Emission of Formaldehyde from Plywood

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Abstract

The emission of formaldehyde from plywood was investigated using commonly available kinds of plywood with different emission levels. The measurement of emission rate was based on JAS method: the rate was expressed in terms of formaldehyde concentration of desiccator water into which formaldehyde emitted from plywood was absorbed. The rate of emission was naturally much higher with longer emission time, but after 96 hours emission, no great difference in the rate was observed amongst all plywood samples tested. For every kind of plywood, formaldehyde emission was markedly reduced after one week exposure in fresh air. Coating of plywood with paint also remarkably reduced formaldehyde emission. Exposure of plywood in fresh air and paint coating on plywood surface appear both to be very effective to improve indoor environment of the room surrounded by plywood walls.

Keywords: formaldehyde, plywood, emission

1. Introduction

Plywood is in general use as a necessary building material. In the manufacture of plywood, thermosetting resins such as phenol-formaldehyde and urea-formaldehyde resins[1)] are exclusively used to bond wooden sheets together. Many kinds of plywood, therefore, slowly emit formaldehyde in greater or lesser extent. Formaldehyde is one of volatile organic compounds (VOC) and often causes *sick house syndrome*, particularly when plywood is applied to indoor walls. Several kinds of formaldehyde-free plywood have recently been available as safe indoor materials. The safe plywood contains no formaldehyde-based resins of adhesive ingredients. Japan Agricultural Standard[2)] (JAS, revised in 2000) classifies plywood into three grades, Fc0, Fc1, and Fc2 according to the level of formaldehyde emission. Wall paper becomes also another origin of formaldehyde emission because the adhesive of starch paste contains formaldehyde as a preservative component.

The present paper aims to examine commonly available several kinds of plywood on formaldehyde emission in connection with the improvement of indoor environment. In addition, an

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effective means to be able to minimize formaldehyde emission from plywood is offered.

2. Experimental

2.1. Materials

Plywood: Five kinds of plywood (4mm thick) were examined; these included commonly available standard F0, F1 (for airtight room), Fc2, substandard T1 (highly water-proof), and lauan plywood. Formaldehyde-free plywood (4mm) was provided by Atopico Co. Ltd.

Table 1. Allowable quantity of formaldehyde emission for plywood (JAS)

Grade	Average emission (ppm)	Maximum emission (ppm)
F0	0.0	0.005
F1, Fc0*	< 0.5	< 0.7
Fc1*	< 1.5	< 2.1
F2, Fc2*	< 5.0	< 7.0
F3	< 10.0	< 12.0

*: Grade for the plywood produced after May, 2000.

2.2. Measurement of formaldehyde emission

A desiccator with an inner perforated plate (140mm diameter) was added by 50ml distilled water. A plywood sample (70mm x 70mm) was placed on the plate dried prior to the emission test. After covered with the lid, the desiccator was left in a dark place at 20˚C. Formaldehyde emitted from the plywood sample was absorbed into water in the desiccator. After 24 and 96 hours passed, the formaldehyde-containing water in the desiccator was analyzed by means of the acetylacetone method.[3)]

3. Results and Discussion

3.1. Emission of formaldehyde from plywood

Most of ordinary plywood slowly emit formaldehyde vapor because a small amount of formaldehyde still remains in the resin adhesive of plywood.

Figure 1 indicates the rates of formaldehyde emission for several kinds of plywood. The rate of the emission is expressed in terms of formaldehyde concentration of desiccator water into which formaldehyde emitted from plywood was absorbed. Concerning 24 hour emission test, the emission rate for Fc2 was greater than that for F1 as suggested by JAS rule, but no great difference in the rate was observed amongst F0, F1, T1, and Fc2 samples in the 96 hours emission test. The rate of emission was naturally much higher with longer emission time.

As expected, formaldehyde-free plywood showed no formaldehyde emission because an adhesive different from formaldehyde-based resin is applied to this type of plywood.

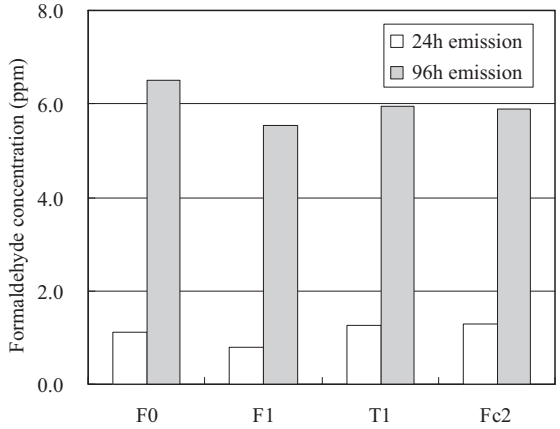

Fig. 1. Formaldehyde emission from plywood. The rate of emission is expressed in terms of formaldehyde concentration of desiccator water into which formaldehyde emitted from plywood was absorbed.

3.2. Effect of outdoor exposure of plywood on formaldehyde emission

Figure 2 shows the effect of outdoor exposure of plywood on the rate of formaldehyde emission. The exposure experiment was performed intending that formaldehyde remaining in plywood may be decreased when plywood is exposed outdoors for several weeks. As expected, formaldehyde emission was markedly reduced after one week exposure for all kinds of plywood tested. A little emission was, however, still observed even after one week though the emission level was below 0.5ppm. The present exposure experiment suggests that to expose newly built rooms with ordinary plywood walls to fresh air for several weeks is effective, though not completely, to improve indoor environment.

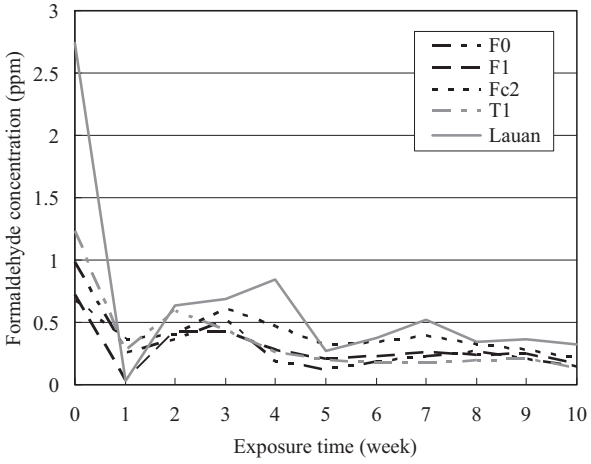

Fig. 2. Effect of outdoor exposure of plywood on the rate of formaldehyde emission (24 h).

3.3. Effect of paint coating of plywood on formaldehyde emission

Coating of plywood with paint is expected to reduce the rate of formaldehyde emission. As shown in Fig. 3, the effect of coating on the surface of plywood with paint was remarkable. For all kinds of plywood tested, every emission rate was decreased to below 0.3ppm through paint coating. Emulsion-type water paint appears preferable to oil paint for indoor use because water paint contains no volatile organic solvents.

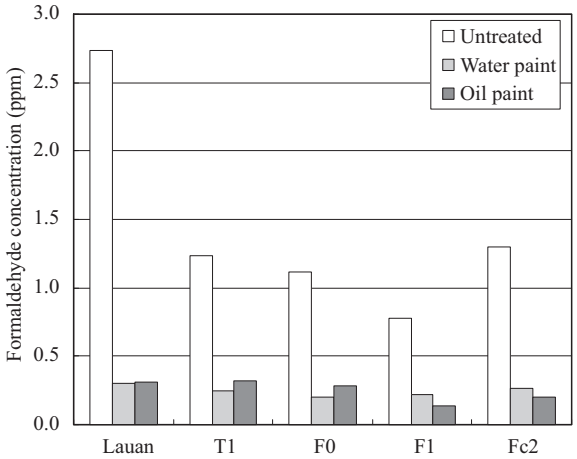

Fig. 3. Effect of paint coating of plywood on the rate of formaldehyde emission (24 h).

Acknowledgement

The present paper describes a part of the research work for the graduation thesis in 2003 performed by Misses Mayuko Aoi and Maiko Suzuki under the supervision of the author. The author greatly appreciates their energetic collaboration.

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