INTERNATIONAL STANDARD

ISO 12460-2

Second edition

Wood-based panels — Determination of formaldehyde release —

Part 2: Small-scale chamber method

Panneaux à base de bois — Détermination du dégagement de formaldéhyde —

Partie 2: Méthode à la petite chambre

PROOF/ÉPREUVE

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 89, *Wood-based panels*.

This second edition cancels and replaces the first edition (ISO 12460-2:2018), which has been technically revised.

The main changes are as follows:

— implementation of different chamber sizes, analytical procedures, re-calculation of results to other standard parameters and establish a correlation between reference chamber method and the method used for factory production control.

A list of all parts in the ISO 12460 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Wood-based panels — Determination of formaldehyde release —

Part 2: Small-scale chamber method

1 Scope

This document specifies a procedure for a chamber test with different options of chamber sizes to measure the formaldehyde concentrations in air from wood products under defined test conditions of temperature, relative humidity, loading and air exchange rate.

Results obtained from this small-scale chamber test method can be used for quality control (factory production control – 'FPC') based on correlation established by reference chamber test methods according to ISO, EN or ASTM standards. The establishment of a correlation is described in Annex D.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
air exchange rate
N
quotient of air volume Q passing through the chamber per hour (m^3/h) and the chamber volume (m^3) expressed in (h^{-1})

3.2
loading ratio
L
total exposed surface area, excluding panel edges, of the product being tested divided by the test chamber's volume (m^2/m^3)

3.3
make-up airflow
Q
quantity of conditioned and filtered air fed into the chamber per unit time, in m^3/h

3.4
***Q/A* ratio**
ratio of air flow through the chamber (Q) to sample surface area (A), in $m^3/h\ m^2$

3.5
sample surface area
A
total area of all sample faces exposed in the chamber, in m^2

3.6
measured concentration
C
formaldehyde concentration (expressed in mg/m^3 and/or ppm rounded to 2 decimal places) under the defined environmental test parameters of this method. In the case of a establishing a correlation, it can be advantageous to round the results to 3 decimal places

3.7
chamber volume
V
interior volume of the test chamber, in m^3

4 General

This document specifies the measurement to quantify the amount of formaldehyde in an air sample from a test chamber accepted in a range of sizes (examples are described in Annex A) and as determined by different analytical methods as specified in Annex C. Other analytical procedures may be used to determine the quantity of formaldehyde in the air sample provided that such methods give equivalent results. The test report shall include full description of the analytical procedure employed.

The values stated in SI units are the standard values. Any values given in parentheses are for information only.

NOTE This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

5 Significance and use

5.1 Various national and regional regulations on formaldehyde emission levels have been established for wood panels. This international test method was adapted from chamber test methods specified in different EN, ISO and ASTM standards. This test method provides a means of testing smaller samples and reduces the time required for testing compared with a reference chamber method.

5.2 Formaldehyde concentration levels obtained by this small-scale chamber method can differ from expected in full-scale indoor environments. Variations in product loading, temperature, relative humidity, and air exchange will affect formaldehyde emission rates and thus likely indoor air formaldehyde concentrations.

5.3 This test method is applicable for the use of a chambers from 0,004 m^3 to 1 m^3 in volume (see examples in Annex A) to evaluate the formaldehyde concentration in air using the following controlled conditions which are defined within this standard method:

a) conditioning of specimens prior to testing;

b) exposed surface area of the specimens in the test chamber;

c) edge sealing;

d) test chamber temperature and relative humidity;

e) the *Q*/*A* ratio;

f) air exchange rate within the chamber.

6 Interferences

Interferences of the used analytical methods should be determined by reference to other applicable standard test methods.

7 Apparatus

7.1 Test chamber

7.1.1 General

The interior volume of the small chamber shall be between 0,004 m^3 and 1 m^3 (examples see Annex A). The interior of the test chamber shall be free of refrigeration coils that condense water and items such as humidifiers with water reservoirs since water has the potential for collecting formaldehyde and thus influencing test results. The interior surfaces of the small chamber, including any sample support system, shall be a non-absorbent material. For example, stainless steel, aluminium, and polytetrafluoroethylene (PTFE) have been found appropriate as chamber lining materials. All joints except for doors used for loading and unloading specimens should be sealed. Doors shall be self-sealing.

7.1.2 Air exchange rate

The clean and conditioned air supply to the chamber shall either be monitored continuously or frequently during testing.

The air exchange rate shall not vary by more than ±5 %.

The effective air exchange shall be regularly checked, by using e.g. either a calibrated gas meter, or the tracer gas procedure (see Clause 11).

7.1.3 Air circulation

Low speed mixing fans or multi-port inlet and outlet diffusers are two techniques that have been used successfully to ensure mixing of the chamber air over all sample surfaces. If the air exchange is higher than 10/h mixing fans are not necessary.

7.1.4 Make-up air

The make-up air should come from a filtered dust-free environment and contain no more than 0,006 mg/m^3 of formaldehyde. Make-up air for the chamber shall pass through a calibrated air flow measuring device. If the make-up air is taken from a conditioning environment it should contain no more than 0,012 mg/m^3.

7.1.5 Equipment for monitoring of test conditions

Measuring equipment and recording facilities capable of continuous or frequent monitoring of the specified test conditions with an error limit as follows:

— Temperature: 0,1 K;

— Relative humidity: 2 %;

— Air exchange rate: 0,03/h.

7.1.6 Air sampling port

The exhaust flow (that is, chamber outlet) is normally used as the sampling point, although separate sampling ports in the chamber can be used. The sampling system shall be constructed of a material to minimize absorption (for example, glass or stainless steel), and the system should be maintained at the same temperature as the test chambers.

7.2 Air sampling system

7.2.1 Sampling system for wet-chemistry analysis

7.2.1.1 General

Figure 1 shows the principle of a sampling system for the determination of the formaldehyde concentration in the chamber air. The sampling tube shall be placed either in the air outlet, or inside the chamber, close to the air outlet.

Other sampling systems may be used based on the requirements of the analytical procedure used.

The numbers in brackets refer to the numbers in Figure 1:

7.2.1.2 sampling tube (1).

7.2.1.3 one or two 30 ml up to 100 ml gas washing bottle(s) (2), with inserts like impinger or Muenke or frits, containing between 8 ml to 40 ml absorber solution, or DNPH cartridges for absorption and subsequent determination of formaldehyde.

7.2.1.4 silica absorber for drying the air (3).

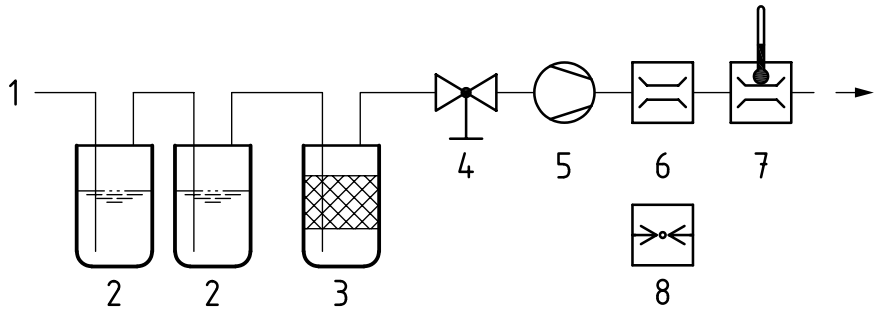
7.2.1.5 gas flow valve (4).

7.2.1.6 gas sampling pump (5).

7.2.1.7 gas flow meter (6).

7.2.1.8 gas meter (including a thermometer) for measuring the volume of air (7).

7.2.1.9 air pressure meter (8).



Key

1	sampling tube	5	gas sampling pump
2	gas washing bottle	6	gas flow meter
3	silica absorber	7	gas meter with thermometer
4	gas flow valve	8	air pressure meter

Figure 1 — Example of a sampling system for the determination of formaldehyde concentration in air

7.2.2 Direct sampling

Formaldehyde in the chamber air is determined by direct sampling analysis (e.g. optical or chemical sensors see Annex C). The measuring cell has to be connected with non-absorbent formaldehyde tubes. The length of tube can have an impact on results and has to be considered.

8 Sample material handling and specimen conditioning

8.1 Handling

Materials selected for testing shall e.g. be wrapped in polyethylene plastic having a minimum thickness of 0,15 mm (0,006 in) until sample conditioning is initiated. When testing wood products that are not newly manufactured such as after original application, installation or use, the method of packaging and shipping the products for testing shall be described e.g. in the quality manual handbook.

8.2 Test specimen

Chambers are operated at a fixed sample size by varying the make-up airflow (Q), or at fixed Q by varying the product sample size by product type. Either mode is acceptable as long as the appropriate Q/A ratios for the product type are met (see Table 1 and Table 2). The minimum requirement of Q/A ratio is 1 $m^3/h\ m^2$ with a range of ±2 %

Products can have different surface coverings on front and back side. Therefore, significantly different formaldehyde release characteristics for each surface can occur. In those cases, panels may be tested back-to-back or face-to-face with edges taped together depending on which surface is to be tested.

Table 1 — Examples of calculated Q/A ratio referring to chamber size used to consider the dimensions specified in the standards (here: EN 717-1[8], DMC[11], ISO 12460-3[3])

Type of chamber	Type of WBP[a]	Flow rate adjusted		Q	Air exchange	Sample size[b] height	Sample size[b] width	Number of samples	Sample surface area A	Q/A ratio
		[l/min]	[l/h]	[m^3/h]	rate N [h^{-1}]	[mm]	[mm]		[m^2]	[$m^3/h\ m^2$]
1 m^3	PB/PLY	16,67	1 000,2	1,000 2	1	500	500	2	1,000 0	1,000
1 m^3	MDF	16,67	1 000,2	1,000 2	1	500	500	2	1,000 0	1,000
0,225 m^3	PB/PLY	3,75	225,0	0,225 0	1	200	280	2	0,224 0	1,004
0,225 m^3	MDF	3,75	225,0	0,225 0	1	200	280	2	0,224 0	1,004
0,045 m^3	PB/PLY	8,91	534,6	0,534 6	12,15	200	381	3	0,457 2	1,169
0,045 m^3	MDF	14,51	870,6	0,870 6	19,79	200	381	3	0,457 2	1,904
0,004 m^3	PB/PLY	1,00	60,0	0,060 0	15	400	50	1	0,040 0	1,500
0,004 m^3	MDF	1,00	60,0	0,060 0	15	400	50	1	0,040 0	1,500

[a] WBP: wood-based panel; PB: particleboard, MDF: medium density fibreboard; PLY: plywood.

[b] Tolerance of sample size for samples used for chamber volume of 1 m^3, 0,225 m^3 and 0,045 m^3: ±2 mm; 0,004 m^3: ±1 mm

Table 2 — Examples of calculated Q/A ratio referring to chamber size considering the requirements for different types of wood-based panels (here: ASTM D 6007[10])

Type of chamber	Type of WBP[a]	Flow rate adjusted		Q	Air exchange	Sample size[b] height	Sample size[b] width	Number of samples	Sample surface area A	Q/A ratio
		[l/min]	[l/h]	[m^3/h]	rate N [h^{-1}]	[mm]	[mm]		[m^2]	[$m^3/h\ m^2$]
1 m^3	PB/PLY	8,33	499,8	0,499 8	0,5	143	500	3	0,429 0	1,165
1 m^3	MDF	8,33	499,8	0,499 8	0,5	85	500	3	0,255 0	1,960
0,225 m^3	PB/PLY	1,87	112,2	0,112 2	0,5	80	200	3	0,096 0	1,169
0,225 m^3	MDF	1,87	112,2	0,112 2	0,5	49	200	3	0,058 8	1,908

[a] WBP: wood-based panel; PB: particleboard, MDF: medium density fibreboard; PLY: plywood.

[b] tolerance of sample size for samples used for chamber volume of 1 m^3, 0,225 m^3 and 0,045 m^3: ±2 mm; 0,004 m^3: ±1 mm

NOTE Table 1 and Table 2 show only examples for some wood-based panel products. Any other wood-based panel or other formaldehyde emitting products (coated or uncoated) can be tested as well, e.g. OSB (Oriented Strand Boards), solid wood panels, cement bonded particleboards, wet process fiber boards, LVL, etc.

8.3 Conditioning

The procedure for pre-conditioning of samples prior to testing shall be specified and standardized on an individual basis i.e. at a factory or laboratory. The conditioning and testing parameters shall be specified and kept consistent.

An established procedure for sample conditioning is for example as described:

Condition test specimens with a minimum distance of 0,15 m (6 inch) between each specimen for minimum of 2 h ± 15 min at the conditions of (24 ± 3) °C [(75 ± 5) °F] and (50 ± 5) % relative humidity. The formaldehyde concentration in the air within 0,3 m (12 inch) of where panels are conditioned shall not be more than the lowest emission limit of the product(s) to be tested during the conditioning period. Alternative conditioning intervals can give better correlation to larger chamber test methods, e.g. 7 days ± 3 h conditioning or 15 days conditioning.

8.4 Sealing of test piece edges

Edges shall be sealed completely air-tight by using self-adhesive aluminium tape or wax.

9 Procedure

9.1 Test conditions

The following conditions shall be maintained in the chamber throughout the test:

— Temperature (25 ± 1) °C [(77 ± 2) °F];

— Relative humidity (50 ± 4) %;

— Q/A ratio minimum of 1 $m^3/h\ m^2$ ± 2 %.

The conditions can be reached by storing the chamber in a well-conditioned surrounding or by using a self-climatisation system.

9.2 Test procedure for materials

9.2.1 General

Purge the chamber by running empty or with the use of filters designed to reduce the formaldehyde background concentration in air, or both. The formaldehyde background concentration in air of the empty operating chamber should not exceed 0,006 mg/m^3. Clean chamber surfaces with water or suitable solvent if formaldehyde background concentrations approach 0,006 mg/m^3. If the make-up air is taken from a conditioning environment it should contain no more than 0,012 mg/m^3.

9.2.2 Locate the specimens in the chamber so that the conditioned air stream circulates over all panel surfaces.

9.2.3 Operate the chamber at (25 ± 1) °C [(77 ± 2) °F] and (50 ± 4) % relative humidity. Record the temperature, relative humidity, and barometric pressure during the testing period. Conduct the chamber test at the specified Q/A ratio and record this ratio in the report.

9.2.4 After placing the specimens in the chamber, allow time for no less than two full air changes before beginning the air sampling.

9.3 Air sampling

The sampling shall be carried out as specified in Annex C. The length of sampling tube can have an impact on results and shall be considered.

9.4 Analysis of air samples

9.4.1 General

Analytical methods for formaldehyde quantification are provided in Annex C. Of the analytical methods provided, the wet-chemistry methods (C.1: Acetylacetone method, C.2: Chromotropic acid method and C.3: DNPH method) are considered reference analytical methods and are the methods that the direct analytical methods (e.g. C.4: Laser Absorption Spectroscopy (LAS), C.5: Chemical sensor) are measured against and have to show equivalent results.

9.4.2 Equivalence of analytical procedures – General requirements

9.4.2.1 General

Where an analytical method other than the wet-chemistry reference analytical methods (C.1 to C.3) is used to determine formaldehyde in the air, equivalence to at least one of this reference methods shall be shown.

9.4.2.2 Demonstration of equivalence – Device manufacturer

Prior to use in a factory's laboratory, the device manufacturer shall carry out at least 15 tests using samples of different types of wood-based panels with varying composition (e.g. glue composition, additives, raw material) per product type (e.g. MDF, particleboard, plywood, OSB) evenly distributed in a wide emission range (at least 0,012 mg/m^3 up to 0,25 mg/m^3). A linear regression shall be calculated and equivalence is shown if the statistical evaluation complies with the requirements of a slope with 1 ± 0,05, $R^2 \geq 0{,}98$ and r value ≥ 0,99.

9.4.2.3 Demonstration of equivalence – Factory laboratory

The factory's laboratory shall validate the device manufacturer's data for the specific product(s) intended for FPC testing. To demonstrate equivalence at least five samples of the type of wood-based material respectively products are tested by using one of the reference wet-chemistry methods and the test procedure to be evaluated. Equivalence is demonstrated if the absolute mean deviation from the wet-chemistry reference method is ≤ 10 %.

10 Calculation

10.1 Convert the volume of air sampled to the volume of air at standard conditions by Formula (1):

$$V_S = \frac{V \times P \times 298}{101 \times (T + 273)} \quad (1)$$

where

V_S is the volume of air at standard conditions (101 kPa and 298 K), in cubic metres;

V is the volume of air sampled, in cubic metres;

P is the barometric pressure, in kPa;

T is the temperature of sample air, in °C.

10.2 Calculate total milligrams of formaldehyde collected in each washing bottle by Formula (2):

$$C_t = C_a \times F_a \quad (2)$$

where

C_t is the total mass of formaldehyde in the sample, in milligrams;

C_a is the total quantity of formaldehyde in the sample aliquots taken from the washing bottle (as determined from the calibration curve in C.1 to C.3, para), in milligrams;

F_a is the aliquot factor:

$$F_a = \frac{V_{s,sol}}{V_a} \quad (3)$$

where

$V_{s,sol}$ is the sampling solution volume, in ml;

V_a is the. aliquot used, in ml.

10.3 Calculate the concentration of formaldehyde in air in the small chamber as follows:

$$C_s = C_t / V_S \quad (4)$$

where

C_s is formaldehyde concentration in air in mg/m^3;

V_s is the volume of air at standard conditions (101 kPa and 298 K), in cubic metres;

Round calculated formaldehyde concentrations to the nearest 0,01 mg/m^3.

NOTE At 25 °C (77°F) and 1 013 hPa the following relationship exists for formaldehyde:

1,23 mg/m^3 = 1 ppm (parts per million);

1 mg/m^3 = 0,81 ppm (parts per million).

10.4 When the chamber temperature as described in the selected options of 9.1 differs from the standard parameter, adjust the formaldehyde concentrations obtained to a standard temperature of 25 °C (77 °F) using an equation developed by Berge et al. or other verified calculation models Annex B contains a table of conversion factors for use at different observed test temperatures as calculated using this formula. The observed test temperature is the average temperature for the total period of 15 min prior to air sampling plus the time of air sampling rounded to one decimal place.

10.5 The measured chamber formaldehyde concentration in air shall be adjusted to a concentration at 50 % relative humidity and shall to be re-calculated when it differs from 50 % (see Annex B). For re-calculation the measured relative humidity should be rounded to one decimal place.

11 Determination of air exchange rate

The determination of the air exchange rate (n) in the unloaded test chamber is based on the method for measuring the contrition dynamics of an indicator gas (tracer gas) which is introduced into the chamber. The indicator gas concentration will decrease over time depending on the air exchange rate. Under ideal air mixing conditions in the chamber, the concentration will follow the Formula (5) and calculated with Formula (6).

$$c_t = c_0 \, e^{-nl} \quad (5)$$

$$n = \left(\frac{1}{t}\right) \ln(c_0 / c_t) \quad (6)$$

where

c_0 is the initial concentration of indicator gas, in milligrams per cubic metre;

c_t is the concentration of indicator gas, in milligrams per cubic metre at time t in hours;

n is the air exchange rate per hour (1/h);

t is the time, in hours.

