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Effect of Woodceramics on Relationship between Temperature and Humidity

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Woodceramics is expected as humidity-regulating effect like charcoal since it is a porous carbon material. Then, in this study, humidity-regulating capability of woodceramics was investigated. Woodceramics is a material that has humidity-regulating capability and humidity-regulating capability is influenced by volume ratio of woodceramics to installation place. Moreover, woodceramics also has ability as a drier. As a method for controlling breeding of ticks, it is effective to use woodceramics for resting ticks. However, in this case, it is necessary to take the volume ratio of woodecramics to incubator into consideration.

Key words: woodceramics, humidity, temperature,pore

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. Recently, the air pollution of the earth is aggravating. Air pollution has very influence on the comfortable nature of living environment. Temperature and humidity are the important factor that influences the comfortable nature in the living environment. By the way, in order to obtain comfortable space, charcoal which has humidity-regulating capability is used as building materials, or new building materials is developed[1)-3)]. On the other hand, there is woodceramics (WCS) with porous structure as charcoal[4)-5)]. Namely, it is able to expect that woodceramics has the humidity controlling ability. Then, the aim of this paper is to investigate the humidity capability of woodceramics and is to discuss the possibility as building materials, especially the control effect of ticks.

2. EXPERIMENTAL METHODS

2.1 Specimen

Woodceramics specimen was made from medium – density fiberboard (MDF, air – dried density: 0.73 g/cm^3, moisture content 8%) made from Pinus radiata. The MDF was impregnated with phenol resin (PX-1600 manufactured by Honen Corporation) using ultrasonic vibration. The average phenolic resin soaking ratio was 68.9% by weight. Specimens were then burned in a vacuum furnace. Two types of woodceramics specimens were prepared; one (WCS400) was carbonized at 400 ℃, and the other (WCS800) was carbonized at 800℃. As the comparative material, we used MDF carbonized at 800℃. In addition, woodceramics and charcoal used in this study have the same surface area.

2.2 Measuring method

Specimens and thermo recorder (Testo175-H1) were put into hermetic chamber made from stainless steel (Amount of contents: 12 L, Inside size: 240×240×240 mm). Chamber was put into the incubator (TVN380DA, Amount of contents: 29 L, Inside size: 310×310×300 mm, Microcomputer PID control). Then, under each setting conditions, temperature in the incubator was controlled, and temperature and humidity inside chamber were measured. Specimens were beforehand dried for 2 hours at 105 ℃. And later, specimens were put into an atmosphere at the temperature range from 15 to 20 ℃ and the humidity range from 40 to 50%RH. When specimens were put into an incubator directly, the effect of woodceramics on the relationship between temperature and humidity in an incubator were investigated.

2.3 Possibility as building materials of woodceramics

2.3.1 Cultivation of ticks

The tatami matting with 10 mm x 10 mm size was cut from the tatami matting (width of 250 mm²) that ticks resists. The five sheets of tatami matting were put into a laboratory dish together with food. And this laboratory dish was put into the incubator (Environment in an incubator: Temperature ranges of 25 to 27℃, the humidity range of 56 to 74%RH), and ticks were cultivated for three weeks.

2.3.2 Methods of ticks breeding

Ticks cultivated by the method of 2.3.1 were put into the laboratory dish with and without woodceramics and they were sealed. In addition, specimens used in this experiment are WCS800 which ground finely with a size of 2.0×10^{-5} m^3 and ticks were cultivated again by the method of 2.3.1. Further, temperature and humidity in incubator with each laboratory dish during cultivation were also measured.

2.3.3 Number of ticks

One tatami matting among five which was contained in each laboratory dish was took out and put into the test tube containing 10 cc refining water. And it stirred for 1 minute using the test-tube mixer. The 10 cc solution in the test tube was drop down on filter paper, and the number of the ticks that lived into solution was measured using the optical microscope. It measured similarly about other tatami matting, and the number of ticks contained in five tatamis matting is totaled. And the average value was defined as number of ticks that bred with the laboratory dish.

3. RESULTS AND DISCUSSION

3.1 Influence of woodceramics exerted on temperature and humidity

Fig.1-a, Fig.1-b and Fig.1-c show the effect of woodceramics on the relationship between temperature and humidity in chamber. In addition, the effect of charcoal on the relationship between temperature and humidity is also shown. Furthermore, humidity changes in incubator where the chamber exists under this experiment are also shown. The volume ratio of chamber to specimens used in this experiment was 100:0.45. Generally, in the relation between temperature and humidity, humidity changes with changes of temperature. In this experiment, when the inside of chamber is blank, such a phenomenon has occurred. As can be seen from Fig.1-a and Fig.1-b, using woodceramics humidity values could be fixed just around 20% regardless of temperature change. On the other hand, as can be seen from Fig.1-c, using charcoal humidity values could be fixed just around 35%.

Humidity showed the lower value using woodceraics than that using charcoal. Woodceramics are an organization reinforcement type material, and porous parts between woody fibers are impregnated by phenol resin. Consequently, because the porous part in woodceramics was filled by phenol region and surface area of woodceramics becomes small, humidity exhibits lower value than that using charcoal. On the other hand, burning temperature did not affect humidity– regulating capability.

Generally, in the case of the material with humidity – regulating capability, humidity values are maintained around 50%. However, because humidity values controlled by charcoal and woodceramics is low, it may not be judged that it is a material with humidity-regulating capability.

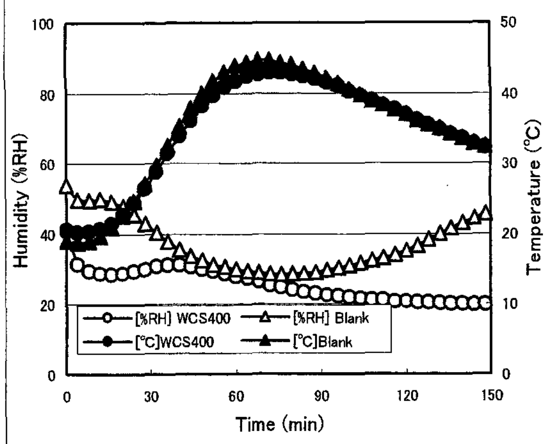

Fig.1-a. Effect of woodceramics on the relationship between temperaturre and humidity in a sealed box. (WCS400)

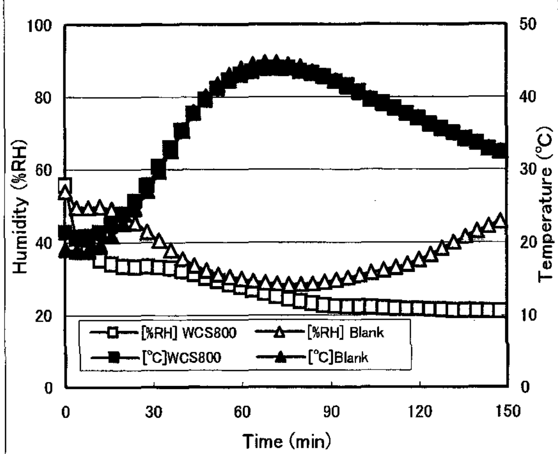

Fig.1-b Effect of woodceramics on the relationship between temperature and bumidity in a sealed box. (WCS800)

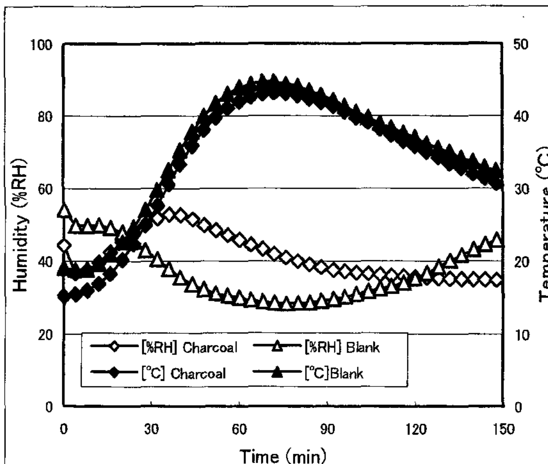

Fig.1-c. Effect of woodceramics on the relationship between temperature and humidity in a sealed box. (Charcoal)

Then, in order to investigate the cause by which the inside of chamber was maintained by the low humidity value, the effect of humidity in incubator where chamber exists on temperature and humidity in chamber was investigated.

Fig.2-A and Fig.2-B show the effect of humidity in incubator on temperature and humidity in chamber. WCS800 was used for specimen. The humidity inside incubator was set as Type A or Type B, and temperature change (T-A, T-B) and humidity change (H-A, H-B) in chamber was measured.

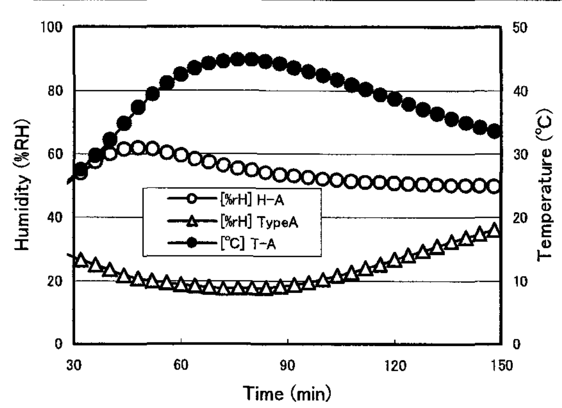

Fig.2-A. Effect of humidity in the incubator on temperature and humidity in the sealed box. (Type A)

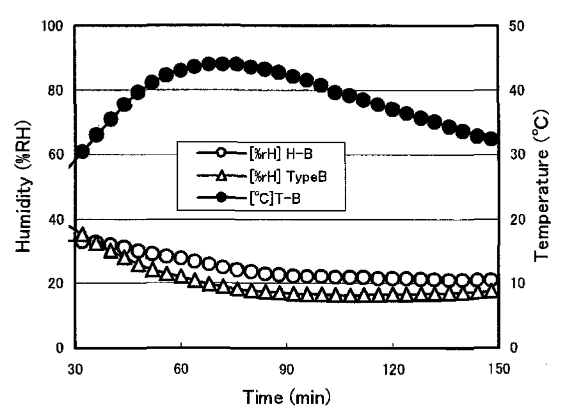

Fig.2-B. Effect of humidity in the incubator on temperature and humidity in the sealed box. (Type B)

As can be seen from Fig.2-A, when humidity in incubator (Type A) changed from 20%RH to near 40%RH, inside chamber humidity values showed around 50%RH. This humidity range is in the allowable as range humidity-regulating capability. On the other hand, as can be seen from Fig.2-B, when humidity in an incubator (Type B) became low 18%RH, humidity in chamber showed humidity values around 20%RH. This humidity change shows the same tendency as the case of Fig. 1-a and Fig.1-b.

Generally, the judgment standard of material as dryness capability is whether humidity values are maintainable just around 20%. From this standard, woodceramics has also an ability as dryness material which depends on environmental conditions.

3.2 Effect of the volume ratio of specimen to incubator on relationship between temperature and humidity

The effect of the volume ratio of the specimen to incubator capacity on humidity – regulating ability of woodceramics was investigated.

Figure 3 shows the effect of the volume ratio of specimen to the incubator on the relationship between temperature and humidity when specimens (WCS800) put into incubator. The volume ratio of specimen to incubator was normalized by setting capacity of incubator as 100. In this experiment, finely grounded woodceramics (WCS800) were used as specimen and the volume ratio was changed as follows;

CASE I =100 : 0.62, CASE II =100 : 1.23, CASE III =100 : 1.85, CASE IV=100 : 2.5.

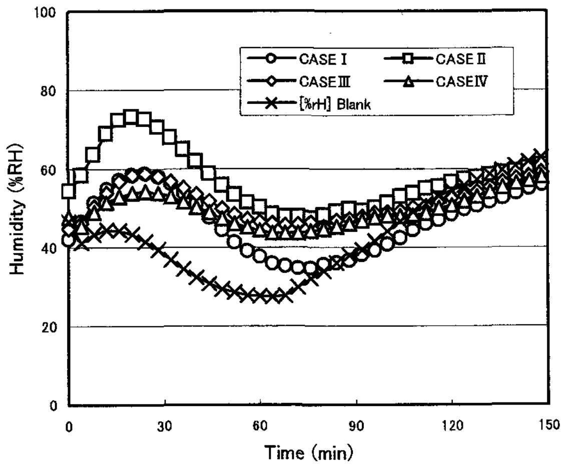

Fig.3. Effect of humidity in the incubator on temperature and humidity in a sealed box.

As can be seen from Fig.3, when the volume ratio of the specimen to incubator was small (CASE I and CASE II), the humidity range showed from 35 to 57%RH in the case of CASE I, and from 50 to 70%RH in the case of CASE II. On the other hand, when the volume ratio of the specimen was large (CASE III and CASE IV), humidity range showed from 38 to 58%RH in the case of CASE III, and from 45 to 58%RH in the case of CASE IV. Namely, changes of humidity became small as increase of volume ratio. In this case, it is shown that inside incubator, humidity value is kept constant by woodceramics. This result suggests that the area of pore contained in the specimen becomes large with increase of volume ratio.

3.3 Effect of woodceramics on tick breeding

Fig. 4 shows the influence of the existence of woodceramics to tick breeding. When ticks was bred in the laboratory dish without woodceramics (Non WCS), the humidity in a laboratory dish showed high value ranged from 68 to 78%RH and the number of ticks was increased to thirty ticks. On the other hand, when ticks was bred in the laboratory dish with woodceramics (WCS), humidity in a laboratory dish showed the humidity ranged from 45 to 52%RH and the number of ticks was controlled inhibited below five ticks.

Figure 5 shows the effect of the volume ratio of woodceramics to laboratory dish. In the case of Type I, the volume ratio of woodceramics to the laboratory dish is 100:2.5, and humidity values showed the range from 45 to 52%RH. On the other hand, the volume ratio of woodceramics in Type II is 100 :1.2, and humidity values showed the range from 62 to 70%RH.

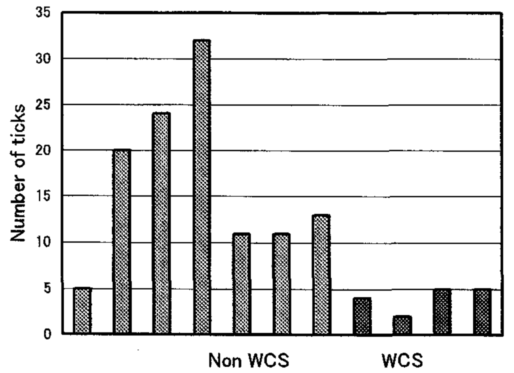

Fig.4 Influence the environment of the existence of woodceramics affects tick breeding.

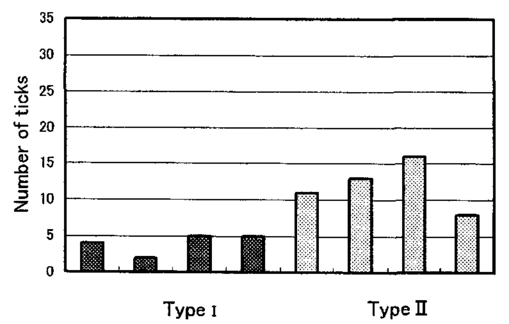

Fig.5 Effect of the share of amount of woodceramics on the capacity of the laboratory dish.

As can be seen from Fig.5, number of ticks was large in the case of Type II than that in the case of Type I. Breeding of ticks is inhibited in the case of Type I. The high humidity value is necessary for ticks to breed.

As mentioned above, in order to demonstrate humidity-regulating capability, it is necessary to take volume ratio of woodecramics to installation place into consideration.

4. CONCLUSIONS

The humidity-regulating capability of woodceramics was investigated. Woodceramics are a material that has humidity-regulating capability, and humidity-regulating capability is influenced by volume ratio of specimens to installation place. Woodceramics also has a ability as a drier. As a method for controlling breeding of ticks, it is effective to use woodceramics..

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