SLOVENSKI STANDARD
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Zaġļ itna sredstva za les ï Ugotavljanje preventivne uļ inkovitosti zaġļ itnega sredstva proti morskim organizmom

Wood preservatives - Determination of the protective effectiveness against marine borers

Holzschutzmittel - Bestimmung der Schutzwirkung gegenüber marinen Organismen

Produits de préservation du bois - Détermination de l'efficacité protectrice vis-a-vis des organismes térébrants marins

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English version

Wood preservatives — Determination of the protective effectiveness against marine borers

Produits de préservation du bois — Détermination de l'efficacité protectrice vis-à-vis des organismes térébrants marins

Holzschutzmittel — Bestimmung der Schutzwirkung gegenüber marinen Organismen

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CEN

European Committee for Standardization
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Foreword

This European Standard was drawn up by the Technical Committee CEN/TC 38 'Durability of wood and wood-based products', the Secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 1993, and conflicting national standards shall be withdrawn at the latest by March 1993.

This European Standard has been approved by CEN, and in accordance with the Common CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Contents

Introduction

This European Standard describes a marine test method which provides a basis for assessing the effectiveness of a wood preservative used to prevent attack of timber in sea-water by marine borers.

The method is only suitable for testing preservatives which are intended to prevent attack by marine wood-boring organisms of treated timber for use in more or less permanent contact with sea-water. It is not suitable for assessing the effectiveness of preservatives against microorganisms.

The main objective of the method described is to evaluate the relative effectiveness of a wood preservative applied by vacuum/pressure impregnation. For this reason permeable timbers are used throughout so that the protective efficacy of various retentions of the preservative can be determined.

However, it is recognized that modifications of the method may be used for other purposes, e.g. to determine the relative efficacy of a preservative treatment or to determine the natural durability of the heartwood and sapwood of a selected timber species.

The method is primarily intended for testing in temperate waters where teredine and Limnorid borers dominate. However, it is also capable of being used in the tropics where attack by pholads and specific crustacean borers may be very destructive.

The test is intended to run for a minimum period (5 years or until the point of failure) before any interpretation of the results can be made.

Variations in the test conditions can be expected from one test site to another depending on temperature, salinity, population density of the various borer species, etc. This will inevitably influence the general rate of attack. However, by comparing the results obtained for specimens treated with the test product with those obtained for specimens treated with a reference preservative and those obtained with untreated control specimens, the relative protective effectiveness of the product tested can be evaluated.

The procedures described in this standard method are intended to be carried out by suitably trained and/or supervised specialists. Appropriate safety precautions should be observed throughout the use of this standard.

1 Scope

This European Standard specifies a marine test method for the determination of the relative effectiveness of a wood preservative applied by vacuum/pressure impregnation or other processes which would lead to deep penetration of the test specimens in order to prevent attack of timber in sea-water by marine wood-boring organisms.

The protective effect is assessed in relation to that of a reference preservative applied by a standard treatment. It is important to realize that the relationship between the results of these marine tests and performance in service can still vary for different preservatives.

This method is applicable for testing any type of wood preservative, provided that complete penetration of the test specimen is achieved.

NOTE. After suitable modification, it is possible to assess the effectiveness of a preservative product in other wood species or its effectiveness when applied by methods other than vacuum and pressure impregnation but only provided that a complete impregnation of the test specimens is achieved[1)].

2 Definitions

For the purposes of this standard, the following definitions apply.

2.1 representative sample

A sample having its physical or chemical characteristics identical to the volumetric average characteristics of the total volume being sampled.

2.2 supplier

The sponsor of the test.

3 Principle

Test specimens are vacuum/pressure inpregnated with preservative solutions to a given range of preservative retentions. After drying and, if necessary, an appropriate fixation period, the test specimens are submerged in the sea at a location where marine wood borers are prevalent. A single test site is regarded as adequate provided molluscan and crustacean borers are both active in this site. Additional sites with different water and/or climate characteristics are optional.

Removal of the test specimens from the water for inspection at regular intervals, with not more than 12 months between each inspection, and examination for marine borer attack, visually as well as by X-ray. The condition of the treated specimens is compared with that of untreated control test specimens and that of test specimens treated with a reference preservative, both of which indicate the aggressiveness of the individual site.

[1)]The only specific European aspect of this standard lies in the choice of the obligatory reference species *Pinus sylvestris*. The method can be used with any other timber species of preference and is not specific to Europe in its field of application.

4 Apparatus

4.1 *Ordinary laboratory equipment.*

4.2 *X-ray apparatus*, with tungsten target and beryllium window with voltage and current continuously variable in the following ranges:

Voltage : 10 kV to 50 kV

Current : 0 mA to 15 mA.

4.3 *Treatment plant*, capable of impregnating the timber (see **7.2**).

5 Sampling

The sample of preservative shall be representative of the product to be tested. Samples shall be stored and handled in accordance with any written recommendations from the supplier.

NOTE. For the sampling of preservatives from bulk supplies, the procedure given in EN 212 should be used.

6 Test specimens

6.1 Species of wood

For every test, the sapwood of *Pinus sylvestris* (Linnaeus) shall be used.

If additional wood species are to be used, they shall be susceptible to marine borer attack and the test specimens prepared from these species shall be capable of being completely penetrated with preservative.

NOTE. It is recommended that a hardwood species of local relevance should be included if the preservative is expected to be used in hardwoods.

6.2 Quality of wood

The wood shall be of uniform growth, straight-grained and free from knots, cracks, stain, decay, insect holes or other defects. Test specimens of resinous appearance shall be avoided. The wood shall not have been water-stored, floated, chemically treated or steamed.

The *Pinus sylvestris* sapwood shall show an average rate of growth of 2,5 annual rings per 10 mm to 8 annual rings per 10 mm.

If additional wood species are to be used the variation in the number of annual rings for each species shall be mentioned in the test report.

The test report shall also include mean density for the wood used in the preparation of the test specimens.

6.3 Preparation of the test specimens

Each specimen shall be:

(200 ± 1) mm long (grain direction) × (75 ± 1) mm × (25 ± 1) mm at (14 ± 2) % (*m*/*m*) moisture content[2)].

Each test shall consist of specimens of similar density and those which are outside the range of ± 15 % of the mean value of the density of the specimens in a test shall be rejected.

The specimen shall be prepared from sawn wood as delivered from the sawmill; no re-sawing or planing of the faces of the specimens shall be carried out.

The test specimen shall have an orientation of the annual rings similar to the ideal orientation (see figure 1). The annual rings should be as parallel as possible to the 75 mm edge. The diameter of any attachment hole shall not exceed 25 mm and shall be taken into consideration when calculating the preservative retention.

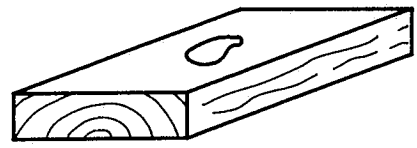

Figure 1. Specimen with an ideal orientation of the annual rings

If an arrangement as described in annex A is to be used the specimens are prepared with a hole of 25 mm diameter in the middle. See annexes A and B. If test arrangements other than those described in annex A are chosen the holes shall not exceed 25 mm and two in number.

6.4 Number of test specimens

The sea is a rough environment for long term testing of materials. Specimens may therefore be lost during the exposure period. This has to be taken into account when deciding the number of test specimens to be exposed.

At least five test specimens per site for each preservative and retention shall be tested. Treat extra specimens so that rejection of those having abnormal uptakes leaves sufficient for the test.

NOTE. Additional specimens may also be included for chemical analysis in order to aid determination of retention and/or distribution of the preservative (see **7.3**).

To assess the severity of the test site conditions a series of five untreated control test specimens are required per site. Further specimens shall be regularly installed at each site (see clause **9**).

Include at each site two series of five standard reference specimens of *Pinus sylvestris* sapwood treated with a reference preservative (see clause **8**) to at least two different retention levels according to **7.2**.

[2)] As determined by ISO 3130.

6.5 Labelling of test specimens

Each test specimen shall be labelled in such a way that it can be identified, even after being exposed for a long time in sea-water.

NOTE 1. This can be done by fixing a small plate of a resistant metal to the specimen. Titanium or stainless steel with a perforated identification code can be used. Thereby the specimen can be immediately identified on the X-ray film (see annex B).

NOTE 2. The label should be attached to the specimen by means of stainless steel ring, shank, nails or screws.

7 Conditioning and treatment of the test specimens

7.1 Drying

The specimens shall be dried to a moisture content appropriate to the method of treatment.

7.2 Treating process

A full cell process shall be used for the reference specimens and, unless otherwise specified, for the test specimens. All specimens shall be spaced by means of stickers during treatment. Initial vacuum shall be less than 10 kPa pressure and maintained for at least 30 min. Pressure of at least 1 MPa shall then be applied for at least 90 min.

A description of the process, including pressure and vacuum details, together with the duration of each period shall be recorded for each charge.

7.3 Determination of retention of wood preservative

Calculate the volume of each specimen before treatment from its dimensions (see **6.3**). Determine the mass of each specimen by weighing to the nearest 0,5 g.

After treatment allow the specimen to drain for several minutes or wipe off with a cloth excess solution from the surface. Reweigh each specimen to the nearest 0,5 g to determine the mass of treatment solution absorbed.

Calculate the retention value of each specimen from the mass of treatment solution absorbed, the concentration of the treatment solution and the calculated specimen volume. Express the retention of the active ingredient as kilograms of preservative per cubic metre of wood. Calculate the mean retention for each series of test specimens.

Specimens with individual retentions deviating by more than 10 % from the mean value shall be rejected.

NOTE. If a highly volatile solvent is used as the carrier it may be necessary to calculate the retentions from chemical analysis on additional specimens treated for this purpose (see **6.4**). It may also be desirable to carry out chemical analysis to determine the retention or distribution of preservatives within the specimens before and at intervals during the exposure period. If retentions are calculated from analysis of specimens used, the methods of sampling and analysis should be indicated in the test report.

7.4 Range of preservative retention

If the preservative is suitable for dilution the retention levels shall be a minimum of three and preferably five different retention levels. These different levels shall be achieved by using fresh preservative solutions at different dilutions and without varying the treatment conditions. Record the concentration in percent (m/m) of each solution used. Use a fresh solution for each concentration.

NOTE. The dilution of a quantity of solution which has been used already can be unsatisfactory because preferential absorption can have occurred during the previous treatment schedule.

If the preservative is unsuitable for dilution, the different retentions shall be achieved by varying the treatment parameters given in **7.2** provided that complete penetration is obtained (see clause **1**).

The middle retention of the series shall correspond to that value recommended by the supplier as suitable for use in sea-water ($\times$ kg/m^3). A suitable range would then be: 0,25 $\times$ kg/m^3, 0,5 $\times$ kg/m^3, 1 $\times$ kg/m^3, 2 $\times$ kg/m^3 and 3 $\times$ kg/m^3. A narrower range can be used if sufficient information exists on the effective range of the product, for example a geometric series with a factor of $\sqrt{2}$.

If the preservative is unsuitable for dilution, the different retentions shall be achieved by varying the treatment parameters given in **7.2** provided that complete penetration is obtained (see clause **1**).

7.5 Post-treatment conditioning of test specimens

As the drying and conditioning procedures used will depend on the nature of the product to be tested and the nature of the diluent or solvent, the recommendations of the supplier shall be followed.

For fixation of the reference preservative, the treated test specimens shall be close stacked, each retention grouped separately, and wrapped in polyethylene sheet or similar material to prevent rapid drying. The minimum period for fixation shall be 28 days. Fixation shall only be carried out at ambient temperatures greater than 10 °C.

For drying after fixation, the specimens shall be open stacked using 10 mm stickers and protected from rain and frost.

8 Reference specimens

8.1 Reference preservative

Specimens of *Pinus sylvestris* sapwood shall be treated according to **7.2**, if possible using the standard reference preservative with the following composition:

$CuSO_4.5H_2O$	35 % (*m/m*)
$K_2Cr_2O_7$	45 % (*m/m*)
$As_2O_5.2H_2O$	20 % (*m/m*)

NOTE 1. Chemical purity of individual components should be at least 98 % (*m/m*).

At least two concentrations of preservative solution shall be used.

NOTE 2. Concentrations of 2,6 % (*m/m*) and 0,6 % (*m/m*) may be adequate, corresponding to sapwood retentions of approximately 18 kg/m^3 and 4 kg/m^3 respectively. In non-European waters additional retentions may be required.

At least five specimens shall be tested with each concentration of the standard reference preservative.

8.2 Alternative reference preservative

If it is not possible to use a preservative containing arsenic, the reference specimens may be treated with an alternative preservative having the following composition:

$CuSO_4.5H_2O$	50 % (*m/m*)
$K_2Cr_2O_7$	48 % (*m/m*)
CrO_3	2 % (*m/m*)

NOTE 1. Chemical purity of individual components should be at least 98 % (*m/m*).

At least two concentrations of the alternative preservative solution shall be used.

NOTE 2. Concentrations of 5 % (*m/m*) and 1,2 % (*m/m*) may be adequate, corresponding to retentions of approximately 30 kg/m^3 and 7 kg/m^3 respectively. In non-European waters additional retentions may be required.

NOTE 3. Additional reference preservatives and wood species can be employed as desired.

9 Untreated control test specimens

It is important that the severity of the test site be monitored throughout the testing period. Therefore at least five additional untreated control test specimens shall be installed at each test site each year. The control test specimens shall be seasoned and stored in the same way as treated test specimens before installation.

NOTE. The object of using untreated control test specimens is to monitor the aggressiveness of the test site and to compare the rate of attack of untreated wood with that of wood treated with the preservative under test and that of wood treated with the standard reference preservative.

10 Test sites

10.1 Number of test sites

One test site is adequate; however two sites or more may be preferred having different populations of marine organisms, which generally relate to differences in physical and chemical characteristics of the water.

10.2 Choice of test site

Select the test site(s) in waters where wood-boring organisms are abundantly and actively represented by at least one species of mollusc and at least one species of *Limnoria*, or other marine crustaceans which attack wood.

NOTE. The population of these organisms should be reasonably stable from one year to the other. Severely polluted waters should be avoided.

The average water temperature and salinity for the coldest and the warmest month shall be made available and the methods used to determine those properties reported. Furthermore the aggressiveness of the test site shall be monitored and evaluated from the average life of the reference wood species *Pinus sylvestris* and considered adequate when the average life is less than 5 years.

10.3 Installation of test specimens in the sea-water

The test shall be started in the spring or at the beginning of the summer before the dispersal of the larvae of the wood-boring molluscs.

NOTE 1. In the tropics, timing of the test initiation is not so important although the effects of rainy season on salinity near river mouths should be considered.

The test specimens shall be exposed within 6 m of the surface at medium high tide. The test specimens shall not become exposed to the air at low tide.

NOTE 2. In temperate waters, both teredine borers and *Limnoria* attack will be most severe within the surface 6 m; severe pholad attack will occur at this depth in tropical sites.

Submerge the test specimens in the sea at the test site(s). They shall be fixed securely on an adequate support which keeps them separated from each other by at least 25 mm. Untreated control test specimens and those added subsequently shall be placed at random on the test device.

NOTE 3. A satisfactory method of achieving a permanent installation consists of attaching the test specimens to a supporting ladder (see annex A) placed on the sea-bed[3)] or, particularly where the tidal range is high, suspending them in the water from a raft.

NOTE 4. The test specimens may also be hung on to a rope. However, it is important to have a robust construction made of long-lasting material. It is also important to inspect the test arrangement regularly, if possible several times a year.

[3)] To avoid the danger of silting, it is recommended not to have specimens too close to the sea-bed.

11 Examination

Carry out examinations at intervals of 1 year for the first 5 years at the period of the year during which the organisms are least active. In particular, avoid the period corresponding to the dispersal of the larvae. Subsequently, further examinations may be made at longer intervals.

NOTE 1. It is important to obtain detailed information of species occurring at the test site and their life cycles in order to determine the time of installment and the intervals between the inspections.

In warmer waters (e.g. the Mediterranean Sea) examine the specimens at 6 month intervals.

At each inspection, the specimens shall be taken out of the water and examined for fouling organisms. The approximate percentage surface area of the specimens covered by fouling organisms shall be noted.

NOTE 2. Heavy fouling may reduce the area of wood surface available for settling of the molluscan larvae.

The dominating types of fouling shall also be noted, e.g. barnacles, tunicates, sponges, bryozoans, red algae, etc. (See annex D giving the bibliography for the assessment of the fouling.)

The fouling organisms shall be removed from the test specimens before further examination. Removing the growth from the surface shall be done with as much care as possible in such a way as to do least possible damage to the surface of the test specimens.

NOTE 3. *Limnoria* bore holes and their galleries just beneath the surface are particularly susceptible to damage by careless cleaning; the life of the organisms would also be threatened.

After careful removal of the fouling organisms the specimens shall be examined for attack by crustaceans (mainly *Limnoria* species). The evaluation of attack shall be graded according to the grading system given in clause **12**.

The test specimens shall then be X-rayed through one of their 200 mm × 75 mm surfaces. Subsequent X-rays shall be taken from the same face to be able to follow the development of attack.

NOTE 4. Depending on the equipment used, factors such as exposure time, distance between object and radiation unit, strength of current, type of X-ray film, etc. may vary considerably, and will have to be determined separately.

After X-raying, the specimens shall be reinstalled in the water at approximately the same place as before. The specimens shall be exposed to the air for the minimum time necessary which shall not exceed 4 h.

NOTE. It is recommended to keep the specimens in buckets or the like covered by circulating sea-water during the period when they are removed from the sea, to avoid damage to the borers.

12 Evaluation

12.1 General

Attack by crustacean or molluscan marine borers shall be evaluated separately.

12.2 Evaluation of Teredinid and other molluscan borers by X-ray apparatus

When the X-ray films have been developed they shall be examined for evidence of marine borer tunnels in the specimens.

NOTE. Because of calcification, some tunnels will show a contrast on the X-ray film.

After the death of the marine borers and the invasion of the tunnels by the sea-water, the chalky lining of the walls is dissolved gradually and the tunnel appears darker than surrounding wood on the X-ray film. However, the boring apparatus (the shells) of the animal usually remains for a longer period of time and is clearly visible on the film even after complete dissolution of the chalky lining.

Similarly, the attack by certain molluscan borers which do not produce a chalky lining of their tunnels is revealed on the X-ray film by marks produced by the boring apparatus, which shows strong contrast, and also by the fact that the tunnel is darker than surrounding wood.

The attack on each test specimen shall be graded in accordance with table 1. Add up the ratings of all test specimens at each retention of preservative and divide by the number of test specimens at each retention of preservative to obtain a notional average rating of attack by Teredinids and other molluscs for each retention of the preservative tested.

Table 1. Rating system for attack by Teredinids and other molluscs

Rating	Classification	Condition and appearance of test specimen
0	No attack	No sign of attack.
1	Slight attack	Single or a few scattered tunnels covering not more than 15 % of the area of the specimen as it appears on the X-ray film.
2	Moderate attack	Tunnels covering not more than about 25 % of the area of the specimen as it appears on the X-ray film.
3	Severe attack	Tunnels covering between 25 % and 50 % of the area of the specimen as it appears on the X-ray film.
4	Failure	Tunnels covering more than 50 % of the area of the specimen as it appears on the X-ray film.