

pallets and packaging

Dry Pallet – Process Standard for Timber Pallets

Best Practice Guide

TIMCON has produced this guide for pallet manufacturers and pallet users in order to determine a dry pallet standard and establish quality control measures to achieve a classification of Service Level Agreement (SLA), to minimize the risk as far as is practicably possible, to ensure pallets are delivered to an acceptable dried pallet standard.

This is the second TIMCON best practice guide on the effects of kiln drying pallets and control of stain and mould. TIMCON recommends that this guide is read in conjunction with the *“Best practice guide to timber stain and mould for users of wooden pallets.”*

The study into kiln drying practices

TIMCON commissioned Edinburgh Napier University Forest Products Research Institute (FPRI) in early 2013 to conduct a study into the existing practices in the UK, (similar to other countries) of kiln drying pallets after manufacture.

Timber pallet manufacturers are facing increasing demands from pallet users to guarantee the supply of pallets free of discolouration from stain, and most importantly discolouration from mould. The only viable method at present is to ensure that the timber is dried, and the moisture content maintained at a level below which, the relevant microorganisms cannot grow.

This is a considerable technical challenge for the pallet industry. There are numerous variables to contend with throughout the timber procurement and storage, manufacture, drying, storage of finished stock and delivery process. At any point in this process mould can form on the surface of timber if conditions are favourable (i.e. temperature, humidity, poor ventilation, and wetting). To compound these factors, the industry has no clear guidelines for a dry specification or standardised method of measuring or sampling the moisture content of a pallet.

To ensure commercial realism the study was carried out at participating working pallet factories. Study trials were limited to the 1000 x 1200mm and 800 x 1200mm 4 way entry pallets.

Timber species was restricted to Sitka Spruce (*Picea sitchensis*) because it is the most common pallet timber in the UK and its properties are well documented.

The trial involved 1360 pallets randomly sampled from 18 kiln batches dried in current technology “heat and vent” kilns employing 6 temperature probes. A total of 14640 separate moisture content readings were taken and the data analysed in accordance with acceptance sampling statistics in British Standard BS 600. The goal of the study is twofold:

1. Define the upper acceptance quality level AQL. Given the risk threshold for mould is a surface moisture content value of 22%, the AQL was set at this level.
2. Determine the specification and quality control measures to guarantee a standardized moisture content for the contracted supply of mould free pallets.

Moisture content threshold

The maximum surface moisture content figure of 20% is widely acknowledged in European Standards and other published documents, as necessary to prevent mould growth. This threshold was first identified by Cartwright and Finley 1946. *Decay of timber and its prevention. London HMSO.*

The threshold moisture conditions for colonisation of timber by mould and sapstain fungi are the same as for decay fungi. The fibre saturation point (FSP) for most temperate species of timber occurs at a moisture content of around 30%. This was lowered to 22% to accommodate most commercial timbers and inaccuracies in moisture content measurement, for simplicity rounded down to 20%. This is where the average 22% moisture content (common industry norm) for kiln dried pallets originates.

Study results

The study focuses on the UK climate conditions and pallet market where air drying is an acceptable method to help reduce moisture content. The findings and recommended practices arising from the study may not be appropriate in other country climates and timber species. It is also acknowledged other drying practices may well have similar successful results, however these have not been evidenced in the study for verification.

Achieving the moisture content target $\leq 22\%$ is challenging for any manufacturer making pallets from green (i.e. unseasoned) timber of different thickness. Trial data indicated the moisture content of green timber for pallets is highly variable and having a huge effect on subsequent drying results..

Consequently it may be reasonably assumed the kiln drying practices operated by most UK (and other countries) pallet manufacturers are not in statistical control.

Implications of these findings are:

- Although the target moisture content may be specified and drying schedules set accordingly (i.e. mean moisture content at or below 22%). The actual moisture content range is variable and wide, such that the maximum moisture content cannot be predicted.

- Current drying practices indicate that wetter sections of the pallet are unavoidable. Risk of mould growth is highly likely in these circumstances, therefore a mould free pallet cannot be guaranteed (this is borne out by the experiences of manufacturers involved in disputes for failing to meet contracted requirements of mould free).
- Air drying of assembled pallets before kiln drying reduces the moisture variability of this natural material and so overcomes this problem. Additional handling considerations and potential extended delivery lead times are important implications.
- It is possible to supply a “delivered” guaranteed mould free pallet, by offering a premium product service but this premium service comes with conditions that should be clearly defined, must be agreed and signed up to by the manufacturer and pallet user. The pallet user must be made aware that the premium service will potentially attract more additional cost
- Not all pallet manufacturers may be prepared to commit the necessary resources, or have the capabilities, to provide the level of quality control requirements to meet the proposed superior dry specification.
- As a result of this exhaustive independent research study the pallet industry has available - for the first time - a rigorous independent assessment of the current drying practices and the likely effect that different drying schedules have on the control of mould.

The most important result of the study, the industry now has independently verified evidence to challenge and discredit current claims that guarantee a maximum moisture content and mould free pallets. TIMCON is committed to promoting and maintaining the highest professional industry and ethical practices in the UK.

Although extensive, the study was limited to participating working pallet factories in the UK using a single species of timber (Sitka spruce). It is recommended that pallet manufacturers should undertake further work to ensure the applicability of the procedures for their own manufacturing operations and species of timber used.

Mould and sapstain

Mould and sapstain are both due to fungi. Fungi which discolour timber are known as stain fungi, fungi that grow on the surface are called moulds.

Stain fungi can refer to sapstain of freshly felled logs and converted timber or to blue stain of timber in service. Sapstain mainly affects the sapwood of susceptible timbers such as Scots pine (*Pinus sylvestris*) whereas bluestain can occur in all timber species given the right conditions.

BS EN 2246 1999 Quality classification of timber used in pallets and packaging, permits the unrestricted use of blue stained timber.

The main focus of attention is concentrated on mould as this is the common cause of biodisfigurement on timber pallets globally

Timber Quality

The quality of the timber used for pallet manufacture is a major factor affecting the dry quality of the end product. Material specifications for timber should always state mould free requirements. It may not always be possible however, or practical due to unavoidable reasons, to reject timber that does not meet specified requirements.

Timber used for the packaging industry is generally at the lower end of grading quality. Packs of pallet boards and blocks may sometimes be delivered discoloured with stain or mould or become discoloured while in transit or storage.

Accepting mouldy timber does introduce the risk of causing spore breeding grounds and release of air borne mould spores. Mould contaminated timber should be quarantined in an area well away from uncontaminated stocks of timber and pallets.

Mouldy timber is not recommended to be used for pallet manufacture unless the mould can be removed thoroughly by cleaning. It is a misguided view that it is acceptable to use mouldy timber, and that subsequent kiln drying of the pallets kills the mould. Although the high temperatures in the kiln do kill mould, dead mould residue remains on the surface of the timber. Unless this is thoroughly cleaned away, the pallets remain unsightly, and continue to be regarded by the customer as being in a mouldy condition.





Kiln dried boards and blocks

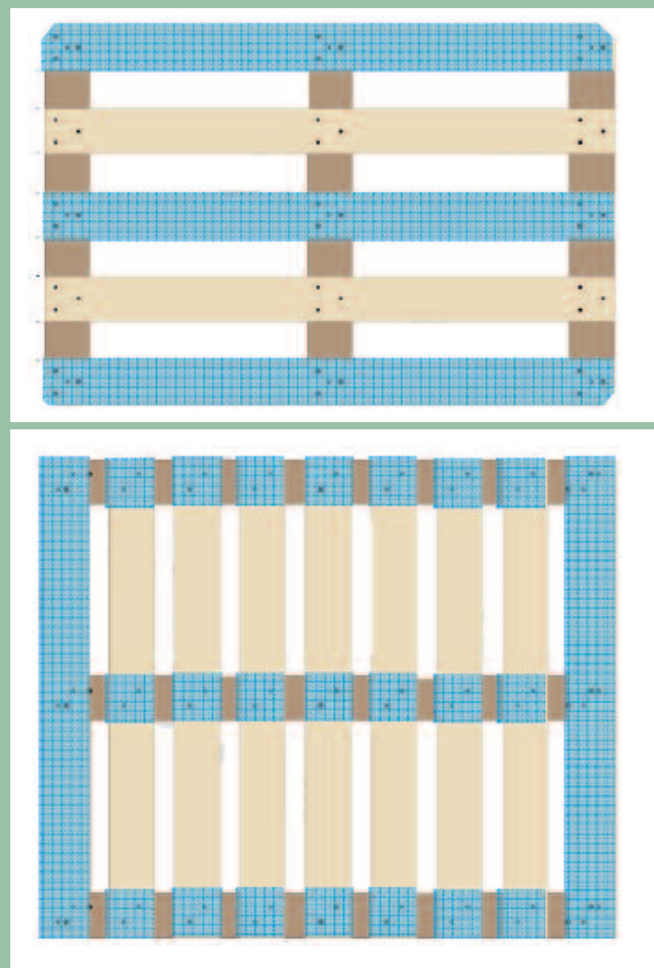
Manufacturing pallets from pre kiln dried pallet components is another option to ensure moisture content is within specified requirements. Even so, moisture content cannot be guaranteed. The advantages nevertheless are generally outweighed by the following disadvantages for the pallet manufacturer:

- Potential additional cost of kiln dried timber.
- Pallet manufacture is a challenging industry constantly under pressure from supply and demand, and price in a highly competitive market.
- Major shortfall in sawmills kiln capacity to supply dry timber for the pallet industry puts pressure on supply capabilities.
- Typically the lead time for dried timber supply is generally incompatible with just-in-time (JIT) pallet user requirements.
- The UK sawmilling industry is geared to drying higher value added long length timber for the construction market.
- Considerable investment by sawmills would be required in handling equipment to dry significant volumes of cut to length pallet timber.
- Maintaining timber stock in dry condition can impose pressure on a manufacturer's storage capacity.
- Thin section dry timber is potentially more susceptible to warping and to splitting when nailed.


Kiln dried timber for some manufacturers may well be a preferred option for specific low volume requirements. Commercial necessity dictates pallets in general will continue to be manufactured from green timber.

Moisture content distribution

The highest surface moisture contents occur where pallet boards are in direct contact with those of adjacent pallets (base footprint wet zone) when stacked. The wet zones are typically where mould growth potentially occurs. Illustrated are the wet zone footprint on the 800 x 1200 mm and 1000 x 1200 mm pallets.



Moisture content of timber blocks tend to be lower compared to the wet zones. This could probably be due to the large amount of exposed end grain in the timber block relative to the short length of the block. Pallets containing composite blocks were not significantly drier than pallets with timber blocks after kiln drying. Therefore dried pallets containing composite blocks did not appear to have any advantage over timber blocks to reduce the risk of mould on the pallet.



Moisture content was measured using calibrated electrical resistance moisture meters, temperature compensated, in accordance with the procedure in BS EN 13182-2. Measurements were initially taken at probe depths of 3 mm and 25 mm as necessary.

The depths were selected as being representative of moisture conditions at the timber surface and the wettest location where boards overlap at block assembly points. As trials progressed only 3 mm probe depths were deemed necessary due to the confidence of the extensive measurement data analysis.

Moisture content measurements were sampled from both the wet and dry zones.

Measuring moisture content

Types of moisture meter

There are two types, resistance and dielectric. Dielectric meters perform well in many conditions but they are affected by timber density and require a flat timber surface.

Pallet timber has variable density and is a rough sawn surface. Consequently dielectric meters are generally unsuitable for measuring pallet moisture content.

Temperature compensated resistance meters are suitable for timber with a moisture content range of 7% to 30%. Measurements outside this range are only indicative. Within this range the meters should be assumed to have an accuracy of $\pm 3\%$. This level of accuracy is adequate for measuring pallet moisture content.

Calibration

The meter must be checked for accuracy according to supplier instructions before use.

Procedure

Use the following method for estimating the moisture content of individual pallets:

1. Correct the meter according to timber species and readings for temperature.

2. Take the measurement in the direction of the grain.

3. Drive the electrodes into the face of the piece of timber. Avoid end grain, board edges, resin wood, bark, knots and close proximity to nails.

4. Take the reading within 3 seconds after insertion of the electrodes and round up the reading of the percentage point figure.

Recommendation for measuring a 4 way pallet

The surface moisture of the pallet top deck should always be measured to a depth of up to 3 mm. It is not generally necessary to measure the moisture content of the core thickness of the board.

The base deck of a pallet has a similar moisture content to the top deck. It is not necessary to measure the surface moisture content of the bottom deck unless the bottom deck has been exposed to wet conditions.

Pallet batch sampling

Pallets must be stored under cover on exit from the kiln and allowed to cool for a period of 24 hours minimum, however best practice would be 48 hours before taking moisture content measurements.

Initial optimisation of drying schedules requires 60 pallets to be sampled until a satisfactory confidence level of a defined moisture content target is achieved. Thereafter a random sample of 30 pallets minimum from each kiln charge should be selected. To avoid edge effects, only take samples in both cases from the middle section pallets from a range of stacks, avoiding the 5 top and 5 bottom pallets.

In four-way entry pallets, the ratio of wet zones to dry zones is approximately 40:60.

The number of readings in each zone should be in the same proportion.

Pallet batch sampling continued...

When measuring the surface moisture content of a four-way entry pallet after it has been kiln dried, the minimum number recommended of surface moisture readings is seven. They should be taken as follows:

- Two readings in the wet zone from 2 top deck boards. The area over the blocks is likely to be wettest. Meter probes should be at least 1 cm from nearest nail heads, and avoid sap pockets.
- Three readings in the dry zone from 3 top deck boards.
- Two readings in the side grain - from any one timber block on opposite sides of the pallet.



800 x1200 mm pallet



1000 x1200 mm pallet

Because of their engineered composition and inherent low moisture content, composite blocks are not required to be measured.

Pallets manufactured from more than one species of timber, each species should be measured at its appropriate calibration setting for the species.

Dry pallet contracts

The aesthetic appearance of pallets is of foremost importance to the pallet user's corporate image, product presentation and quality integrity of the unit load. These conditions do make a difference as to whether the load is accepted or rejected by discerning major retailers and supermarket chains.

Pallet users are therefore increasingly specifying kiln dried pallets or want a guarantee that pallets will be free of mould.

Often the contractual terms and conditions of pallet supply between manufacturer and pallet user do not set out the service offer in sufficient and clear detail. Whilst stain and mould do not cause significant loss of strength in timber they are unsightly; to the inexperienced eye it may be difficult to tell the difference, stain can easily be mistaken for mould and result in complaints and potential disputes.

TIMCON recommends where pallet user's requirements specify dry or mould free pallets, contractual agreements should ensure the difference is clearly defined to avoid such problems arising.

Contracts for dry pallets should clearly describe that the dry standard applies only up to the point of despatch from the factory, for a known delivery duration taking 24 hours or more. Less than 24 hours pallets are delivered dry. Responsibility thereafter passes to the customer to maintain the pallets in a dry condition.

Reference should be made to, the TIMCON ~ *best practice guide to timber stain and mould for users of wooden pallets*, and recommended that a copy is appended to the contract.

The contracted dry pallet standard is only possible provided that the pallet user complies with the agreed order lead times defined in the contract. It is suggested that good working practice to cover for short lead time (or JIT) pallet orders/call offs, should be accompanied by a quality conformance concession in writing issued to the pallet supplier.

Is the AQL achievable?

The AQL is achievable and there are two options capable of delivering the drying conditions required to guarantee a mould free pallet. They do however have very different commercial implications.

1. Pallets that are kiln dried and separated with stickers, and dried to a target moisture content of 15 to 17%. This option was not fully investigated because at the present time it is not regarded as a commercially viable option. That said, the probability can be estimated as being in the region of 70% +.

2. Pallets stacked under ventilated cover and air dried for 14 days, then kiln dried to a target moisture content 15 to 17% have a high probability of being below the upper AQL. A probability of almost 100%.

3. The 800 x1200 mm pallets are more susceptible to distortion dried at low moisture content compared to the 1000x1200 mm full perimeter base pallet. The 800 x1200 mm pallets dried at the 15 to 17% target showed no signs of distortion and splitting of blocks and boards. This is due to air drying reducing the moisture content of the green timber before kiln drying.

Dry pallet standard

AQL:

This is the overall upper moisture content level defined at 22% ($19 \pm 3\%$).

Target moisture content:

The mean range 15% to 22%.

The dry pallet standard due to the formal quality control procedures involved - a premium product that is clearly differentiated from mainstream production. The following service level agreement (AQL) classification is proposed:

Option 1 Premium

Pallets made from a single timber species, air dried for 14 days before kilning to a target moisture content of 15 to 17% (monitored by at least 6 moisture sensors in the kiln) and stored after drying in a ventilated shed. Formal quality assurance procedures should be applied. The mean moisture content of the surface of the pallet decks being $\leq (19 \pm 3)\%$ with a confidence level between 95% and 100%.

Option 2 Standard plus

Pallets made from single or mixed timber species, kiln dried from green to a target moisture content of 18 to 22% (monitored by at least 6 moisture sensors in the kiln), stored after drying in a ventilated shed. No formal quality assurance is required. It is unlikely that more than around 60% of the pallet surface will conform with the $\leq (19 \pm 3)\%$ moisture content.

Applying formal quality assurance procedures plus air dried for 14 days improves confidence level in the region from around 60% to $\geq 80\%$.

Option 3 Standard

Drying pallets to a nominal moisture content of below 22% but without air drying or extensive kiln monitoring. Subsequent storage is uncontrolled. The percentage of pallets $\leq (19 \pm 3)\%$ cannot be predicted.

Reduced Environmental Impact

The extra time taken to air dry the pallets and additional associated handling implications are offset to some extent by a saving in kiln operating time, in the region of 35% plus energy consumption compared to non-air dried green timber pallets.

Recommendation

Information provided in this guide is based on the extensive study undertaken by FPRI. The study trials were limited to participating working factories in the UK, therefore the results cannot be considered definitive. Pallet manufacturers wishing to introduce a guaranteed dry pallet standard should undertake their own drying trials to ensure that the dry standard is applicable to their operation and timber species.

The Dry Pallet – Process Standard for Timber Pallets provides informative guidance to enable a pallet manufacturer to formulate a range of dry pallet service options to meet the requirements of a specific pallet user (first time use).

Self declaration by a manufacturer indicating that pallets are in accord with the Dry Pallet – Process Standard for Timber Pallets are meaningless unless such declaration can be substantiated. The accepted practice is to provide supportive evidence of quality control statistics as outlined in the ~ Dry Pallet - Essential Guide to the pallet user.

pallets and packaging

Essential Guide Pack

TIMCON has produced the guide for pallet manufacturers wanting to introduce the dry standard as the basis for a contractual SLA.

It is important to dry pallets as close as possible to target AQL and minimize deviation as much as possible. The methodology and quality statistical control of dried pallets batch sampling are primary requirements in determining the effectiveness of the whole drying process in order to minimize the risk of mould.

Preserving the integrity of the data and to ensure method of analysis is carried out in a consistent manner.

TIMCON has developed a computer model, as an essential tool for this purpose.

Only those pallet manufacturers that are committed to the undertaking, to provide a dry pallet service option and comply with the requirements described in the Essential Guide Pack, shall be recognised and endorsed by Timcon.

In addition to the guide, should further on site guidance or training be required, this can be arranged through Timcon.

Disclaimer

The information in this publication has been produced in good faith for general informational purposes only, and is subject to change without notice. Nothing contained in any part of this document constitutes legal, investment, tax or other advice, nor should it be relied upon in making an investment or other decision or for any other specific purpose and no undertaking, representation or warranty (express or implied) is given as to its accuracy, reliability or completeness. We have made reasonable efforts to ensure that all information in this document is accurate at the time of inclusion; however, there may be errors in such information for which we apologise, but shall have no liability. We cannot guarantee that any information displayed here has not been changed or modified through malicious attacks or "hacking". We may have included certain material in this document which has been produced, provided or written by third parties. Such material is provided for information purposes only and should not be taken to represent the opinions, beliefs or views of TIMCON or any of its directors, members, officers or employees."

Effective mould minimization strategy

- Management has to be committed to implementing and maintaining an effective control strategy.
- Reduce air borne mould spore density by carrying out regular checks of timber stocks and pallets.
- Maintain low surface moisture of timber.
- Timber packs wrapped in plastic film should not be placed in the direct sunlight for long periods of storage to prevent condensation build up and moisture absorption by the timber.
- Timber should be stored so that it does not get splashed with water from passing vehicles.
- Segregate mouldy timber and pallets well away from clean stocks.
- Kiln dried pallets should be stored in a well ventilated covered area; the roof cover must extend at least 30 cm over the stacked pallets to offer protection from rain.
- Protection against ground moisture, dried pallets stacks should be supported off the ground to improve ventilation, using bearers or slave pallets.
- Storage areas must be well drained and free of standing water.