

## Timber/Mould Control

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To understand and exercise control over the presence and development of mould on wooden packaging products such as pallets and fruit bins, some relevant background on the properties and behaviour of wood and mould is necessary. A brief general overview of these aspects, describing the factors involved, is given below.

### Wood properties and behaviour

Wood, a renewable, biomaterial, consists of various types of dead wood cells. In the living tree, the walls of the wood cells are fully saturated with water and free water is present in the lumen of the cells and cavities between cells. Various chemical compounds are dissolved in the water (sap) in the cells. In the tree, especially in the outer few growth rings part of the stem, called the sapwood, active transport of water takes place. Especially in sapwood, compounds such as sugars, lipids (e.g. fats), starch, proteins, etc. are present.

Under suitable drying conditions, after felling of the tree and sawing of logs into boards, evaporation of water from the boards occurs. Free water is lost first and at a point called the fibre saturation point (FSP), bound water starts to leave the cell walls. At FSP, a moisture content (MC) of roughly 30% (calculated on a mass/mass basis), shrinkage sets in.

Depending on environmental conditions created, moisture loss and shrinkage can continue until no more water is present, i.e. when the wood is "bone dry" (MC=0%). Being a hygroscopic, porous material, wood can again take up water and swelling occurs. Operating MCs of wood products in-service are, therefore, determined by the prevailing environmental conditions.

- Provided that enough time is given to reach equilibrium with its environment, the MCs of wood products stored/used inside buildings are primarily determined by the surrounding air temperature and relative humidity, i.e. water in the gas state. E.g. the MC of wood products stored/used inside buildings at an average temperature of 20°C and 65% relative humidity (RH) can vary around 11%. However, when wood is subjected to ambient atmospheres reaching 100% RH such as in unventilated spaces, and with standing water present also, it can reach MCs close to FSP, c. 30%, again.
- When kept outside, under shelter, i.e. protected from direct wetting by liquid water from rain, dew, mist and fog, as well as protected from drying caused by direct heat exposure to the sun, MCs in South Africa throughout the year can roughly vary anywhere between 4% (e.g. in Upington) to 19% (e.g. in East London).



- Exposed to unsheltered outside conditions, wetting by and penetration of liquid water into the wood can result in MCs higher than 30% (FSP). Especially during exposure to outside, open air and cloudless conditions in the evenings, heat is lost to the atmosphere resulting in undercooling of the wood surface. Under these conditions, condensation of dew on wood surfaces cannot be detected visually as dew is absorbed into the porous structure of the wood. Higher MCs than FSP (>30%) can, therefore, also be expected on and in the outer surface layers of the wood.

## Fungi properties and behaviour

As part of the natural cycle, a tree (wood) is recycled (degraded) by biological agents such as insects, fungi and bacteria, as well as heat (fire), a physical agent. Fungi are simple plants that also, like other living organisms, need access to the basic growth requirements i.e. nutrients, warmth (heat), air (oxygen) and water. Fungi involved in the degradation of wood material range from those that use the macromolecular cell wall components as food to those that can only live on the simpler nutrients stored/deposited inside the cell lumens. The first group causes structural damage to the wood, i.e. the traditional wood rot, while the second group of fungi, to which moulds and stain fungi belong, mostly discolour the wood and do not cause noticeable structural damage.

Fungal attack on wood can only start when enough water is present in or on the substrate and maintained long enough for the specific fungus to grow. Only wood MCs of 21% and higher can support fungal growth. Optimum temperatures for the development of most fungi are between 20 and 28°C and obviously, in open air (aerobic) situations, enough oxygen is present.

Fungi reproduce by the release of microscopically small, airborne spores (“seeds”). As soon as when these ever-present, mobile spores land on a suitable substrate (i.e. a nutrition source in which an acceptable moisture content is maintained), fungal growth can start and continue. Under ideal circumstances, including poor ventilation, mould can be established on wood surfaces within 24h, whereas the deeper penetrating staining fungi require more time. The two types can be distinguished by spot cleaning the discolouration with a 2:1 water: household bleach solution. The surface mould can be removed whereas the blueish sap stain discolouration, deeper into the wood, cannot be removed at all.

## Mould control measures

From the wood and fungi background above it is obvious that to prevent mould on wooden products during storage, handling and in service, the primary objective is to just keep the MCs below 21%, i.e. KEEP TIMBER DRY! In practice, this starts by using adequately dry timber in the manufacture of wooden products. Usually, the MC of kiln dried timber delivered for conversion into a range of wood products is c. 14%.



Should MCs increase above 21% again during storage, handling and use of such products, both kiln drying and subsequent ISPM15 heat treatment, the latter intended to make products insect and nematode free, cannot prevent any future attack by fungi (or insects). When MCs cannot be kept below 21%, only treatment with (normally unacceptable) antifungicidal, chemical preservatives remains.

Although specific situations may vary, some general control steps that can be followed, are:

1. Store, handle and use under conditions where products such as pallets and bins are protected from sources of water e.g. rain, fog, mist, dew and high RH conditions. Several circumstances, favourable to condensation, can exist. E.g. unsheltered, open air exposure during apparently dew free nights. Warm air with a higher capacity for water vapour than colder air cooling down under plastic wrapping. Direct exposure of plastic wrapped pallets to the sun causing release of water from wood followed by cooling of the air/wood.
2. Keep wooden products ventilated, especially when warm temperatures are experienced. During storage, close stacking must be avoided as spore contaminated surfaces and darkness support fungal growth. As far is practically possible, storage time in trailers and containers must be minimised.
3. Avoid direct contact with colder materials such as building walls and steel cladding leading to condensation.
4. Storage, handling and use on damp or wet surfaces such as concrete, soil, container and trailer floors should be avoided.
5. Avoid and clean mould contamination from other nearby sources.

### Further reading

Morrell, J J. (2008) Mould and stain fungi. Chapter 4 in "Development of commercial wood preservatives. Efficacy, environment, and health issues. Tor P. Schulz, editor (et al). ACS symposium series 982. American Chemical Society, Washington, DC, USA. ISBN 978-0-8412-3951-7

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