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Durability of wood and wood-based products - Recommendations for measurement of emissions to the environment from treated wood in service

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Durability of wood and wood-based products - Recommendations for measurement of emissions to the environment from treated wood in service

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Foreword

This document has been prepared by CEN /TC 38, "Durability of wood and wood-based products", the secretariat of which is held by AFNOR.

The status of this document as CEN Report has been chosen because the most of its content is a review of methods of measurement of emissions from preservative treated wood in order to stimulate the discussion of the test parameters and the test methods for emissions to be retained.

Introduction

The regulatory control of biocides and biocidal products (as defined under the UE Directive 98/8/EC, including wood preservatives, requires increasing amounts of environmentally related information on which to base decisions.

In the case of wood preservatives (product type 8) this includes the provision of data concerning wood preservative treated articles.

This data is used to assess whether there is an unacceptable environmental impact likely to arise from the use of the treated timber product.

Such a risk assessment has to consider potential releases to all environmental compartments, namely air, soil, surface water, groundwater and sediment.

Many uses of wood preservative products are intended to extend the natural durability based expectation of service life, sometimes in the order of several decades.

It is therefore necessary to have a means of determining not only absolute values for potential emissions to the environment but perhaps more importantly the fluxes, or rates of emission during the course of time. They should be representative.

That is to say they should represent the emissions from in service sized pieces of treated wood.

Flux rates and profiles can then be inserted into mathematical models usually based on defined scenarios .

Such determinations of emission rates will also be invaluable in the development of new products because they will enable the researcher to identify early in the development of the product whether there are potential problems with the product in its areas of intended use.

It is quite impractical to mimic all of the biotic and abiotic factors present the natural environment in the laboratory. It has to be decided if a means can be found which will take into account as many as possible of these factors together with the large variation in climate and socio-economic factors present in Europe. Is it possible to conceive of a “surrogate” environment into which to determine emissions?

If it is believed that there is a potential for creating EN standards in this area it is vital that the methods can be reproduced in any suitably equipped laboratory, whether government, institute or industry. The methods should also not be costly, but must be cost effective.

Having produced an emission this should then be characterised. This might be through chemical analysis of the active substances, substances of concern and relevant metabolites; or by some other tests which can indicate ecotoxicological effects, for example so-called “soup testing”. The next steps would be to identify the environment ‘belonging’ to the treated component and to characterise the physical-chemical behaviour of the active substances, substances of concern and relevant metabolites in order give an answer about their bioavailability in a given environment.

These aspects are being considered by other expert groups in the EU and the OECD and should not be considered part of the remit for CEN/TC 38 to produce standards.

Any proposed standards should also take into consideration of the Technical Guidance Documents (currently being revised) in place for the Biocidal products Directive (98/8/EC), and the New and Existing Substances Regulations

1 Scope

This CEN Report is intended to stimulate discussion of the test parameters and the test methodologies to achieve a consensus of opinion. This should allow test methods for emissions from preservative treated wood to be prepared and tested before they become standards. The standards will allow competent authorities and manufacturers of wood preservatives to comply with the requirements of the Biocide Products Directive(BPD.)

2 Framework of cases for determination of needs for emission test methods

The following matrix has been established taking into account different documents and works (see [2] to [7] included).

The aim is to try to link the different end-use categories for treated timber in service, with the Biological Hazard Classes on one hand and the exposed environmental compartment on the other hand; through this, it is possible to list the specific cases of emissions from treated timber to the environment (see Table 1).

Table 1 — Specific cases of emissions from treated timber to the environment

Targets	Biological Hazard Classes	Use categories and typical scenarios	Exposed Environmental Compartment	Emission data needed	First Exposed Non targets
Insects	HC 1	Internal non structural Bedroom floor	Indoor Air	**Emission to indoor Air**	**Human**
Insects + Fungi	HC 2	Internal structural Roofing timber	Indoor Air	**Emission to indoor Air**	**Human Environment** Indoor air organisms (Bats)
Insects + Fungi	HC 3	External above ground and above fresh-water House cladding Fence rails Jetty planks	Soil by run-off rain water Fresh water by run-off rain water	**Leaching by rain water** **Leachate migration into soil /surface water**	**Environment** Soil organisms Fresh water organisms
Insects + Fungi	HC 4 a	External in ground contact Transmission Pole Fence post	Soil by run-off rain water Soil by direct contact	**Leaching by rain water + Leachate migration into soil + Direct emission into soil**	**Environment** Soil organisms
	b	External in freshwater contact Jetty in a lake Poles Sheet Pilings	Fresh water by run-off rain water Fresh water by direct contact	**Leaching by rain water + Direct emission into water**	**Environment** Fresh water organisms Ground water
Insects + Fungi + Marine borers	HC 5	External in seawater contact	Sea water by run-off rain water Sea water by direct contact	**Leaching by rain water + Direct emission into sea water**	**Environment** Sea Water organisms

There are two ways to approach the question of the need for emission data to feed in the exposure assessment calculations in the different scenarios.

The first approach would be to consider globally the emission from the commodity to the environment without any differentiation of all the mechanisms. This would mean to have one test method for each of the commodities listed in the reference scenarios ; or, if it is possible to define a worst case scenario for each use category or a model case, then one test method would be needed for each of the use categories where the conditions are strongly different ; only may be the cases of HC 1 and HC 2 could be combined (emissions from wood to indoor air) , as well as HC 4 b and HC 5 where the difference is only the kind of water. This approach looks rather difficult to handle in a systematic way of producing emission data, as the list of tests needed might change if scenarios are revised.

The second approach would be to consider each possible mechanism of emission to obtain elementary emission data, and then to combine these (sum up) to calculate the global emission of one commodity to a given environmental compartment in a scenario.

In this second approach, the list of types of emission data needed is the following :

- emission from treated wood to indoor air ;
- leaching from treated wood by rain water ;
- rain water leachate migration into soil/water ;
- direct emission from wood into soil/ground water ;
- direct emission from wood into water (fresh water or sea water).

3 Review of methods of measurement of emissions from preservative treated wood

3.1 General

Methods are required for the measurement of emissions from preservative treated wood in service. This document reviews a number of methods which have been used to measure emissions from preservative treated wood under laboratory conditions. These methods do not include tests using small specimens or sawdust, or for measuring emissions from wood during drying after treatment.

The methods are for wood in service in biological HC 2 to HC 5, with exposure to the environmental compartments of air, soil, ground water beneath soil, fresh water and sea water.

3.2 Air

It is possible that treated wood used in a building could affect air, indoor air, and treated wood outside buildings could affect outdoor air. The Existing Substances Directive uses a value of 0,01 Pa as the vapour pressure threshold. Below this vapour pressure a substance is not considered to be volatile and emissions to air are not considered in the risk assessment. If the substance has a vapour pressure greater then 0,01 Pa, the substance is considered sufficiently volatile to evaporate and produce a concentration in air. The effect of that concentration should be considered in a risk assessment. The concentration is used in an equation which predicts deposition on to surface water and the resulting concentration in the surface water (Predicted Environmental Concentration) assessed for the risk to aquatic organisms by dividing the PEC by the PNEC (Predicted No Effect Concentration) from an ecotoxicological test organism (e.g LD_{50} *Daphnia*).

If the PEC / PNEC ratio is greater than 1, there is a potential environmental risk and the tiered approach allows the PEC to be measured, rather than calculated. As it is not possible to measure the concentration in surface water which is solely emitted from treated wood, and the emissions from treated wood are likely to be affected by many parameters, the actual emission from treated wood could be measured.

The 'Metre cube box' method has been used for the measurement of formaldehyde emission from wood. The principle of the test is realistic in that treated wood could be placed in the chamber at a defined temperature and air at a defined flow rate can be passed over it. Any volatile materials at the temperature of the test will evaporate and pass out of the chamber. The air will then have to be tested for its environmental effects. If the active ingredient can be analysed, then it will have to be extracted from the air and chemically analysed. The result can be converted to an amount of active ingredient emitted in mg/m^2/day.

If the active ingredient cannot be analysed, or all of the substances emitted from the wood need to be assessed for their environmental effect, and not just the active ingredient of the wood preservative, then the outlet air will have to be used in a test which measures the environmental effect of air. It is probably outside the scope of CEN TC/38 Working Group 25 to suggest a suitable test. The OECD Biocides programme is considering methods of ecotoxicological testing and are considering this issue.

Note that the vapour pressure of 0,01 Pa is the vapour pressure of the components *in the dry wood* and not of the components in the treating solution. It is unlikely that any of the components of current wood preservatives used indoors have components which have a vapour pressure in dry wood of greater than 0,01 Pa, so this test is unlikely to be required in support of a wood preservative to comply with the data requirements of the BPD.

Meyer and Boehme (1997) (see |13]) determined formaldehyde emission from solid wood using a specially designed chamber of 1 m^3. During testing, the temperature was (23 ± 1) °C and the relative humidity was (45 ± 5) %. The air exchange rate was fixed at 1 h^{-1}. The chamber was loaded with four solid wood samples measuring 500 mm by 250 mm by 20 mm, giving a total surface area capable of emission of 1 m^2 (neglecting the edges). Thus, the ratio of air exchange rate to loading was 1. These test conditions were in accordance with specific provisions (Chemikalien –Verbotsverordnung, 1993) (see [9]). The sampling period was 50 min and the test ran for 15 days. Concentrations of 2µg/kg to-9 µg/kg formaldehyde were measured.

Van Eetvelde and Stevens (1993) (see [18]) used a 7,9 l column containing a specimen of meranti 55cm x 6cm x 1 cm, coated with preservative, and exposed for 48 h or 96 h to an air flow rate of 2 l/min. The ratio of wood volume to air volume is 1:24 and the wood surface area to air volume is 1: 10. Air changes are 16 changes per hour. The emission rate for dichlorofluanid applied in a primer-type formulation at 80 g/m^2 after 48 h drying, emitted 2,6 µg/m^2/h over the first 24 h at 40 °C. This is equivalent to an emission rate of 0,06 mg/m^2/day.

Wu and Milota (1999) (see [20]) used a 1m^3 laboratory kiln connected to two sets of condensers to cool the exhaust air and to collect water. The quantity of wood (Douglas fir) was 20 boards, 17,.3 cm long, 42mm x 147 mm cross section. The temperature and humidity were chosen to simulate kilning schedules at temperatures from 71,1 °C to 93,3 °C using air at ambient temperature and humidity flowing at 2l/min for 48 h. Emissions were 0,70 to 0,84 g/kg oven dry wood, equivalent to 0,00024 mg/m^2/day. The ratio of wood volume to air volume is 1:46, and the wood surface area to air volume is 1: 63. Air changes are 0,12 changes per hour.

The European Wood Preservative Manufacturers Group (EWPMG)has proposed a test using a 1 m^3 box . The method uses (23 ± 1) °C and a relative humidity of (45 ± 5) %. The air exchange rate is 1 h^{-1}. The chamber is loaded with wood having a surface area of 1 m^2 so the ratio of air exchange rate to loading is 1. The rate of emission in mg/m^2/day should be determined over 0 day to 10 days, and 10 days to 100 days.

In the Organisation for Economic Co-operation and Development (OECD) emission scenario the ratio of wood surface area (205 m^2) to receiving compartment volume in the roof (227 m^3) is 1:1,1. If the 1 m^3 box is acceptable, the test parameters to be decided are wood dimension and surface area, air temperature and humidity, air changes per hour, duration of test and sampling times.

A research report in the context has been published in "UBA-Texte (51-99)" as "BAM-Forschungsbericht : Entwicklung eines standardisierbaren Prüfverfahrens zur Bestimmung des Eintrages von Holzschutzmittel-Wirkstoffen aus behandeltem Holz, Altholz und daraus hergestellten Holzwerkstoffen in die Luft". The report includes the results of emission measurements with regard to Lindan, Furmecyclox, Dichlofluanid, Permethrin, Tebuconazol, Propiconazol taking into account also different types of emission test chambers. Extracts of this report are also published in [23], [24] and [25].

3.3 Above Ground

The environmental risk of preservative treated wood in service out of ground contact is considered to be soil or surface water. For example the components of a fence or deck which are above soil but not in contact with the soil, and the components of a jetty or fisher cabin which are above water, but not in contact with it.

Stilwell and Gorny (1997) (see[16]) measured the amount of Cu ,Cr and As beneath seven treated decks in service and compared the concentrations with soils samples not beneath the deck. The decks ranged in age from 4 months to 15 years. The average contents (mg/kg) in soil beneath decks were Cu 75 mg/kg , Cr 43 mg/kg, As 76 mg/kg, and the control soils were Cu 17 mg/kg, Cr 20 mg/kg and As 4 mg/kg. The Cu, Cr and As emissions can be calculated from the data in the paper (Table 2). The emission is higher in the first four months, and decreases with time so that the Cu, Cr and As levels beneath the 15 years deck are close to background levels. The level of emission is less than 4 mg/m^2/day.