FORMALDEHYDE EMISSION FROM MALAYSIAN WOOD-BASED PANELS

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CHEW, L.T. & ONG, C.L. 1989. Formaldehyde emission from Malaysian wood-based panels. Regulations regarding formaldehyde emission from wood-based panels are strictly enforced in Europe and the United States of America. Malaysia, as an exporter of wood-based panels, has not imposed such regulations yet; there is neither a national standard for the determination of formaldehyde emission from wood-based panels nor a permissible limit of formaldehyde emission from them. We examined the formaldehyde emissions of plywood and particleboards from 11 wood-based panel mills in Peninsular Malaysia. The emission levels of these wood-based panels exceeded the permissible formaldehyde levels stipulated in the industrialised countries. Various methods for the determination of formaldehyde emission from wood-based panels are also introduced.

Key words: Formaldehyde emission - wood-based panels - testing procedures

Introduction

Formaldehyde is a key ingredient in the production of resin for the manufacture of particleboard, medium density fibreboard and plywood (Christianson & Garett 1988). At room temperature, formaldehyde gas is colourless and pungent. There is no concrete evidence that formaldehyde gas is a human carcinogen but at exposure levels as low as 0.1 ppm, it irritates the eyes, nose and throat. Thus, it may be a source of environmental pollution.

Regulations regarding formaldehyde emission from wood-based panels are strictly enforced in Europe and the United States of America. At present, there is no Malaysian standard for the evaluation of formaldehyde emission or any permissible limit of formaldehyde emission of panels. The Malaysian wood-based panel industries are not too concerned with this. However, sooner or later, the industries must heed certain regulations, especially with the public becoming more conscious of environmental issues.

Wood-based panels manufactured with phenol resins show practically no formaldehyde emission and can easily meet the standards of formaldehyde emission stipulated in the various international standards (British, German and Japanese Standards) on wood-based panels. However, this is not true for wood-based panels produced with urea resins. The potential source of formaldehyde emission from a urea resin is the methylol group present in it

(William 1982). The methylol group is an unstable functional group and releases the free formaldehyde, especially at high temperatures.

In the United States of America, the Department of Housing and Urban Development has since 1985 specified a maximum level of 0.2 and 0.3 ppm for the formaldehyde emission from plywood and particleboard, respectively, used in the interiors of homes (Anonymous 1985). In West Germany, particleboards are classified into three classes: they are E1 (formaldehyde emission <10 mg $100g^{1}$ board), E2 (formaldehyde emission >10-30 mg $100g^{1}$ board) and E3 (formaldehyde emission > 30-60 mg $100g^{1}$ board) (Anonymous 1988).

In Japan, particleboards are classified according to the Japanese Industrial Standard (Anonymous 1983b) on the type of adhesive and quantity of formaldehyde emmission. The three classes are U (urea resin), M (urea melamine resin) and P (phenol resin). The formaldehyde emission for all classes should be < 5 μg ml^{1}. In the Japanese Agricultural Standard, for specialty plywood (Anonymous 1983a), plywoods are classified as F1 (average formaldehyde emission < 0.5 μg ml^{1} and maximum formaldehyde emission < 0.7 μg ml^{1}), F2 (average formaldehyde emission < 5 μg ml^{1}) and maximum formaldehyde emission < 7 μg ml^{1}), and F3 (average formaldehyde emission < 10 μg ml^{1} and maximum formaldehyde emission < 12 μg ml^{1}) (Anonymous 1983a).

We examine the formaldehyde emission of some Malaysian urea particleboards and plywood.

Materials and methods

Samples of particleboards (5-18 *mm* thick) and plywood (3-18 *mm* thick) were obtained from three particleboard and eight plywood mills in Peninsular Malaysia. The panels were cut into various sizes for the different methods in the evaluation of formaldehyde emission, namely: (a) the WKI method (German Quality Control Method) (Roffael 1987); (b) the perforator method (EN 120) (Anonymous 1979); and (c) the desiccator method (JIS A 5908 - 1983 and JAS) (Anonymous 1983a & b).

According to the WKI method, test samples of dimensions 25 x 25 *mm* are suspended with rubber bands over 50 *ml* distilled water in a tightly closed 500 *ml* capacity polyethylene bottle. A series of polyethylene bottles containing the samples are then maintained at a constant temperature of 40°*C* for 24 *h*. After the reaction period, the bottles are placed in ice water for 30 *min* in order to achieve complete absorption of the formaldehyde in water. The formaldehyde emitted is then determined iodometrically or spectrophoto-metrically based on oven-dried weight of the sample.

In the perforator method, particleboard samples are extracted with toluene at its boiling temperature of 100°*C* for 2 *h*. The formaldehyde extracted by toulene is reabsorbed by water and then determined iodometrically or spectrophotometrically. The perforator value is expressed in *mg* 100 g^1 dry board.

In the Japanese desiccator method, samples of particleboard/plywood of dimensions 150 x 50 *mm* x thickness (Table 1 & 2) are placed in a desiccator of 9 to 11 *l* in capacity. The tightly closed container is kept at 20°*C* to 25°*C* for 24 *h* to allow the released formaldehyde to be absorped in 300 *ml* of distilled water in a dish at the bottom of the desiccator. The solution is then spectrophotometrically measured for formaldehyde emission.

Results and discussion

The formaldehyde emission of particleboards and plywoods, sampled from the three particleboard and eight plywood mills (Tables 1 & 2) show that Malaysian wood based panels possessed high levels of formaldehyde emission. In the case of particleboard samples, evaluated by the perforator method, none could be classified as Class E1 (< 10 *mg* 100g^1 board). Only one board could be classified as Class E2 (10-30 *mg* 100 g^{-1} board), four as Class E3 (30-60 *mg* 100 g^1 board) while the rest exceeded the values of formaldehyde emission stipulated for Class E3. All the particleboards, when evaluated according to the desiccator method, had values exceeding the maximum 5 $\mu g\ ml^1$ limit (Class U, urea type of resin) of the Japanese Industrial Standard, JIS A 5908 (Anonymous 1983b).

Table 1. Formaldehyde emission of Malaysian particleboards

Mill	Thickness of particleboard (*mm*)	Desiccator method ($\mu g\ ml^1$)	Perforator method (*mg* 100 g^1)	WKI method (*mg* 100 g^1)
A	5	34.3	89	84
	9	43.3	90	102
	15	54.9	106	128
	18	53.6	95	129
B	9	32.7	53	68
	12	31.7	54	67
	15	52.6	100	164
C	9	12.6	25	40
	12	25.0	45	69
	15	18.3	48	50

Table 2. Formaldehyde emisssion of Malaysian plywoods

Mill	Thickness of plywoods (*mm*)	Desiccator method (μg ml^{-1})	Perforator method (*mg* 100 g^{-1})	WKI method (*mg* 100 g^{-1})
A	9	15.7	17	27
	12	11.9	15	19
	15	25.0	31	36
B	9	10.1	21	11
	12	10.2	12	17
	15	23.2	74	84
C	12	28.6	41	58
	18	4.9	9	12
D	9	19.1	19	33
	12	10.0	16	30
	18	25.0	18	56
E	9	11.6	26	23
	12	20.1	25	36
	15	25.0	41	57
F	3	27.3	32	41
	12	44.1	43	55
G	12	26.5	36	52
H	18	36.4	43	61

In the case of plywoods (Table 2), none could be classified as Class F1 when evaluated by the desiccator method for the Japanese Agriculture Standard, JAS for specialty plywood (Anonymous 1983a). Only one of the samples could be classified as Class F2 (5-7 μg ml^{-1}) while five as Class F3 (<12 μg ml^{-1}). The tables also show that there is a big difference in the formaldehyde emission between the panels made by different mills.

For example, 9 *mm* particleboards produced by mills A and B (Table 1) had perforator values of 90, 53 and 25 *mg* 100 g^{-1}, respectively. In general, particleboard mill C tended to produce panels of lower formaldehyde emission. Plywoods of 12 *mm* thickness, evaluated by the desiccator method, (JIS A 5908: Anonymous 1983b) had the highest formaldehyde emission value of 44.1 $\mu g\ ml^{1}$ from plywood mill F and the lowest formaldehyde emission value of 10.0 $\mu g\ ml^{1}$ from plywood mill D (Table 2).

These high formaldehyde emission values from Malaysian wood based panels could be explained by the lack of standards and regulations for permisssible levels of formaldehyde emission in Malaysia. The big difference in the formaldehyde emissions between the wood based panels produced by different mills is due to the supply of the urea resins manufactured by the three different local adhesive mills, which have their own glue formulations for the manufacture of wood based panels.

Another cause for this vast difference of formaldehyde emissions between panels could be due to the different kinds of wood species being used for wood based panel manufacture: different wood species have varied levels of formaldehyde emission (Sundin 1987). For example, one particleboard mill uses only rubberwood as the raw wood material while the other two particleboard mills use various wood species available from their own subsidiary factories.

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