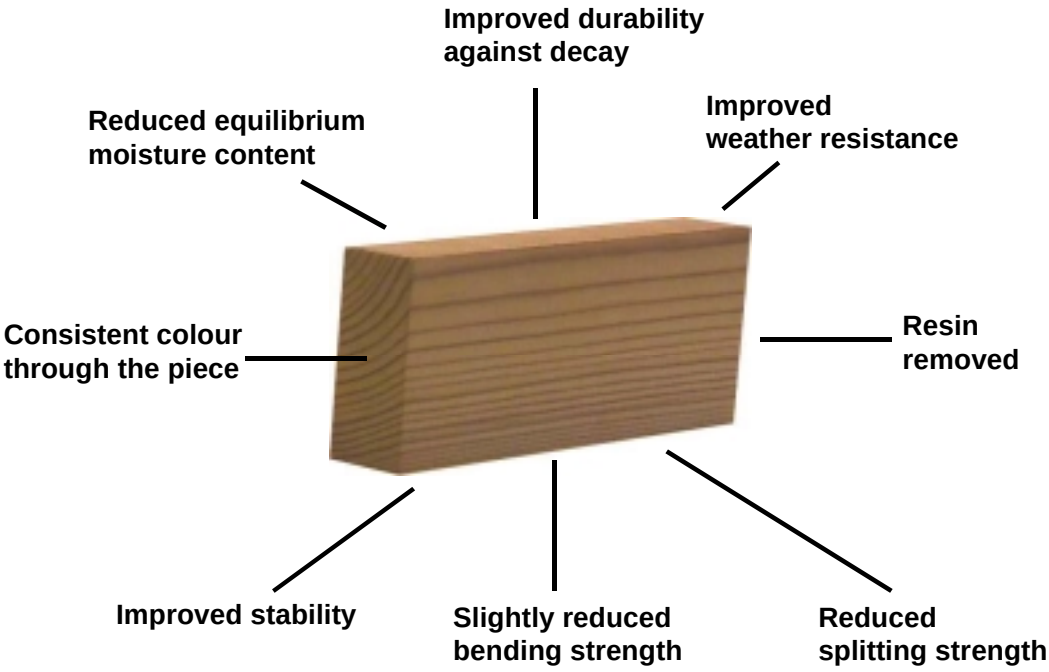
FINNISH ThermoWood ASSOCIATION

ThermoWood®

ThermoWood® - properties



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ThermoWood® is a registered trademark owned by Finnish Thermowood Association

Finnish Thermowood Association was established in December 2000. The aim of the association is to enhance the use of heat treated wood produced by its members. Other important duties of the organisation are quality control of production, product classification and R&D activities.

The members of the Finnish Thermowood Association are either heat treated wood producers or kiln manufacturers.

Patented ThermoWood® heat treatment process

ThermoWood® heat treatment process has been developed and patented by VTT Technical Research Centre of Finland. The process can be divided into three phases:

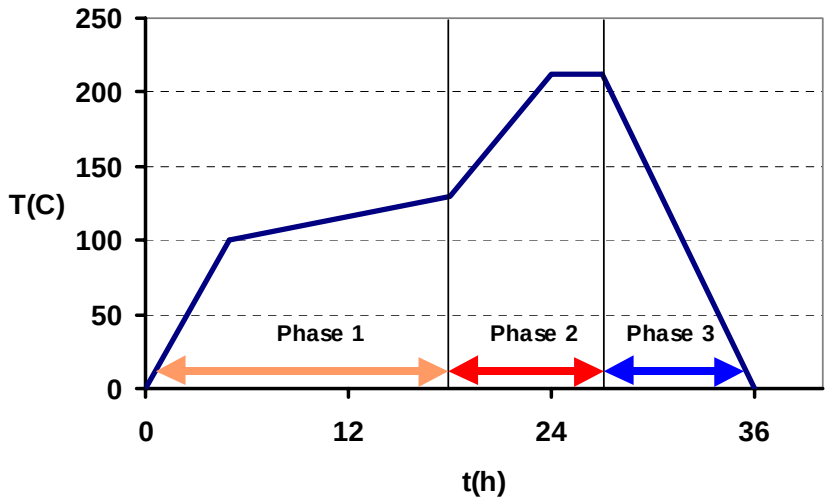
1. Temperature increase
Wood temperature is raised at a rapid speed using heat and steam to a level of around 100 ^{o}C. Thereafter the temperature is increased steadily to 130 ^{o}C. Raw material can be green or kiln dried wood. Steam is used to prevent cracking of the wood. It also affects the chemical changes taking place in the wood. Moisture content reduces to nearly zero.

2. Actual heat treatment
During actual heat treatment phase the temperature is increased to a level of 185 – 215 ^{o}C. Temperature depends on the desired treatment class. When the target level is reached the temperature remains constant for 2 – 3 hours. Steam is used to prevent the wood from burning and it also affects the chemical changes taking place in the wood.

3. Cooling and moisture conditioning
The temperature is reduced using water spray systems. Conditioning and re-moisturising takes place to bring the wood moisture content to a level over 4 percent.

ThermoWood® heat treatment process is suitable for all wood species but the process must be optimised individually.

ThermoWood® heat treatment process



Key properties of ThermoWood®

1. Density

The density is measured by measuring the weight and the dimensions of the sample. The unit of density is kg/m^3. ThermoWood® had lower density than untreated wood.

2. Strength

Genarally the strength of wood has strong correlation with density. Heat treated wood has slightly lower density and therefore it is obvious, that ThermoWood® has in some cases lower strength values, but weight-strength-value can be practically unchanged.

Bending strength

Heat treatment at temperatures below 220 ^{o}C does not have significant effect on bending strength. However, using timber containing knots, the strength values of heat treated wood are lower than untreated. The reason for that is that the resins flows out and especially in spruce the dead knots come loose. It is recommended that heat treated wood is **NOT** used for load bearing structural usage.

Compression strength

The Compression strength is mainly dependent on the actual density of wood. According to tests it is proved that the heat treatment process has no negative effect on the compression strength values. In some cases the results actually prove that the values were better than with normal kiln dried wood. Heat treated wood has not the same elasticity as normal kiln dried wood.

Shear strength

Heat treatment in very high temperature (>230 ^{o}C) has negative effect on the shear strength properties. It was found that radial shear strength values reduce 1-25 percent and tangential values 1-40 percent. In normal heat treatment temperatures the effect was very low.

Splitting strength

Heat treatment reduces splitting strength values 30 - 40 percent depending on heat treatment temperature.

Screw holding strength

The screw holding strength has strong correlation with density. Bigger effect on screw holding strength came from the general variance in wood density than heat treatment process. It was found that material with lower density the results were better when narrower pre-drill holes were used.

3. Hardness

The hardness value improves as the heat treatment temperature level increases. This change has no effects on practise.

4. Equilibrium moisture content

The heat treatment of wood reduces the equilibrium moisture content. In high temperature treated wood the equilibrium moisture content can be 40-50 percent lower compared to untreated wood.

5. Stability

Because of lower equilibrium moisture content the tangential and radial swelling decreases significantly.

6. Permeability

Heat treatment reduces the water uptake of wood. Reduced water absorption have to be taken into account when working with water solvent glue or paint.

7. Thermal properties

The tests have shown that the thermal conductivity of ThermoWood® is 20 - 25 percent lower compared to untreated wood.

8. Fire properties
Fire safety of ThermoWood® does not significantly differ from untreated wood.

9. Biological durability
Standard tests (EN 113, ENV 807) made in laboratory conditions showed very good biological durability.

In field tests it has been found that the results were not acceptable. At the moment due to insufficient information it is recommended that ThermoWood® is not used in continual contact with wet ground.

10. Weather resistance
According to various field tests it has been found that ThermoWood® has about half the moisture content compared to untreated wood.

As with most natural materials ThermoWood® is unable to resist ultra violet radiation. As a result over period of time when exposed to direct sunlight, the colour changes from the original brown appearance to a grey weathered colour.

Ultra violet radiation causes small surface shakes to occur on uncoated panels when exposed. According to tests levels of surface shakes in ThermoWood® shows signs of improvement compared to the control material of untreated wood.

As a conclusion from the effects of ultra violet radiation (sunlight), it is highly recommended to apply a pigment based surface protection to prevent colour changes and surface shakes.

Working with ThermoWood®

ThermoWood® is more susceptible to mechanical damages compared to untreated wood.

Two important things have to be taken into account when further processing ThermoWood®:

- sharp tools are recommended to prevent tearing
- dust has smaller particle size than normal wood. Special attention has to be paid to the dust removal system or dust masks must be used.

1. Sawing
Sawing of ThermoWood® does not significantly differ from sawing of untreated wood. Due to the stabilisation of the wood after heat treatment process the effect of further distortion after sawing is reduced.

As there is no more resinous substance in ThermoWood®, the machines works well and are very clean after working.

2. Planing
Planing of ThermoWood® can be made by using ordinary planing machines. According to tests machines works well and also the surface quality is good. Good results are achieved with hard metal blades in cutters. ThermoWood® should be processed with parameters that are adjusted more for hardwood than for softwood.

3. Milling
In order to get a good surface quality blades must be sharp, otherwise tearing may occur. Greater tearing is observed when the wood is milled across grain. The greatest problems with tearing occur at the start and end of the milling, when the blade comes out of wood. The best results can be found when there is enough solid wood material behind the blade. Therefore processing must be pre-planned carefully.

4. Sanding
General working is the same as with untreated wood. There is very often no need for sanding, because after planing or milling ThermoWood® has good surface quality. Sanding is easy and the sanding paper is not clogging up by resin.

5. Surface treatment
To prevent colour changes and surface shakes it is recommended that surface treatment against ultra violet radiation is used.

Oil-based substances work as with normal wood. When working with water-solvent substances it has to be taken into account, that ThermoWood® has lower water absorption than normal wood. Water-based work well, when they are slowly drying and there is enough time to penetrate into wood.

When surface treating ThermoWood®, the paint manufacturers instructions must always be referred to.

6. Gluing
ThermoWood® absorbs slowly water and water based glues, such as PVAc. That is why longer pressing times than normal is needed. Some PVAc glues can cause problems is substantially prolonged drying times due to the requirement of the water to penetrate into wood, e.g. the hardening of the glue is based on the water absorption into wood. When working with PVAc glue the water content of the glue should be minimised.

PU (polyurethane) glues work well with ThermoWood®. Although when using PU-glues, it has to be kept in mind, that the hardening reaction of PU needs water. The water can be absorbed either from the wood or surrounding air. If both wood and air are very dry, gluing may fail.

Chemically hardening glues allow unchanged drying times and other gluing parameters compared to normal wood.

When gluing ThermoWood®, the glue manufacturers specific instructions must always be referred to.

7. Mechanical joints
<u>Screwing</u>
Heat treatment reduces splitting strength of wood. The use of self-tapping screws or pre-drilling of holes must be made to avoid cracking of the material. With ThermoWood® it is recommended to use less threaded screws compared with normal wood. Stainless steels screws with countersunk heads are most suitable in external usage or other humid environments.

<u>Nailing</u>
Recommended using compressed air gun with adjustable nailing depth on the gun. Using normal hammer increases risk of splitting due to hammer contact with the wood.

To reduce risk of discoloration from nail in external usage stainless steel are best, however if using compressed air gun fixing, galvanised nails can be used as no metal on metal contact occurs to brake the galvanised seal. Galvanised nails are also working, if ThermoWood® will be treated with covering paint after nailing. It is recommended to use small oval head nails to reduce the risk of splitting.

Treatment classes of ThermoWood®

ThermoWood® has two standard treatment classes for softwoods and for hardwoods. Standard treatment classes are called Thermo-S and Thermo-D.

In addition to standard classes it is possible to produce ThermoWood® in higher or lower temperatures for special purposes.

Recommended end uses of standard classes

Softwood (pine, spruce)	
Thermo-S	Thermo-D
- building components - furnishing and fixtures in dry conditions - furnitures - garden furnitures - door and window components - sauna	- cladding - outer doors - shutters - environmental constructions - sauna and bathroom furnishing - flooring - garden furnitures

Hardwood (birch, aspen)	
Thermo-S	Thermo-D
- furnishing and fixtures - furnitures - garden furnitures - flooring - sauna	End uses of hardwood Thermo-D products are same as Thermo-S products have. The colour is darker because of higher treatment temperature

Environmental aspects

ThermoWood® is natural wood product without any chemicals added to it. When not glued or painted ThermoWood® waste can be handled as any other untreated wood waste. In the end of its life cycle ThermoWood® can be burned for energy production or it can be taken to the waste dump.

In many cases energy needed for ThermoWood® process is produced by burning bark and wood waste. Also fuel oil and liquefied petroleum gas is used. Energy is needed mainly for drying, which accounts for 80 percent of the heat energy used. The total energy demands is thus only 25 percent higher than that of the ordinary timber drying process. Need for electricity is the same as in ordinary kilning.

Further information

ThermoWood® handbook
Finnish Thermowood Association
www.thermowood.fi