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Formaldehyde emission—Comparison of different standard methods

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Abstract

The emission of formaldehyde is an important factor in the evaluation of the environmental and health effects of wood-based board materials. This article gives a comparison between commonly used European test methods: chamber method [EN 717-1, 2004. Wood-based panels—determination of formaldehyde release—Part 1: formaldehyde emission by the chamber method. European Standard, October 2004], gas analysis method [EN 717-2, 1994. Wood-based panels—determination of formaldehyde release—Part 2: formaldehyde release by the gas analysis method, European Standard, November 1994], flask method [EN 717-3, 1996. Wood-based panels—determination of formaldehyde release—Part 3: formaldehyde release by the flask method, European Standard, March 1996], perforator method [EN 120, 1993. Wood based panels—determination of formaldehyde content—extraction method called perforator method, European Standard, September 1993], Japanese test methods: desiccator methods [JIS A 1460, 2001. Building boards. Determination of formaldehyde emission—desiccator method, Japanese Industrial Standard, March 2001 and JAS MAFF 233, 2001] and small chamber method [JIS A 1901, 2003. Determination of the emission of volatile organic compounds and aldehydes for building products—small chamber method, Japanese Industrial Standard, January 2003], for solid wood, particleboard, plywood and medium density fiberboard.

The variations between the results from different methods can partly be explained by differences in test conditions. Factors like edge sealing, conditioning of the sample before the test and test temperature have a large effect on the final emission result. The Japanese limit for F^{****} of 0.3 mg l^{-1} (in desiccator) for particleboards was found to be equivalent to 0.04 mg m^{-3} in the European chamber test and 2.8 mg per 100 g in the perforator test. The variations in inter-laboratory tests are much larger than in intra-laboratory tests; the coefficient of variation is 16% and 6.0% for the chamber method, 25% and 3.5% for the gas analysis method and 15% and 5.2% for the desiccator method.

Keywords: Emission testing; Formaldehyde; Chamber; Building materials; Wood; Particleboard; Wood-based boards

1. Introduction

The emission of formaldehyde is an important factor in the evaluation of the environmental and health effects of wood-based board materials. Different test methods are used in different countries.

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In a global market it is of vital importance to be able to compare products with formaldehyde emission classes like E1 in Europe with *F**** and *F***** in Japan. It is also important that inter-laboratory tests are performed to make it meaningful to compare results and possible to evaluate the variation that can be expected in the results obtained by different laboratories.

In this article, comparisons of formaldehyde emissions measured with different test methods on solid wood, particleboard, plywood and medium density fiberboard (MDF) are presented. The impact of different test conditions, sample treatments, etc. are shown and discussed.

2. Standard test methods

Determination of formaldehyde emission according to reference methods as the European chamber method EN717-1 requires, for example, chamber facilities and measurements until steady-state condition. There is, however, also a need for more simple and less time-consuming standard test methods for production control and similar tasks. As some of the commonly used simple methods are performed at increased temperature (as EN717-2 and EN717-3) or includes extraction with solvents (as EN120), it cannot be expected that these methods always result in evaluations in compliance with results obtained by the emission chamber reference method. In Table 1, some main characteristics of the methods are given and they are also discussed in an article by Yu and Crump (1999).

2.1. Chamber methods

The European chamber method, EN 717-1, is the reference method for the evaluation of the formaldehyde emission. The sample is placed in a chamber, normally 1 or 0.225 m^3 in volume. The loading factor is 1 $m^2\,m^{-3}$ and the air exchange rate 1 h^{-1}. The temperature is held at 23 °C and the relative humidity (RH) at 45%. Formaldehyde released from the test pieces mixes with the air in

Table 1
Comparison of standard methods for the determination of formaldehyde emissions

	Method	Test sample		Conditioning	Test conditions	
		Size loading factor	Edge sealing (m open edge m^{-2})	Temp/RH	Temp/RH	Air exchange/hour
Europe	EN 717-1 0.225, 1 or >12 m^3 chamber	1 $m^2\,m^{-3}$	Partly (1.5 m m^{-2})	23 °C/45%[a]	23 °C/45%	1
	EN 717-2 gas analysis 41 chamber	0.4 × 0.05 m	Yes	Not stated	60 °C/⩽ 3%	15
	EN 717-3 500 mL flask	0.025 × 0.025 m, 20 g	No (80 m m^{-2})	Not stated	40 °C/˜100%	No
	EN 120 perforator	0.025 × 0.025 m, 110 g	No	Not stated	Toluene extraction at 110 °C	No
Japan	JIS A 1901 20 l – 1 m^3 chamber	2.2 $m^2\,m^{-3}$	Yes	28 °C/50%	28 °C/50%	0.5
	JIS A 1460 9–111 desiccator	0.18 m^2	No (27 m m^{-2})	20 °C/65%	20 °C/0–80%[b]	No
	JAS 233 9–111 desiccator	0.18 m^2	No (27 m m^{-2})	No[c]		No
Global	ISO/CD 12460 1 m^3 chamber	1 $m^2\,m^{-3}$	Partly (1.5 m m^{-2})	23 °C/50%[a]	23 °C/50%	1

[a]Conditioning in the chamber, the values reported are steady-state values.
[b]See Fig. 4.
[c]Stored at 20 °C for 1 day wrapped in plastic before testing.