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THE ESSENTIALS OF WOOD PRESERVATION FOR THE CONSTRUCTION INDUSTRY

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Introduction

Wood can be degraded by various bio-deteriorating agents such as termites, insect borers, decay fungi, marine borers and sapstain fungi. They use wood as a source of food and shelter. The degradation of wood causes immeasurable losses each year. Therefore, the cause and effect of wood degradation can hardly be overlooked.

Preservation of wood by treatment with chemicals, which is toxic to these bio-deteriorating agents, is the effective way to protect wood and prolong its service life. However, the degree of success in using treated wood products depends not only on the type of chemical preservatives but on the treatment method as well. The period of service for wood components depends on the absorption, retention and penetration of the chemical preservatives into wood. The magnitude of these parameters depends also on the usage conditions, or the hazard class of the wood components.

This paper describes some basic principles of wood preservation and relationship between the type of wood preservatives, treatment methods and hazard class rating.

Wood preservatives

An important factor in selecting a suitable chemical as wood preservative is the capability of the chemical to impede bio-deteriorating agents from destroying wood. Different chemical preservatives have different toxicity effects against bio-deteriorating agents. There are many varieties of chemical formulations that can be used, but an ideal wood preservative should be:-

1. Highly toxic to bio-deteriorating agents (termite, decay fungi, insect borer, marine borer, sapstain fungi) but non-toxic to human and environment
2. Permanently fixed to the wood
3. Able to penetrate wood easily
4. Odourless, non-corrosive to metal and non-deleterious effect on polishes and paints
5. Safe in handling
6. Inexpensive

Generally, wood preservatives are classified into three main groups: oil-borne wood preservatives, water-borne wood preservatives and light organic solvent preservatives (LOSP).

Creosote is the most widely known of the oil-borne wood preservative. Creosote obtained from distillation of coal tar was used to preserve wood since ancient time. The wood-preserving properties of creosote are due to the presence of pyroligneous acids, naphthalenes, anthracene, etc. However, the scope of creosote application is comparatively small. Creosote is particularly well suited for railway sleepers because of its good weathering properties. Copper naphthenate and copper-8-quinolinolate are other oil-borne preservatives. However, both chemicals are expensive, thus limiting their use as commercial wood preservatives.

Water-borne wood preservatives are water-soluble chemicals used to treat wood. There are two types of water-borne preservatives: leach-resistant and leachable. Leach-resistant preservatives refer to chemicals that react with water to form insoluble compounds that bond to the wood. The bond prevents preservative from being leached during the lifetime of the wood in service. This property allows treated wood to be used in areas of high hazard (ground contact). The most commonly used water-borne wood preservative is chromated copper arsenate (CCA). CCA is classified as leach-resistant and suitable for ground contact applications. Leachable chemicals on the other hand do not fix chemically in the wood. If exposed for prolonged time in running water such as rain, they can easily be leached out. Therefore, wood treated with leachable chemicals cannot be used for outdoor application. Borate compounds are classified under leachable preservatives which can partially be leached out if exposed repeatedly to water that flows away the boron. Other water-borne wood preservatives include alkaline copper quaternary (ACQ) and copper azole.

Light organic solvent preservatives (LOSP) usually use volatile solvent such as kerosene or white spirit as a carrier to deliver chemical preservatives into the wood structure. Synthetic pyrethroids such as permethrin and cypermethrin are typically used as chemical preservative in LOSP system. LOSP is of particular value to manufacturers because it offers fast drying-preservatives that are clean to handle.

Treatment techniques

Methods of treatment can be classified into pressure treatments and non-pressure treatments. The selection of treatment process depends on the application of wood and the environmental conditions to which treated wood will be exposed.

1) Pressure treatment method:-

Pressure treatment method is the most effective wood treatment technique. This method involves the vacuum phase, while high pressure is used to force the chemical preservatives into the wood cell structure. The method provides deeper, more uniform penetration and higher chemical retention. Wood treated using this method can be recommended for use in high hazard environment.

Generally, most of the chemical preservatives can impregnate wood using pressure treatment. However, suitable treatment schedule should be properly designed for effective treatment. Good preservative loading and penetration in wood can be achieved by appropriately adjusting the following parameters:

i) The concentration of the treatment solution
ii) The level and duration of the initial and final vacuum stage
iii) The level and duration of the initial and main pressure stage
iv) The temperature during pressure treatment process

This treatment can be done using a Bethel (full cell) pressure treatment process. Basically in this treatment process, the wood is loaded into the treatment cylinder on bogies before the door is sealed. Wood has to be dried to moisture content value of about 30 % before it can be treated using this treatment process. The cylinder is then vacuumed to draw most of the air out of the wood cells leaving space for preservative to penetrate into it. Preservative solution is then pumped into the cylinder followed by hydraulic pressure. The applied pressure will force preservative to enter the wood cells. This treatment method is effective for deep penetration of preservatives into the wood cells. However, for certain difficult-to-treat wood species, which do not treat well by the Bethel pressure process, the alternating or oscillating pressure method is used instead.

Figure 1a-b shows the Bethel pressure treatment plant and oscillating pressure treatment plant available at the Wood Preservation Unit, Forest Products Division, Forest Research Institute

Malaysia (FRIM). The difference between both treatment processes is that the pressure method has a fully automatic vacuum and pressure system in which it can easily alternate the vacuum and pressure setting. There are standards that can be used as references to run these treatment processes which include the Malaysian Standard: Treatment of Timber with Copper/Chrome/Arsenic Wood Preservatives-Specification (3rd Revision) (MS 360: 2006).

Figure 1 (a) Bethel and (b) oscillating treatment plants available at the Wood Preservation Unit, Forest Products Division, Forest Research Institute Malaysia (FRIM)

2) Non-pressure treatment methods:-

Many different commercial non-pressure treatment methods have been developed, each differing in the penetration and retention attained. These methods are simple, inexpensive and some of the treatment may give good protection, but they are generally not as satisfactory as pressure treatments. Non-pressure treatment methods include:

i) Brushing, spraying and dipping

Brushing, spraying and dipping are the simplest and inexpensive wood treatment techniques. However, they are only effective to protect wood in very short period of time and suitable only to be used under mild decay hazard condition.

ii) Vacuum treatment

In the vacuum treatment process, wood is placed in a sealed container. Air is pumped out as much as possible creating lower than atmospheric pressure in the wood cells. Preservative will then fill the container. The seal is then opened such that the preservative is sucked into the wood due to the vacuum in the wood cells.

Hazard class rating

The hazard classes (H1 to H6) refer to the level of treatments that need to be done to ensure wood is durable against bio-deteriorating agents when used in a specific condition. Table 1 shows the hazard class description.

Table 1 Hazard class description (MS 360: 2006)

Hazard class rating	Description
H1	Wood used in the interior and protected from the weather. This class is split into two categories: (i) Dry in services - need an insecticidal treatment to protect against borers (ii) Risk of moisture exposure – need fungicide treatment to protect against fungi
H2	Wood used in the interior and protected from the weather but includes an insecticidal treatment to protect against termite
H3	Wood exposed to the weather but is not in contact with the ground. This class is split into 2 categories: (i) Without risk of water entrapment, generally in non-structural application such as boards (ii) With risk of water entrapment such as decking, pergola and fencing
H4	Wood used in high bio-deteriorating areas such as wood that is in contact with ground or fresh water but not with sea water. For example, wood used for landscaping timbers, bridge decking etc.
H5	Wood used for severe decay hazard risk such as ground contact with condition of severe or continued wetting but not in contact with sea water. For example, wood used for building piles and poles, retaining wall, horticultural supports etc.
H6	Wood used for marine environment such as jetty components which are susceptible to attack by decay fungi and marine borer.

How good is treated wood?

Service performance evaluation of treated wood should be carried out to identify the durability status of the wood after chemical preservation. Four types of tests are recognized: laboratory test, graveyard test, simulated service test and real time test. However, graveyard test, simulated test and real time test are not economical and time consuming, thus making these tests less preferable nowadays.

(1) Laboratory tests

These are screening tests, in which the permanence and effectiveness of a treatment are examined under accelerated but with carefully controlled conditions. The efficacy test against termite can be carried out based on standard test methods of AWPA D3345-08 and AWPA E1-90, While efficacy test against decay fungi can be carried out according to BS EN 350-1: 1994 (detailed in BS EN 113:1997) or ASTM D2017-05.

(2) Graveyard test

Graveyard test refers to the outdoor test area (Figure 2). This test is useful to determine the effectiveness of treated wood for outdoor and ground contact applications. Regular assessments are carried out and comparisons made between various treatment processes.

(3) Simulated service test

In this test, the treated wood will be built into an artificial structure in such a way that the hazard class rating can be identified. For example, window joinery and roof-trusses can be tested in this way.

(4) Real service test

This is a realistic test, since the test is conducted under actual services condition such as the evaluation of termite attacks on standing building.

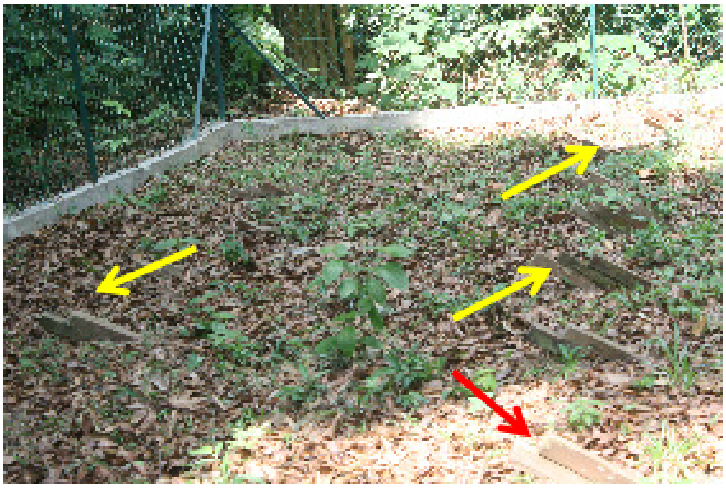

Figure 2 Graveyard test available at Forest Research Institute Malaysia, FRIM (arrows show the treated wood exposed to ground contact)

Quality control of treated wood

The determination of the retention and penetration characteristics of chemical preservatives in treated wood are the important steps to identify whether the treatment quality meets the hazard classes requirements or not. A number of international and local standard methods have been developed to characterise the retention of chemical preservatives such as:

(1) Determination of Copper, Chrome and Arsenate (CCA) (MS 821: 2011)

(2) Wood Preservatives, Treated Wood and Treated Plywood - Quantitative Analysis for Boron-Part 3: UV-Visible Spectrophotometer Method (MS 2371-3:2010)

(3) Method for Sampling and analysing timber preservatives and preservative-treated timber; Part 4: Analysis methods for determination of preservatives solution concentration (AS/NZS 1605.4: 2006), etc.

Penetration refers to the depth that preservative seeps into the wood cell structure. The minimum penetration and retention of CCA preservative needed for hazard classes of wood are as specified in Table 2. The CCA treated wood is labelled as 'fail' in term of treatment quality if the minimum penetration and retention criteria are not met.

Table 2 Minimum penetration and retention of CCA preservative for various hazard classes (MS 360: 2006)

Hazard classes	Minimum penetration (mm)	Minimum retention (Kg/m^3)
H1	-	-
H2	6	5.6
H3	6	8
H4	10	8-12
H5	20	6
H6	20	32

Conclusions

The selection of correct chemical preservatives and proper treatment method is important to ensure that treated wood products fulfil the minimum requirements of hazard classes. The strength and elasticity of wood can only be sustained if it is not altered and damaged by bio-deteriorating agents, and appropriate chemical protection is pertinent as described here in.

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