SLOVENSKI STANDARD
SIST ENV 717-1:2000

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Lesne ploġ e - Ugotavljanje sproġ anja formaldehida - 1. del: Sproġ anje formaldehida po komorni metodi

Wood-based panels - Determination of formaldehyde release - Part 1: Formaldehyde emission by the chamber method

Holzwerkstoffe - Bestimmung der Formaldehydabgabe - Teil 1: Formaldehydabgabe nach der Prüfkammer-Methode

Panneaux a base de bois - Détermination du dégagement de formaldéhyde - Partie 1: Emission de formaldéhyde par la méthode a la chambre

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This European Prestandard (ENV) was approved by CEN on 15 November 1998 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Foreword

This European Prestandard has been prepared by Technical Committee CEN/TC 112 "Wood-based panels", the secretariat of which is held by DIN.

This European Prestandard is one of a series which specifies methods for determining formaldehyde potential in or formaldehyde release from wood-based panels. The other standards of this series are:

EN 120
Wood based panels – Determination of formaldehyde content – Extraction method called the perforator method

EN 717-2
Wood-based panels – Determination of formaldehyde release – Part 2: Formaldehyde release by the gas analysis method

EN 717-3
Wood-based panels – Determination of formaldehyde release – Part 3: Formaldehyde release by the flask method

This Eupopean Prestandard is based on CEN report CR213 "Particleboards – Determination of Formaldehyde Emission under Specified Conditions" and COST Project 613: Indoor Air Quality and its Impact on Man, Report No. 2: "Formaldehyde emission from wood-based materials: Guideline for the determination of steady state concentrations in test chambers".

The status of an ENV instead of EN, has been proposed because in the test institutes which are generally working with only one or two types of test chambers (options), a large amount of knowledge indeed has been gained, but no convincing information exists on the reproducibility and repeatability of each of the options, and even less, information on the degree of mutual inter-correlation of results (see NOTE to the scope).

During the ENV period, a number of test institutes are prepared to participate in cooperation with the aim mentioned above, to acquire the necessary information, including solutions to some statistical questions, raised with regard to annex C.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Prestandard specifies a chamber method with three options of test chambers for the determination of the formaldehyde emission from wood-based panels in terms of the steady-state concentration in a climate chamber under defined conditions, which relate to average conditions in real-life. This chamber method can also be applied to the estimation of formaldehyde concentrations under various conditions in practice, by the use of mathematical models.

NOTE: During the ENV period, inter-laboratory tests will be carried out to determine the reproducibility and repeatability of this test method.

2 Normative references

This European Prestandard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 326-1
Wood-based panels – Sampling, cutting and inspection – Part 1: Sampling and cutting of test pieces and expression of test results

3 Definitions

For the purposes of this Prestandard the following definitions apply:

3.1 Volume of the Chamber

Total air volume of the unloaded chamber, including recirculating ventilation ducts, expressed in cubic metres (m^3).

3.2 Loading Factor

Ratio of the total surface area of the test piece, excluding the area of the edges, to the volume of the chamber, expressed in square metres per cubic metre (m^2/m^3).

3.3 Air Exchange Rate

Quotient of air volume passing through the chamber per hour (m^3/h) and the chamber volume (m^3).

3.4 Air velocity

Velocity of the air near the surface of test pieces in the chamber in metres per second (m/s).

3.5 Steady-State

A steady-state (see clause 10) is reached when the formaldehyde emission of the wood-based panels is quasi constant under the test conditions, this means that the formaldehyde concentration in the chamber remains constant.

NOTE: In practice, a true steady-state is not achievable because formaldehyde is emitted irreversibly. This Prestandard defines a steady-state condition for the purpose of the test.

3.6 Emission Value

The steady-state formaldehyde concentration in the chamber, obtained under constant temperature, relative humidity, loading factor and air exchange rate, expressed by mass to volume in milligrams formaldehyde per cubic metre air (mg/m^3).

NOTE: At 23 °C and 1 013 hPa, the following relationship exists for formaldehyde:
1 ppm (parts per million) = 1,24 mg/m^3
1 mg/m^3 = 0,81 ppm (parts per million)

4 Principle

Test pieces of known surface area, are placed in a chamber, in which the temperature, relative humidity, air velocity and exchange rate are controlled at defined values. Formaldehyde emitted from the test pieces mixes with the air in the chamber. The air in the chamber is sampled periodically. The formaldehyde concentration is determined by drawing air from the chamber through gas washing bottles containing water, which absorbs the formaldehyde. The formaldehyde concentration in the water is determined. The concentration of formaldehyde in the chamber atmosphere is calculated from the concentration in the water in the gas washing bottles and the volume of the sampled air. It is expressed in milligrams per cubic metre (mg/m^3). Sampling is periodically continued until the formaldehyde concentration in the chamber has reached a steady-state.

NOTE 1: The chamber method can also be used for the testing of formaldehyde emitting products other than wood-based panels.

NOTE 2: The influences of temperature, relative humidity, loading factor and air exchange rate on the formaldehyde concentration in the chamber atmosphere can be described by the Andersen formula. An interrelation between the structure of the test pieces, especially of their surfaces and the air velocity is also apparent but cannot be exactly described by a formula.

5 Reagents

5.1 General

Reagents and water of recognised analytical purity shall be used for the analysis.

5.2 Acetylacetone solution

4 ml acetylacetone are added to a 1 000 ml volumetric flask and made up to the mark with water.

5.3 Ammonium acetate solution

200 g ammonium acetate are dissolved in water in a 1 000 ml volumetric flask and made up to the mark.

NOTE: Commercially prepared solutions may be used.

6 Apparatus

6.1 Test chamber

6.1.1 General

This Prestandard applies to different test chambers for formaldehyde emission testing which are described in Annex A.

General specifications and requirements which apply to all types of test chambers included in this Prestandard are given in 6.1.2 to 6.1.8.

6.1.2 Test chamber materials

Materials used for the inner walls and ducts of test chambers shall have a smooth surface, which, prior to testing, can be effectively cleaned with water. The surface shall be as inert and non-absorptive as possible to formaldehyde.

NOTE: Proven materials are stainless steel or aluminium (sandblasted or polished), glass and some types of plastics (PVC, PMMA).

6.1.3 Air-tightness of the chamber

The test chamber shall be air-tight in order to avoid uncontrolled air exchange.

The criteria of air-tightness are given in 8.2.2.

6.1.4 Air circulation in the test chamber

The test chamber shall contain facilities (such as fan systems) capable of maintaining:

- intensive air mixing in the chamber;
- an air velocity of 0,1 m/s to 0,3 m/s at the surface of the test pieces (see 8.2.5).

6.1.5 Air exchange facilities

The test chamber shall contain air inlet and/or outlet facilities capable of regulating the air flow and thus the rate of air exchange (replacement of chamber air by clean, conditioned air) with an error limit of 5 % at an air exchange rate of 1/h.

Precautions shall be taken to ensure that the clean air inlet and the air circulation system are adequately placed to ensure sufficient mixing and that ambient air cannot enter into the air outlet, even during sampling.

6.1.6 Clean air supply of the test chamber

Equipment capable of providing clean air with a maximum formaldehyde content of 0,006 mg/m³ (0,005 ppm).

6.1.7 Temperature and relative humidity regulating systems

Equipment capable of maintaining the temperature and the relative humidity in the test chamber within the following limits:

- Temperature: (23±0,5) °C
- Relative humidity: (45±3) %

6.1.8 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 °C
- Relative humidity: 1 %
- Air exchange rate: 3 %
- Air velocity: 0,05 m/s

6.2 Air sampling system

6.2.1 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.

NOTE: Other sampling systems may be used, provided it can be shown that they give equivalent results.

6.2.2 Equipment

The air sampling system consists of the following components which are given in figure 1. The numbers in brackets refer to the numbers in figure 1:

6.2.2.1 Sampling tube (1)

6.2.2.2 Two 100 ml gas washing bottles, containing water, for absorption and subsequent determination of formaldehyde (2)

6.2.2.3 Silica absorber for drying the air (3)

6.2.2.4 Gas flow valve (4)

6.2.2.5 Gas sampling pump (5)

6.2.2.6 Gas flow meter (6)

6.2.2.7 Gas meter (including a thermometer) for measuring the volume of air (7)

6.2.2.8 Air pressure meter (8)

6.3 Equipment for chemical analysis

6.3.1 Spectrophotometer, suitable for use with cells with a path-length of at least 50 mm and capable of measuring absorbance at 412 nm

6.3.2 Water bath, capable of maintaining a temperature of (40±1) °C

6.3.3 Six volumetric flasks, 100 ml (calibrated at 20 °C)

6.3.4 Two volumetric flasks, 1 000 ml (calibrated at 20 °C)

6.3.5 Bulb pipettes, 5 ml, 10 ml, 15 ml, 20 ml, 25 ml, 50 ml, and 100 ml (calibrated at 20 °C)

6.3.6 Microburette

6.3.7 Six flasks, 50 ml, with stoppers

6.3.8 Balance, scale interval 0,001 g

6.4 Equipment for verification of air exchange rate

6.4.1 Compressed-gas cylinder with tracer-gas

6.4.2 Detector for continuous monitoring of tracer-gas

6.4.3 Recorder

NOTE: Dinitrogen monoxide (N_2O) with infrared (IR) detection has proved to be suitable.

7 Test pieces

Sample the test pieces according to the general principles of EN 326-1 and cut them to a size which corresponds to a total loading rate of 1 m^2/m^3 (see Annex A). Wrap the test pieces hermetically immediately after cutting and leave them wrapped until the start of the test.

8 Procedure

8.1 Test conditions

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

- Temperature (23±0,5) °C;
- Relative humidity (45±3) %;
- Loading factor (1,0±0,02) m^2/m^3;
- Air exchange rate (1,0±0,05)/h;
- Air velocity at the surface of the test pieces (see 8.2.5) (0,1 to 0,3) m/s.

8.2 Verification of test conditions

8.2.1 Clean air supply of the test chamber

When determined in accordance with clause 9, the formaldehyde content of the air supplied to the chamber shall not exceed 0,006 mg/m³ (0,005 ppm).

8.2.2 Air-tightness of the test chamber

In order to avoid uncontrolled air exchange by intrusion of ambient air, the test chamber shall be operated at a slight over-pressure.

Air-tightness shall be checked regularly, either by pressure drop measurements or by comparison of simultaneous measurement of flow rates at the inlet and the outlet ports, or by measuring tracer gas dilution.

The test chamber is considered sufficiently air-tight if at least one of the following requirements is fulfilled:

– the air leakage is less than 10^{-3}xchamber volume per minute at an overpressure of 1 000 Pa;

– the inlet and outlet air flow differ by less than 1 %;

– the tracer gas dilution is less than 0,05/h.

8.2.3 Temperature and relative humidity control system

Temperature control shall be either by placing the test chamber within a location controlled to the appropriate temperature, or by controlling the temperature within the chamber.

In the latter case, the chamber walls shall be insulated effectively to avoid condensation of moisture on their inner surface.

Control of relative humidity shall be made either by external humidity control of the clean air supply, or internal humidity control of the air within the chamber. In the latter case, precautions shall be taken to avoid condensation, or spray of water, inside the chamber.

Temperature and relative humidity shall be monitored either continuously, or frequently, and independently of the air conditioning system. Sensors shall be placed in a representative position inside the chamber.

After loading the chamber, any initial deviations of temperature and relative humidity due to ambient air and unconditioned test pieces shall be recorded.

8.2.4 Air exchange

The clean and conditioned air supply to the chamber shall either be monitored continuously, or frequently. Suitable methods are specified in Annex A.

The air exchange rate shall not vary by more than 0,05 exchanges of air per hour.

The effective air exchange rate shall be regularly checked, by using either a calibrated gas meter, or the tracer gas procedure described in Annex B.

8.2.5 Air velocity in the chamber

Prior to testing, the air velocity in the test chamber loaded with test pieces shall be set to a value from 0,1 m/s to 0,3 m/s, measured at representative positions not more than 20 mm from the surface of the test pieces.

NOTE 1: Hot wire or film anemometers calibrated in the range of 0 m/s to 0,5 m/s are suitable for air velocity measurement.

The positions of the measuring points depend upon the volume of chamber and the type of air flow.

NOTE 2: Air velocity should be measured at a minimum of 4 positions in large chambers (≥ 12 m^3) or at a minimum of 2 positions in small chambers (1 m^3 or 0,225 m^3).

8.2.6 Performance of the chamber

The performance of the test chamber can be tested by a procedure described by Hoetjer and Koerts in the CEN Report CR 213 (cited in Annex E).

8.3 Chamber preparation

Set the chamber to the conditions given in 8.1. The determination (see 8.6) of the formaldehyde concentration in the empty chamber ("background-level") shall be carried out not less than 1 h after establishing the test conditions according to 8.1.

If the formaldehyde concentration in the chamber atmosphere is 0,006 mg/m^3 or lower, the chamber can be loaded with the test pieces.

NOTE: If the formaldehyde concentration is higher than 0,006 mg/m^3, the chamber should be purged by running empty to reduce the formaldehyde concentration to the accepted background level of 0,006 mg/m^3. If necessary, dust and other particles from the bottom should be removed and the walls and other interior surfaces of the chamber should be cleaned before starting the air cleaning procedure.

8.4 Preparation of test pieces

8.4.1 General

Unwrap the test pieces, seal the edges if necessary and place the test pieces in the chamber. The ratio of the length of open (unsealed) edges U related to the surface area A shall be U/A = 1,5 m/m^2.

NOTE: As a result of the constant ratio U/A = 1,5 m/m^2 the percentage of open edges area related to the surface area depends on the thickness of the test piece, as shown in the following examples:

Panel thickness	Percentage of open edges area
10 mm	1,5 %
19 mm	2,8 %
32 mm	4,8 %

8.4.2 Large chambers (see A.1)

Edge sealing shall not be done for the 1 m×2 m test pieces tested in large chambers (≥ 12 m^3). The perimeter, i.e the length of open (unsealed) edges U for 1 m×2 m pieces is 6 m and the surface area A is 4 m^2. Thus the ratio of U/A is 1,5 m/m^2.

8.4.3 Small chambers (see A.2 and A.3)

In order to obtain the same ratio of U/A = 1,5 m/m^2 for smaller test pieces in small chambers, partial edge sealing is necessary. This sealing should be done using self-adhesive aluminium tape.

NOTE: The length of edges to be sealed is given in A.2.3 for 1 m^3 chambers and in A.3.3 for 0,225 m^3 chambers.

8.5 Loading and starting procedure

Place the test pieces in the test chamber. They shall be vertical and approximately in the centre of the chamber, with their surfaces parallel to the direction of the air flow, and separated by not less than 200 mm (see figures A.1 to A.5 and A.7). The first air sampling shall be made not less than 3 h after loading the chamber and starting the test procedure.

8.6 Air sampling and analysis

Add at least 25 ml of water to each of the two gas washing bottles and connect them to the apparatus (see 6.2 and figure 1). Sample the air from the chamber periodically by passing a minimum of 120 l, at a rate of approximately 2 l/min, through the gas washing bottles. The mass of the absorption solution has to be determined after each sampling. Pipette 10 ml of each of the absorption solutions into a 50 ml flask and add 10 ml acetylacetone solution (see 5.2) and 10 ml of ammonium acetate solution (see 5.3). Stopper the flasks and determine the formaldehyde content of the solutions according to clause 9.

NOTE: The volume of air to be sampled depends on its formaldehyde concentration. With photometric determination the procedure described above is suitable for concentrations higher than 0,005 mg/m³. For determination of lower concentrations, the volume of the sampled air should be increased and/or the volume of the air sample solution reduced. The sensitivity of the analysis can also be increased by using a fluorimetric determination of the reaction product (diacetyldihydrolutidine) instead of a photometric determination. Furthermore the mass loss of the absorption solution should be determined by weighing and a sufficient water level above the gas wash bottle inserts should be ensured.

8.7 Test duration

The sampling procedure is repeated twice a day until enough data are available to calculate the steady-state (see Annex C).

NOTE: The time intervall between the two samplings should be greater than 3 h.

9 Determination of formaldehyde emission

9.1 General

The formaldehyde content of the aqueous solutions from each sampling period shall be determined photometrically by the acetylacetone method.

NOTE: To enhance the sensitivity of the analysis, the formaldehyde content can also be determined fluorimetrically (procedure see annex D).

9.2 Principle

The determination is based on the Hantzsch reaction in which formaldehyde reacts with ammonium ions and acetylacetone to yield diacetyldihydrolutidine (DDL) (see figure 2). DDL has an absorption maximum at 412 nm. The reaction is specific to formaldehyde.