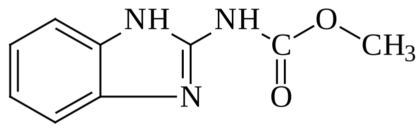
TIMBER PRESERVATION

Because wood is a good source of carbohydrate and other nutreints, timber is attacked and destroyed by fungi and insects. Structural timber must be protected from such attack.

Fungi grow on freshly felled timber to cause "sap stain". A common anti-sapstain contains carbendazim:



To prevent fungi and insects attacking structural timber, preservative chemicals are used. Boric acid (H_3BO_3) and borax ($Na_2B_4O_7 \cdot 10H_2O$) are used to protect internal framing from attack by insects such as borer.

Copper, chromium and arsenic salts (CCA treatment) or tributyl tin oxide (TBTO), which fix to the cellulose, are used for external timbers. The amount used is given a rating H1 - H6, the larger the number the more preservative used and hence the more durable the timber.

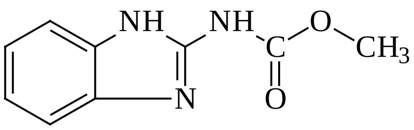
Present research in antisapstains and preservatives involves finding more efficient ways of fixing the chemicals into the wood to result in less waste and quicker treatment times, and in trialling environmentally friendlier compounds.

INTRODUCTION

In New Zealand, timber is used widely as a structural material. New Zealand produces about 14 million tonnes of pine logs a year. Because wood is a good source of carbohydrate and other nutrients, it is a supply of food for a variety of fungi and insects. However, this results in deterioration and discolouring of the wood, so for many centuries people have been trying to find ways to protect the wood. In Europe prior to the 1630's, attempts were made to preserve timber by treating the surface with oils or charring it. From 1630 to 1830 many chemicals were tried as wood preservatives, and by the early 1900s wood was pressure-treated to expel the sap. By the 1930s CCA (copper chromium arsenate) treatment had been developed by Kamesan, and was introduced to New Zealand in 1955. Prior to that boron treatment had been used in this country since 1952 and quite recently, in 1982, treatment with TBTO was introduced.

Types of treatments needed

To prevent fungi from growing on freshly felled logs and sawn wood, causing a blue-black sapstain, antisapstain chemicals are used. In the past, sodium PCP (sodium pentachlorophenate) was used. Health and environmental concerns resulted in its ban in 1988. More environmentally acceptable antisapstains have been trialled throughout the world, including at the NewZealand Forest Research Institute in Rotorua. One antisapstain in common use is an organic compound carbendazim, which is usually used in association with other chemicals.



To prevent fungi and insects attacking wood in use, preservative chemicals are used. For internal framing, the wood may be treated with borate ($Na_2B_8O_{13}.4H_2O$) to prevent insect attack (e.g. by borer). For external use, wood is often CCA treated, i.e. treated with copper (as $CuSO_4$), chromium (as $K_2Cr_2O_7$) and arsenic (as As_2O_5) or tri-butyl tin oxide (TBTO). These compounds fix to cellulose in the wood. The amount of preservative needed depends on the end use of the wood. Less is required if timber is to be above ground; the rating is called H3. More is required if timber is to be in contact with the ground; poles and retaining walls are H4 or H5 treated. Even more preservative is needed for wood in very wet conditions; piles on wharves are H6 treated. Although CCA is poisonous and not desirable in the environment, the rate of preservative leaching is extremely slow. If leaching was rapid, wharves and retaining walls would soon collapse.

Applications in Everyday Life
Timber preservation is rated on an 'H' (hazard) scale refering to the degree of preservation, the higher the number the more preservative used. If you are building any structure with timber, make sure you have timber with the correct H rating: H1 for internal framing, H3 for outside above ground uses, H4 for timber in contact with the ground (e.g. poles and retaining walls) right up to H6. The 'H' ratings are administered in New Zealand by the Timber Preservation Council, and coincide with the Australian timber standards.

If you are using pieces of timber in a barbecue or burning it in a home fire, make sure that it has not been treated. If in doubt, chemicals for a simple colour test are available in a kit called *Burnsafe*.

THE PRESERVATION PROCESS

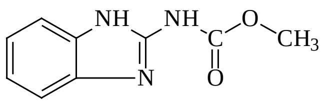
Wood is dipped into the preservative solution. Chemicals penetrate the wood by self diffusion or are aided by application of high pressure. Antisapstains that need to be applied to freshly exposed surfaces only can be sprayed on. A Lektraspray spray system charges the particles so that they are attracted to wood.

Finding Suitable Chemicals
In the investigation of new compounds the following guidelines are used:

- the active compound must penetrate wood and be retained under a variety of physical conditions
- the compound should be environmentally acceptable, as should its degradation products and products formed when the compound is burned
- it should be inexpensive and readily available.

It is an added bonus if the compound is both a fungicide and insecticide.
Colourless and faintly coloured formulations sometimes have a dye added, so that treated

Table 1 - Chemicals commonly used as antisapstains or timber preservatives in New Zealand

Name of Compound	Formula	Source	Use	Advantages	Disadvantages
Polyborate	$Na_2B_8O_{13}.4H_2O$	Mined in USA, also in Turkey and Peru	Preservative. Guards internal framing against insect attack.	Self diffusing. Water soluble. Colourless	Leachable
CCA (copper, chromium arsenic)	$CuSO_4$, As_2O_5, $Na_2Cr_2O_7$ (amounts vary in different formulations)	UK, Sweden	Preservative. Guards timber used externally against fungal and insect attack.	Water soluble in formulations. Fixes in wood. Broad spectrum biocide.	High pressure required to permeate wood.
Carbendazim *		USA	Antisapstain	Low toxicity. Stable in aqueous formulations in which it forms a suspension.	No significant disadvantages
TBTO (*bis* tri-butyl tin oxide)	$[(CH_3CH_2CH_2CH_2)_3Sn]_2O$	USA, Germany	Preservative. Guards above ground timber (e.g. piles) against insect and fungal attack.	Colourless. Difficult to leach.	Solvent soluble. Toxic
Creosote		By-product of coal manufacture. Not as widely used in NZ as it is in USA	Preservative. Guards timber used externally (e.g. railway sleepers) against insect and fungal attack.	Broad spectrum biocide. Good use of an otherwise undesirable product.	Oil soluble. Unpleasant to work with. Increasingly expensive.

* More than 10 different antisapstain formulations are currently available. They are being developed and tested to replace sodium PCP which was a most effective antisapstain, but highly toxic. Carbendazim, mixed with other compounds, is widely used at present.

timber can be distinguished from untreated. More than twenty antisapstain and preservative formulations are available in New Zealand and some of the more common compounds are given in **Table 1**.

THE ROLE OF THE LABORATORY

Samples of treated wood are sent regularly to laboratories for analysis of treatment chemicals. They are analysed to find out how far the solution has penetrated into the wood and how much chemical is present. Methods of analysis of some of the commonly used preservatives are given below.

CCA
Copper, chromium and arsenic ions are analysed by a method called atomic absorption spectroscopy. The wood is oxidised to CO_2 and water by reacting it with hydrogen peroxide and sulphuric acid. This leaves copper, chromium and arsenic ions (cupric, dichromate and arsenate) in a solution of sulphuric acid. The solution is sucked into a flame that is produced by burning acetylene (ethyne). Ions absorb energy from the flame (similar to a flame test). The amount of energy absorbed at a certain wavelength depends on the concentration of a particular ion.

X-ray analysis provides a method of determining copper, chrome and arsenic without destroying the wood. The energy absorbed from the X-ray beam gives information about the elements present and their quantities.

Sodium Borate
Borate ions are leached from the wood by refluxing with aqueous acid. Boric acid, H_3BO_3, in the resulting solution is determined by acid base titration. Boric acid is too weak an acid to be ionised in solution, pK_a = 9.24. A polyhydroxy compound, mannitol, is added to enhance ionisation of the first proton and boric acid behaves as a monoprotic acid.

Carbendazim
Carbendazim is analysed by high performance liquid chromatography (HPLC) and detected using a UV absorbance detector. A solution of carbendazim is pumped under pressure through a small column. The inside of the column is packed with long hydrocarbon chains on a silica based framework. Compounds are retained in this packing according to their solubility in it, so that they come out of the column at different times. Carbendazim is thus separated from other compounds in the mixture. The structure of the carbendazim molecule enables it to absorb UV radiation of wavelength 254 nm. The amount absorbed depends on the concentration of carbendazim and this is measured on a reporting integrator.

Tin Compounds
One compound used is *bis*-(tri-butyl tin) oxide (TBTO) which is soluble in organic solvents such as kerosene. This is extracted by refluxing wood with ethanol. The ethanol solution is analysed for tin by atomic absorption spectroscopy.

Determining the Success of Timber Treatment
To determine whether a treatment is successful, the wood is subjected to conditions that favour the growth of fungi and bacteria. At the Forest Research Institute, pieces of wood are

buried in the "graveyard" and their progress is monitored. A fungal cellar provides favourable conditions for fungal growth.

Process monitoring

Treatment plants that are treating wood to certain hazard ratings are constantly monitored. Chemical analysis of both the treating solution and the treated timber are carried out to ensure that the hazard rating requirements are met. For treated timber, a spot test is carried out to see that the preservative is penetrating to the required depth, and chemical analysis of the wood by a laboratory determines whether the required concentration of preservative is met. The Timber Preservation Council, established in 1988, oversees the process, and timber mills themselves carry out their own quality control.

ENVIRONMENTAL EFFECTS

Timber treatment plants are very aware of their responsibilities to the environment. Every effort is made to reduce contamination by spillage or dumping of treated wood waste. Pollution by treatment plants is monitored by Environmental Scientists for District Councils and Government agencies. In addition, the CCA solution is recycled by ion exchange and with both TBTO and boron preservatives there is now very little waste of solution. Moreover, posts and telephone poles are now reused for landscaping purposes.

Article written by May Croucher and Glenda Parker (Forest Research , Rotorua, NZ) and edited by Heather Wansbrough and John Packer.