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Development of Far Infrared Radiation Woodceramics Heater

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The far infrared radiation characteristics of the woodceramics heater and the trial drying experiment using the woodceramics heater in an warehouse were investigated, the results revealed that the woodceramics board showed to be valid for the far infrared radiation heater.

Keywords: woodceramics, far infrared radiation, heater, emissivity

1. INTRODUCTION

Woodceramics are new porous carbon materials which are made by carbonizing wood or woody materials such as MDF (Medium Density Fiberboard) impregnated with phenolic resin in a vacuum furnace [1]. As woodceramics have superior mechanical property [2], wear property [3], electric property *etc.* [4] ,they could be used in several kinds of material fields. However, there are still potential applications that are not clarified up to now, for example, the research on the far infrared-ray radiation of the woodceramics has been scarcely done. Accordingly, in the present study, the emissivity of the far infrared radiation from the woodceramics boards and the trial drying experiment using the woodceramics heater in warehouse were investigated, and the validity of the far infrared radiation heater was examined.

2. EXPERIMENTAL PROCEDURE

2. 1 Material preparation for woodceramics heater

The woodceramics used in the present work were made by carbonizing MDF (Medium Density Fiberboard) impregnated with phenolic resin in a vacuum furnace at 650℃.

2.2 Drying test

In order to test the far infrared radiation from the woodceramics heater, the trial drying experiment was carried out in the warehouse. The arrangements of the woodceramics heaters in the warehouse for wood drying are shown in Fig.1 and 2. Twenty-seven pieces of woodceramics heaters (12Ω) with the size of 20 x 40 x 300 mm were placed on the three stages of the warehouse, and the woodceramics heaters were connected with lead wires by the method shown in Fig.3. The surface temperatures of the woodceramics heaters were kept at 100℃ by the PID(Proportional-Integral-Differential)controller under the voltage of 35V and the air temperature in the warehouse was kept at 55℃. For comparison, the drying experiment using the nichrome heater was also carried out under the same conditions.

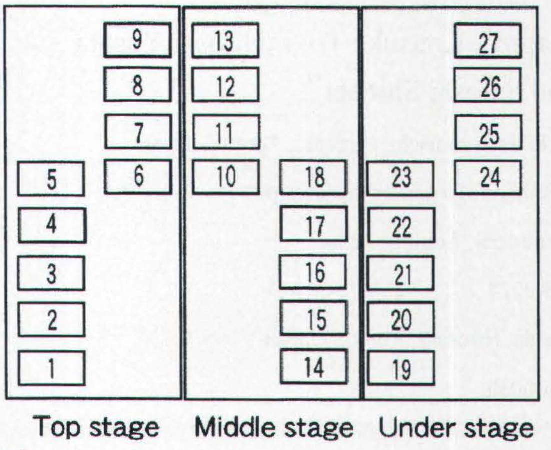

Fig.1Arrangement of woodceramics heaters in warehouse for wood drying.

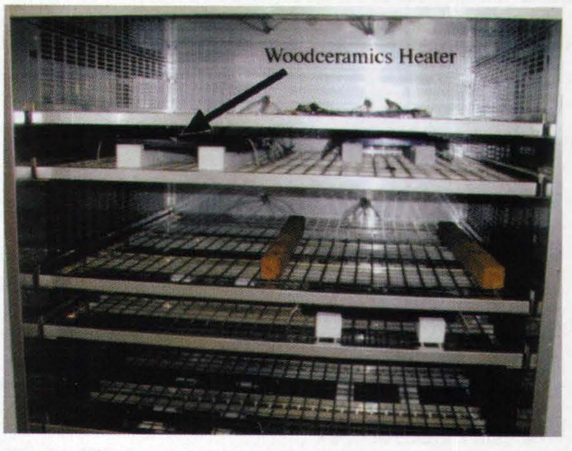

Fig.2 Whole view of the warehouse with the arrangement of woodceramics heater.

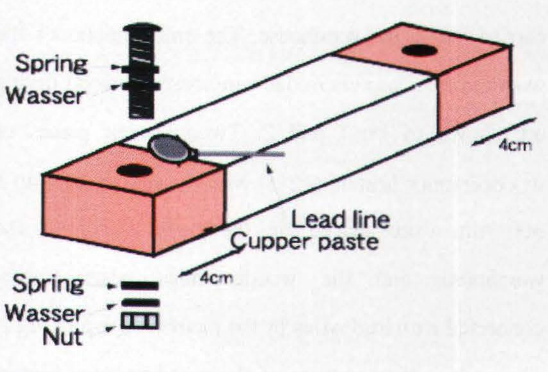

Fig.3 Method for connecting the lead wire with the woodceramics heater.

2.3 Measurement of far infrared radiation emissivity

The measurement of the far infrared emissivity of the woodceramics heater was carried out in PARKINERMER FTIR-2000 fourier transform infrared radiation system where the distance between the woodceramics heater (specimen) and the sensor (device) for measuring the amount of the far infrared radiation was 10cm as shown in Fig.4. The amount of the far infrared radiation (R_1) from the woodceramics heater was measured after 5 minutes when the temperature of the woodceramics heater reached the set values, 40℃, 60℃ and 80℃, respectively, by applying the voltage of 20V to the heater. In order to measure the far infrared radiation from the standard black body (R_0), the same measurement was also done for the woodceramics heater covered with black spray. Then, the emissivity (ε) was calculated by the following equation,

$$\varepsilon = (R_1 / R_0) \times 100\ (\%)$$

The surface temperature distributions in woodceramics heater were measured using NEC TH3102 type thermal tracer.

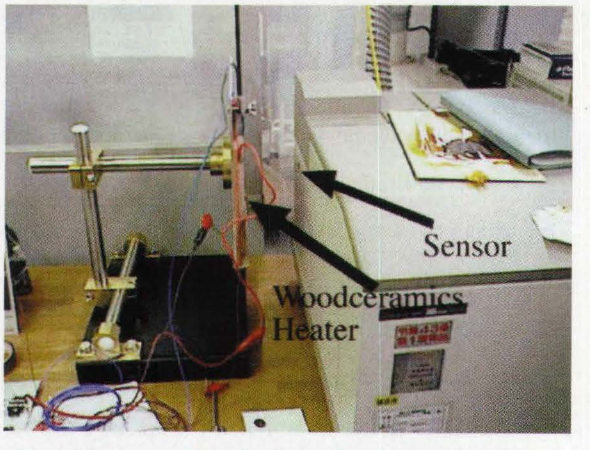

Fig.4 Setting method of adapter for the measurement of far infrared radiation from the woodceramics heater.

3. RESULTS AND DISCUSSION

Figure 5 shows the comparison between the hot-wind drying by the nichrome heater and the far infrared-ray radiation drying by the woodceramics heater in the same warehouse. The drying rate of the beech board by the far infrared radiation drying with woodceramics heater was slightly larger than that by the hot-wind drying with nichrome heater. The effects of the far infrared radiation upon the inner structure and chemical structure of the board specimen will be further reported in the next study.

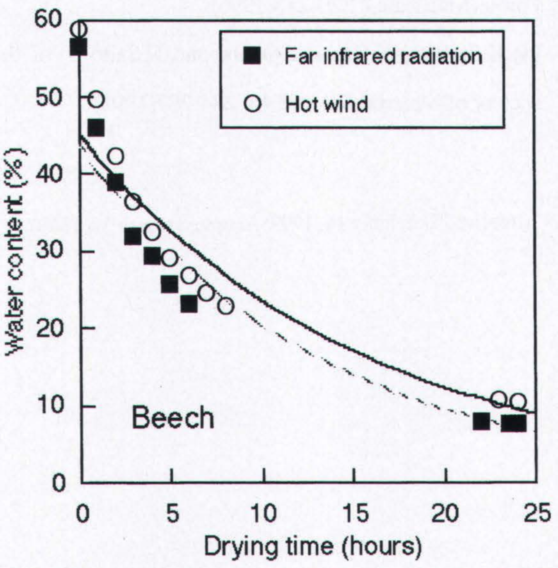

Fig.5 Comparison between far infrared radiation drying and hot-wind drying.

Figures 6-8 shows the far infrared radiation emissivities from the woodceramics heaters when the surface temperature was set as 40℃, 60℃ and 80℃, respectively. It could be seen that the far infrared radiation emissivity was 80%, 90% and 90% at the surface temperature of the woodceramics heater 40℃, 60℃ and 80℃, respectively. These results showed that the far infrared radiation emissivity of the woodceramics heater increases with increasing surface temperature and it is nearly stable at higher temperature.

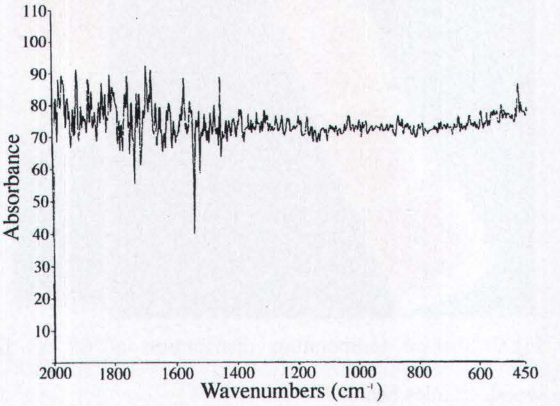

Fig.6 Emissivity at the surface temperature of 40 ℃.

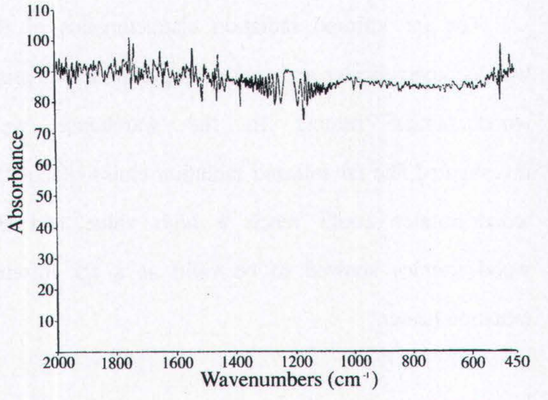

Fig.7 Emissivity at the surface temperature of 60 ℃.

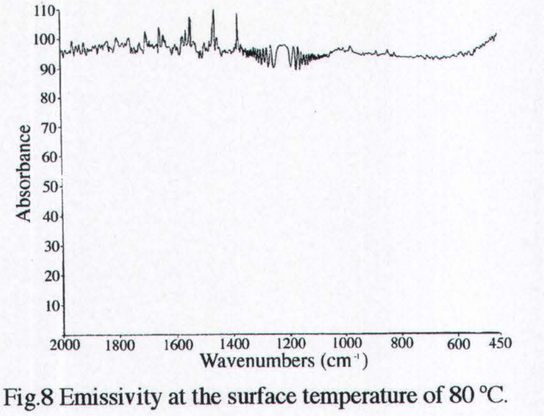

Fig.8 Emissivity at the surface temperature of 80 ℃.

Figure 9 shows an example of the surface temperature distribution of the woodceramics heater set at 60℃, which suggested that temperature distribution was uniform in the whole area of the woodceramics heater.

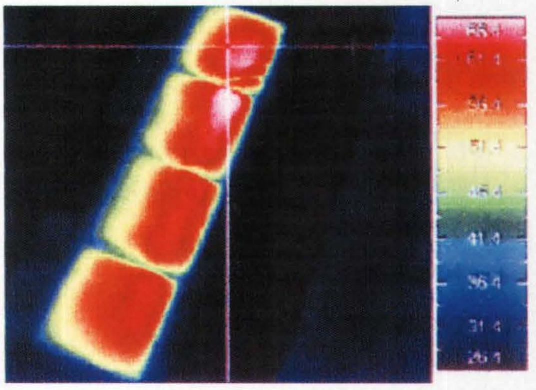

Fig.9 Surface temperature distribution at 60 ℃ in woodceramics heater.

4. SUMMARY

The far infrared radiation characteristics of the woodceramics heater and trial drying experiment using woodceramics heaters in the warehouse were investigated.The far infrared radiation emissivity of the woodceramics could reach a high value and the woodceramics showed to be valid as a far infrared radiation heater.

ACKNOWLEDGEMENT

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