENTAL

Materials
Sepiolite was prepared by pulverizing a block-sepiolite into a powder smaller than 44
ƒÊm in size. The block-sepiolite, having brown color, was supplied by Turan Madencilik Sanayi Ticaret Ltd., Turkey.
Inorganic porous materials such as coconut-shell active carbon (carbon), 5A-zeolite,
13X-zeolite, and diatomaceous earth were used for comparison. The carbon (Kintal-BFG)
in the size smaller than 44ƒÊm was supplied by Cataler Industrial Co., Ltd., Japan.
5A-zeolite, 13X-zeolite and diatomaceous earth (ShimaliteR), were supplied by Wako
Pure Chemical Industries, Ltd., Japan, and were used after pulverizing into a powder
smaller than 44ƒÊm in size. The chemical and physical properties of these porous materials

are shown in Table 1.
OABA was from Wako Pure Chemical Industries, Ltd., Japan, and was used as-received.
Acetaldehyde as adsorbate was from Merck Schuchardt.

TABLE 1. Chemical and physical properties of porous materials

Removal of Acetaldehyde by Sepiolite-OABA Complex 259

Preparation of sepiolite-OABA complex and other porous material-OABA complexes
The sepiolite-OABA (10%) complex was prepared in the following method: 10 g of
OABA, 90 g of sepiolite and 200 ml of ethanol were mixed in a beaker. The mixture
was sonicated for 5 min. The beaker was covered with a sheet of poly-vinylidene chloride
(Saran rapR, made by Asahikasei Ind., Ltd., Japan) to minimize the alcohol vaporation,
and heated for 30 min at 70•Ž. Then, the mixture was dried by heating at 100•Ž. The
obtained sepiolite-OABA (10%) complex was crushed in a porcelain mortar and was kept
in an electric oven at 110•Ž for three days. It was immediately transferred into a desiccator
at 25•Ž, and was kept there until it was used.
Carbon, 5A-zeolite, 13X-zeolite and diatomaceous earth were prepared in the same
way as mentioned above.
In addition to them, the sepiolite-OABA complexes containing 1.0, 3.0, 5.0, 9.1, 10

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23, 33, 50, 69, 80, and 90% OABA were also prepared in the same way as mentioned
above except for mixing 30 ml of ethanol with 5g portions of sepiolite-OABA mixture

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Furthermore, to examine the effect of granular OABA on the reaction an additional
sample was prepared by mixing a normal amount of OABA powder (0.146 mmol) and
sepiolite powder (0.18 g) corresponding to the sepiolite-OABA (10%) complex in an agate
blender.

Removal of acetaldehyde: Measurement of acetaldehyde concentration
The apparatus used for the measurements of the concentration of acetaldehyde consists
of four parts as shown in Fig. 1: A bag, a vaporizing system, an air-flow meter, and
an air-flow pump (Sugiura, Hayashi & Suzuki, 1991). These parts were connected in series
by teflon tubes. The volume of bag was 51, whose outside is made of aluminum foil
laminated with polyethylene-telephthalate. The bag was set in a conditioning chamber,
to control both temperature and relative humidity of the air inside. The vaporizing system
consists of a glass tube (6mmƒÓ•~200mm) having a silicon tube on one end and an electric
resistance furnace around itself. The silicon tube was used to introduce an acetaldehyde
solution into the glass tube. A given volume of the solution was injected into the glass
tube through the silicon tube using a microsyringe. The pump coupled with air-flow meter
was used to fill the bag with 51 of air containing gaseous acetaldehyde with a certain fixed
concentration.

FIG. 1. Apparatus for the measurement of the concentration of acetaldehyde in ambient air:
(1) bag; (2) vaporizing system; (3) air-flow meter; (4) air-flow pump

260 M. Sugiura and K. Fukumoto

About 1 g of the sepiolite-OABA (100%) complex was put into the bag. 50%
acetaldehyde aqueous solution in the amount of about 42, 60 and 94 pl was introduced
into the bag through the vaporizing system with the stream of the air in the conditioning
chamber having 9.0% relative humidity. The bags were kept for 20 h in the same
conditioning chamber controlled at 25•Ž. It was confirmed earlier that acetaldehyde
concentration, C (ppm), in the bag with the sepiolite reached the equilibrium apparently.
The concentration, C, of acetaldehyde in the bag was measured using a gas chromatograph
as described in the previous paper (Sugiura, Fukumoto, and Inagaki, 1991). The 50%
acetaldehyde aqueous solution of the same amount was vaporized in the bag containing
no sample under the same condition, and the initial concentration, CO, of the
acetaldehyde in the bag containing no sample was measured.
The amounts of acetaldehyde in the bag containing 1 g of sepiolite, the carbon, and
the carbon-OABA (10%) complex were also measured in the same way as mentioned
above, except the amount of the aldehyde aqueous solution (0.8-44ƒÊl) introduced
into the bag.
The equation of the state of an ideal gas gives the following expression for the amount
of acetaldehyde removed by the unit weight of the sample, W (mmol/g or mg/g):

(1)

or

(1)'

where n is the number of moles of acetaldehyde, m is the amount of acetaldehyde removed
by the sample, M2 is the molecular weight of acetaldehyde. Pa, V and T are the pressure,
volume and absolute temperature of the air in the bag, respectively, and R is the gas

constant.

Removal rate: Measurement of acetaldehyde concentration
0.2 g of the sepiolite-OABA (10%) complex (others) was put into the bag, 10 pl of
10% acetaldehyde aqueous solution were introduced into the bag through the vaporizing
system with the stream of the air in the conditioning chamber having 9.0% relative
humidity. The bag was kept for 4 h in the same conditioning chamber kept at 25•Ž. The
initial concentration of the acetaldehyde was 255 ppm, when a 10% acetaldehyde aqueous
solution of the same amount was vaporized in the bag containing no sample under the
same condition.
The removal rate of the acetaldehyde in the bag, RR, was given by:

(2)

Removal of Acetaldehyde by Sepiolite-OABA Complex 261

The removal rate of the acetaldehyde in the bag containing 0.2 g of sepiolite, carbon
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5A-zeolite, 13X-zeolite, diatomaceous earth and these porous material-OABA (10%)
complex were also measured in the same way as that mentioned above. The initial
concentration was also 255 ppm.
In another experiment, the removal rates of the acetaldehyde in the bag containing
0.2 g of sepiolite-OABA complex at the concentration of 0, 1.0, 3.0, 5.0, 9.1, 23, 33,
50, 69, 80, and 90% OABA and 0.02 g of OABA were measured in the same way. The
initial concentration was 178 ppm.

Reactivity of OABA on sepiolite: Measurement of acetaldehyde for the sample with and
without OABA
Furthermore, a separate experiment was carried out to study the reaction of acetaldehyde
with OABA in a long time (170 h), and the effect of granular OABA on the reaction

as follows: 0.2 g of the sepiolite-OABA (10%) complex (0.146 mmol for 0.18 g of sepiolite)
was put into the bag. 50% acetaldehyde aqueous solution in the amount of about 50
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was introduced into the bag through the vaporizing system with the stream of the air
in the conditioning chamber having 9.0% relative humidity. The bag was kept for 20
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96, 121, 144, and 170 h in the same conditioning chamber controlled at 25•Ž. It was
confirmed that at 96, 121, 144, and 170 h the reaction reached the apparent equilibrium .
The 50% acetaldehyde aqueous solution of the same amount was vaporized in the bag
containing no sample under the same condition, and the initial concentration of
acetaldehyde was measured and it was 2880 ppm.
The equation of the state of an ideal gas gives the following expression for the amount
of acetaldehyde removed by the sample, Q (mmol):

(3)

The amount of acetaldehyde removed from the bag containing 0.04 g of the sepiolite-OABA (50%) complex (0.146 mmol for 0.02 g of sepiolite), 0.2 g of the sample of OABA powder (0.146 mmol) and sepiolite powder (0.18 g) prepared by the dry process or 0.2 g of the sepiolite was given in the same way as mentioned above.
The area occupied by OABA on sepiolite, A (m2), was calculated from the following equation (Keii, 1960) under the assumption that OABA formed a monolayer:

(4)

where s (nm2) is the molecular cross section, and q (mmol) is the amount of adsorbed

OABA. s was calculated from the following equation (Keii, 1960):

(5)

where M is the molecular weight, and d (g/cm3) is the density of OABA at 25•Ž. The
calculated cross section of OABA was 0.33 nm2 (Chemical Society of Japan)

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262 M. Sugiura and K. Fukumoto

Measurement of Infrared Spectra
The IR spectrum of sepiolite-OABA (50%) complex exposed to acetaldehyde for 170 h was measured with a JASCO FT/IR-5M spectrometer (Nippon Bunko Co., Ltd., Japan) using the potassium bromide disc technique. The infrared spectra of the sepiolite-OABA (50%) complex and sepiolite were also measured.

RESULTS AND DISCUSSION

Removal of acetaldehyde

Fig. 2a and b show the relationship between acetaldehyde concentrations and reaction
time in ambient air with 9.0% relative humidity at 25•Ž. The acetaldehyde adsorption
on sepiolite reached near equilibrium after 4 h or so (Fig. 2a). The aldehyde concentration
over the sepiolite-OABA complex (10%) decreased greatly with time and became constant
20 h and so (Fig. 2b), while the concentration over OABA only slightly (Fig. 2b), suggesting that the aldehyde is much more reactive with the system of sepiolite-OABA complex. Fig. 3 shows the amounts of acetaldehyde removed by the sepiolite-OABA (10%) complex, the carbon-OABA (10%) complex, sepiolite, and the carbon after 20 h. The figure shows that the removal of acetaldehyde by the sepiolite-OABA (10%) complex was

FIG. 2. Acetaldehyde concentration plotted as a function of time in ambient air having 9% relative humidity
a) sepiolite. b) sepiolite-OABA complex and OABA

Removal of Acetaldehyde by Sepiolite-OABA Complex 263

remarkably value even at very low concentrations from 1 to 10 ppm.
The slope of the curve for the sepiolite-OABA (10%) complex was much smaller than that for sepiolite (Fig. 3). This means that the interaction of the aldehyde with OABA on sepiolite is much stronger than that by the sepiolite, indicating that the reaction is chemical rather than physical adsorption. This result is consistent with the infrared spectrum of the sepiolite-OABA (50%) complex exposed to acetaldehyde (Fig. 4b). Fig. 4a and b clearly show that the NH2 stretches (indicated by peaks 1 and 2 in Fig. 4a) disappeared in Fig. 4b, and new peaks 11 and 13 of C = C of benzene skeleton conjugated with N = C stretch appeared. These show that OABA having NH2 changes into the Schiff base product having N = C or quinoline skeleton, which is given by scheme (6) or (7) as mentioned later. The amount of the aldehyde removed from the air by the sepiolite-OABA (10%) complex was about 0.3-0.6 mmol/g in the acetaldehyde concentration range of 2-50 ppm, which was much larger than that adsorbed on the sepiolite (about 0.007-0.07 mmol/g).
The increase in removal of acetaldehyde by complex formation with OABA was much

FIG. 3. Apparent acetaldehyde adsorption isotherms (25%) for sepiolite and carbon and the amount of the aldehyde removed by the sepiolite- and carbon-OABA (10%) complex plotted
as a function of the aldehyde concentration remained in ambient air having 9% relative humidity

264 M. Sugiura and K. Fukumoto

smaller for carbon than for sepiolite. the curve by the carbon-OABA (10%) complex runs nearly parallel to the isotherm on the carbon (Fig. 3).
The increase is probably caused by the activation of OABA by some impurities in the carbon such as K ions. Less increase in adsorption capacity would probably due to the less amount of the activator in the carbon.

Removal of Acetaldehyde by Sepiolite-OABA Complex 265

The curve of the amount of the aldehyde by the carbon-OABA complex shows that the amount of the aldehyde removed from the air was about four times larger than that by the carbon in the acetaldehyde concentration range of 1-50 ppm. This means that the reaction of the aldehyde with OABA on the carbon depends upon the amount of acetaldehyde adsorbed on the carbon, which is dependent on the equilibrium constant of reaction scheme (6) or (7).
As shown in Fig. 3, the adsorption capacity of the carbon to eliminate the aldehyde
is smaller than that of the sepiolite. The surface area of the carbon (1050-1075m2/g) is much larger than that of sepiolite (250-300m2/g), indicating that the surface area is not necessarily a factor of primary importance and structure and composition of substrate for OABA should also be considered.

Removal rate of acetaldehyde
The acetaldehyde concentration in ambient air having initial lower concentration was plotted as a function of time in Fig. 5. The rate of the removal of acetaldehyde in the initial concentration of 255 ppm was rapid at the initial stage, became slow after 4 h or so, and nearly stopped zero after 20 h.
At the time of 4 h, it is not in saturation of the surface with the aldehyde, but on the way of reaction or adsorption. Then, the value of the removal rate at 4 h can be used as the measure of the adsorption or reaction velocity as well as capacity of the materials. Table 2 shows the removal rate of acetaldehyde by the porous materials and these porous material-OABA (10%) complexes after 4 h. As shown in Table 2, the removal rate by the porous materials followed the order of carbon >sepiolite>13X-zeolite>5A-zeolite> diatomaceous earth. On the other hand, that by these porous material-OABA (10%) complexes followed the order of sepiolite->carbon->13X-zeolite->5A-zeolite->

FIG. 4. Infrared spectra
(a) Infrared spectrum of sepiolite-OABA (50%) complex.
Peak No.: Wavenumber (cm-1); 1: 3475, 2: 3375, 3: 3050, 7: 2700-2500, 9: 1675, 10: 1615,
12: 1590, 14: 1563.
These peaks are thought to be assigned as follows*):
peak 1,2: NH2 stretchs,
peak 3: O-H stretch,
peak 7: overtones and combinations of C-O stretchs,
peak 9: broad C = O band due to aromatic carboxylic acid dimer,
peak 10,12,14: C= C stretchs from benzene skeleton.

*) See Reference (Colthup, 1964)
(b) Infrared spectrum of sepiolite-OABA (50%) complex exposed to acetaldehyde
Peak No.: Wavenumber (cm-1); 4: 2960, 5: 2925, 6: 2870, 8: 1720, 9: 1670, 11: 1600, 13: 1580 These peaks are thought to be assigned as follows*):
peak 4,6 : CH3 stretchs,
peak 5 : CH2 stretch,
peak 8 : C = O stretch from acetaldehyde,
peak 9 : C = O band due to aromatic carboxylic acid dimer,
peak 11,13 : C = C of benzene skeleton conjugated with N= C stretch such as Schiff base or quinoline skeleton.

*) See Reference (Colthup, 1964)
(c) Infrared spectrum of sepiolite

266 M. Sugiura and K. Fukumoto

FIG. 5. Acetaldehyde concentration plotted as a function of time in ambient air having 9% relative humidity (with low initial concentration of acetaldehyde)

TABLE 2. Removal rate of acetaldehyde in the bag with porous material-OABA complex,
or porous material

1)Initial concentration: 255 ppm.

Removal of Acetaldehyde by Sepiolite-OABA Complex 267

diatomaceous earth-OABA complexes. The removal rate by OABA is very small for the aldehyde in the air. Sepiolite can adsorb much more acetaldehyde, but the adsorption capacity is still much smaller than the amount removed by the sepiolite-OABA complexes. Therefore, the combination of sepiolite and OABA seems to enhance the adsorbing or reacting capacity of sepiolite and/or OABA. Infrared spectra of the sepiolite-OABA (50%) complex before (Fig. 4a) and (Fig. 4b) exposed to acetaldehyde showed the presence of products formed from the aldehyde after the exposure of the sepiolite-OABA to aldehyde for 170 h and it also showed the compounds had Schiff base bond. Therefore, it must be concluded that the removal of the aldehyde is mainly caused through the reaction of the aldehyde with OABA not through physical adsorption by OABA. The reactivity of OABA with the aldehyde is much enhanced by the presence of some chlorides such as hydrogen chloride (Doebner and Miller, 1884), or the presence of Fe ions like reactions such as Scraup reaction (Ogata, 1962). In sepiolite, some of Mg ions are present on the sepiolite surface, which are thought to activate OABA. The activation is realized at the low relative humidity of 9.0%, under which water molecules are thought to be adsorbed on narrow holes on the sepiolite, so the activation under the low relative humidity would be made without the help of water molecules. When water molecules are abundant on the surface, it would be made with their help, but it is not clear which of the activation processes (with and without water) is dominant. Both might be responsible, and further study is necessary to determine it. In addition, OABA is preferred to locate on Mg ion, if the interaction between them is strong. The OABA on Mg ion will be activated much stronger than the other OABA which is located on Si ion. The removal rate would largely change above and below the concentration at which OABA just covers Mg sites, if OABA is adsorbed first on Mg sites and then Si sites, because Si sites will be occupied after the occupation of Mg sites is completed. The critical concentration would be about 6.4% OABA. But, as shown in Table 3, the removal rate did not change largely above and below about 6.4% OABA, suggesting that the interaction is not so strong, even if the dry mechanism for the activation is true, as mentioned later. Concerning the reaction of OABA with the aldehyde, two schemes are known. One
is that by Doebner and Miller (1884):

(6)

and the other is that by Niementowski & Orzechowski (1895):

(7)

Table 3 shows the removal rate, concentration and the amount of acetaldehyde removed and the amount of OABA on the sepiolite in the 51 air in the bag containing 0.2 g of the sepiolite-OABA complex after 4 h. The initial concentration of the aldehyde is 178 ppm, which corresponds to 0.0364 mmol aldehyde in the bag. The removal rate reached the maximum nearly on the complex with 0.0729 mmol (0.01g) of OABA and 0.19g of sepiolite, which corresponds to the removal of 0.0355 mmol aldehyde. There, almost all aldehyde was removed by the sepiolite-OABA complex. The rate began to decrease

268 M. Sugiura and K. Fukumoto

TABLE 3. Removal rate, concentration and removed amount of acetaldehyde, amount of OABA contained in 0.2 g of the sepiolite-OABA complex

1 initial concentration: 178 ppm, which corresponds to 0.0364 mmol of gaseous acetaldehyde
in 5l air.
2) after 4 h

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3) 0.02g OABA + 0g sepiolite.
4) 0.2g sepiolite.

gradually above 0.337 mmol OABA on the sepiolite. Also, below the OABA amount of 0.0729 mmol (0.01g), the removal of the aldehyde was incomplete. The removal rate for 1.02-1.31 mmol OABA (79-92%) was almost the same as that for about 0.0438 mmol OABA (85%). This means that only about 0.0438 mmol OABA could react with the aldehyde and that more amount of OABA was not so reactive with the aldehyde. The removal rate for OABA itself was 3%. Therefore, the decrease of the removal rate with the amount of OABA is thought to be resulted from the formation of some thick layer or large particles of OABA on the sepiolite surface, suggesting that only the bottom of thick layer or large particles was in direct contacts with the sepiolite surface.
As mentioned before, the OABA on sepiolite plays an important role on the removal of the aldehyde, and also does the sepiolite. The minimum amount of OABA which can react with the aldehyde completely is about 0.0182 mmol according to scheme (6), or about 0.0364 mmol according to scheme (7). In any case, the amount was much smaller than that of OABA at which amount the removal rate reaches the maximum, and the measured concentration of the aldehyde was rather high at 0.0438 mmol OABA which was larger than amounts of OABA expected for reaction (6) and (7). This result suggests that some of the OABA spread on the sepiolite surface does not still contact with the aldehyde or that it is still inert.

This hypothesis was confirmed from the results of the removal of acetaldehyde. The removal of acetaldehyde by the sepiolite-OABA complex of 0.146 mmol OABA on 0.02g

Removal of Acetaldehyde by Sepiolite-OABA Complex 269

sepiolite was about 0.089 mmol at 96 h and 0.088 mmol at 170 h, which amount corresponds to the decrease of about 430 ppm acetaldehyde as shown in Fig. 6. The value is the same for both reaction times, which means that the reaction nearly stopped within 96 h. Furthermore, the amount of OABA removed by the reaction is about 30% of the total amount according to the scheme (6), and 60% according to scheme (7). Anyway, the reaction between OABA and acetaldehyde is incomplete and some OABA is left unreacted. This means that some parts of OABA are active and the other are inert. The inert part will be apart from Mg ions, or separated by underlying OABA from Mg ions. This shows the presence of nonuniform distribution of OABA. The active parts of OABA will be thin layers or small particles of OABA. The amount of acetaldehyde removed by the sepiolite-OABA complex of 0.146 mmol OABA on 0.18g sepiolite is much larger (0.270 mmol which corresponds to the decrease of about 1570 ppm at 144 h) than the value removed by the excess amount of OABA (0.088 mmol) (Fig. 6, Table 4). These results suggest that only the OABA in direct contacts with sepiolite surface reacts according to scheme (6) and also that the reaction in scheme (7) cannot occur because the amount of the aldehyde removed actually (0.270 mmol) was much larger than that of the theoretical amount (0.146 mmol) according to the scheme (7) and because OABA is not so reactive

FIG. 6. Acetaldehyde concentration plotted as a function of time in ambient air having 9% relative humidity (with high initial concentration of acetaldehyde)

270 M. Sugiura and K. Fukumoto

TABLE 4. Amount of aldehyde removed, multiplicity of OABA, amount of aldehyde formed by scheme (6), amount of aldehyde adsorbed by surface of sepiolite, amounts of OABA and sepiolite, and weight percent of OABA

with acetaldehyde. The sepiolite-OABA complex of 0.146 mmol OABA on 0.18g sepiolite
prepared by the dry method removed 0.156 mmol which corresponds to the decrease of
about 2120 ppm at 144 h (Fig. 6). The amount (0.156 mmol) was much smaller than that
(0.270 mmol) prepared by wet method using alcohol. On this basis of the interpretation
of the removal by OABA in Table 3, the decrease of the removal rate with the amount
of OABA is thought to be resulted from the formation of some thick layer or large particles of OABA.
The inert OABA must be of the upper parts in the OABA stacked on the bottom OABA which contacts with sepiolite surface directly. The multiplicity of OABA layer on sepiolite can be calculated theoretically by using scheme (6), the amounts of OABA and sepiolite and the actual multiplicity can be calculated by adjusting the multiplicity of the layered OABA so as to make the calculated amount of OABA agree with that actually removed. The results are shown in Table 4. The deviation from the theoretical value of multiplicity of the measured value is thought to give the degree of dispersion of OABA on sepiolite.

CONCLUSIONS

1) The sepiolite-OABA complex can remove much acetaldehyde.
2) The amount of acetaldehyde removed from the air by porous material-OABA complexes was larger almost in the order of sepiolite, carbon, 13X-zeolite, 5A-zeolite and diatomaceous earth. These by sepiolite and carbon were remarkably improved by the addition of OABA. Particularly, that of the sepiolite-OABA complex was very large.
3) The aldehyde-adsorbing capacity of porous materials in ambient air was larger in the

Removal of Acetaldehyde by Sepiolite-OABA Complex 271

order of carbon, sepiolite, 13X-zeolite, 5A-zeolite and diatomaceous earth.
4) The removal rate of the aldehyde in the 51 air containing the sepiolite-OABA (9.1%) complex reached the maximum (99%) at 4 h for the air containing 178 ppm acetaldehyde.
5) The removal of the aldehyde from the air is mainly caused through the reaction with OABA under the strong influence of sepiolite.
6) The removal behavior of the aldehyde on the sepiolite-OABA complex showed a different behavior from that without OABA.

7) The carbon-OABA complex removed the aldehyde about four times or more as much as that the carbon adsorbed in the aldehyde concentration range of 1-50 ppm.
8) The sepiolite-OABA complex is very useful for deodorant against aldehyde in actual
uses.

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