Heat Treatments (ISPM 15) and Thermal Modifications of Wood

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Thermal treatment or thermal modification of woods?

- Temperatures scale -

1. **Drying**
   - Dried woods
   - Phytosanitary treatment ISPM 15

2. **Slow Pyrolyse**
   - Thermal Modified Woods

**Low Pyrolyses**
- Green charcoals

**Fast Pyrolyses**
- Pyrolysis oils

**Gaseous fuels**
- Gasification

Wood materials and Packaging

Energy
Why?

The standard describes measures designed to “practically eliminate the risk for most quarantine pests and significantly reduce the risk from a number of other pests”.

Targeted Wood Material

- wide range of pests (insects, nematodes, fungi)
- all species of wood (hardwoods, softwoods)
- all sizes of wood
- wood of different moisture contents

Wood Packaging Material [WPM]

**Included:**
- pallets
- dunnage
- crating
- packing blocks
- drums
- cases
- load boards
- pallet collars
- skids

**Excluded:**
- plywood
- particle board
- oriented strand board
- veneer
- veneer peeler cores
- sawdust
- wood wool
- shavings
- wood < 6 mm thick
Phytosanitary treatments according to ISPM 15

Treatment options for wood packaging material:

- These options apply to units of wood packaging material or to pieces of wood that are to be made into wood packaging material.
- See ISPM 15 for all specific treatment details; this graphic is for information only.

**Heat treatments**

56 °C – 30 minutes

- Bark must be removed after treatment.
- Temperature should monitored at the location of the wood likely to be the coldest.
- Treatment schedules should be specified or approved by the NPPO.

**Methyl Bromide (MB)**

10-20°C with various concentrations

- Bark must be removed before treatment.
- Wood pieces must be smaller than 20 cm cross-section at smallest dimension.
- Note that CPM adopted a Recommendation on replacement or reduction of the use of methyl bromide as phytosanitary measure.
- Forbidden in several countries
- Contracting parties encourage to use other chemical and physical treatment options.
- Ex: Sulfuryl fluoride (chemicals cots = 63 € / 60m³)

**Conventional Heating (HT)**

- Conventional steam or dry kiln heat chamber.
- Treatment to core.
- Eco friendly and low technology of the process.
- Difficult for some wood species (humidity, density, etc.).

200-250 € / 60m³

**Dielectric Heating (DH)**

- Surface temperature is likely to be the coldest.
- Wood must not exceed 20 cm cross-section at the smallest dimension (including bark).

Radio Frequency waves

- RF waves penetrate wood more deeply than microwaves but also more slowly.
- RF not adopted – R&D

**Microwaves**

- In 2013, microwaves treatment was adopted, by ISPM 15 requirements
- 2 methods: batch (also referred to as bulk volume or chamber processing) and continuous (also referred to as conveyor or tunnel processing)

> 120 € / 60m³

**Bark must be removed after treatment.**

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Targeted countries... [Debarking + HT or MB]

- **Importation in the European Union**: Debarcking + HT ou MB + marque officielle NIMP15
- **Importation in the Overseas Territorial Departments** (Guadeloupe / Martinique / French Guiana / Reunion / Mayotte):
  - Packing + dunnage originating from a third country or from Portugal must comply with ISPM 15
  - Packing + dunnage originating from European country (without Portugal) or Switzerland: ISPM 15 is recommended
Phytosanitary treatments according to ISPM 15

❖ Environmental impacts...

Global Warming Impacts (Kg CO₂ eq.)

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Wood Pallets</th>
<th>Plastic Pallets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heat Treatment</td>
<td>Me-Br Fumigation</td>
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<tr>
<td>Production</td>
<td>7.86</td>
<td>7.86</td>
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<tr>
<td>Transportation (per trip)</td>
<td>0.6</td>
<td>0.6</td>
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<tr>
<td>Phytosanitary Treatment</td>
<td>2.2</td>
<td>5.46</td>
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<tr>
<td>End of Life</td>
<td>2.03</td>
<td>2.03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12.69</strong></td>
<td><strong>15.95</strong></td>
</tr>
</tbody>
</table>

**MB:** largest global warming/ozone depletion impacts of the treatment types

**HT:** largest impact of treatment alternatives in all other environmental categories

**RF:** lower life-cycle impacts in all categories

**MW/RF** carbon footprint approximately 10 - 20% lower during their life cycle than plastic pallets or wooden pallets treated with methyl bromide fumigation
Phytosanitary treatments according to ISPM 15

- Stamp including the IPPC mark...

**ISPM15: HEAT TREATED PALLETT / WOODEN PACKAGING**

The stamp includes the IPPC (International Plant Protection Convention) mark.

It includes the country code (GB – for Great Britain) and the unique registration number for the company that applied the treatment: FC-0000 (a list of the companies who are registered to heat treated pallets and packaging is available on the Timcom website).

It includes the treatment applied: DB – HT (debarked and heat treated) or DB – MB (debarked and fumigated with Methyl Bromide).

It also includes the Forestry Commission logo (although if space is an issue this does not need to be included).
Thermal Modified Wood

Chemical modifications occurring wood properties evolutions

❖ Industrial eco-friendly Process

Native wood → Heat treated wood

180 °C ≤ T ≤ 240 °C, 20 h ≤ t ≤ 60 h

❖ Wood modification under heat treatment – New properties!

- HEMICELLULOSES → Degradations → Equilibrium Moisture Content (EMC)
  - Increase

- CELLULOSES → crystallinity modification → Dimensional Stability
  - Increase

- LIGNINE → Modification of lignin polymer network → Decay Resistance
  - Decrease

- EXTRACTIVES
  - Low TT intensity: Increase
  - High TT intensity: Decrease

- Mechanical Properties

- Gluing/Machining / Surface
Depending on heat treatment intensities, Thermal Modified Wood can be used in use class 3, without contact between the wood material and the ground.
Wood thermal degradation = Mass Loss (ML%)

> Thermal degradation level depend on:
- the nature of wood species  [Chaouch et al. 2010]
- temperature & duration  [Candelier et al. 2011]

The intensity of the treatment must be established with precision:
- A high treatment intensity mechanically degrades the woods,
- A low intensity does not make it possible to reach the durability performances expected.
Wood thermal degradation is not controlled, due to heterogeneous heat transfer in treatment oven.

Controlling the homogeneity of native wood density/humidity is a fundamental factor.

The mixture of essences in the oven is forbidden.

Obtain a good heat treated wood quality

Homogeneity and repeatability

Find indicator control heat treatment process and to predict heat treated wood decay resistance:

- Not destructive mechanical test, colorimetry, spectroscopy, etc...

Improve the process pilotage by developing of optimal treatment conditions, depending on the desired material properties.
Thermal Modified Wood
Main international Companies

❖ In Europe: 96 Companies of TMT -> > 386 220 m³/an

Main Wood Species

- Pine
- Spruce
- Birch
- Aspen
- Ash
- Larch Alder
- Beech
- Oak
- Poplar

+ other tropical wood species:

- Sapelli
- Lati
- Iroko
- Limba (Fraké)

...  

In Europe: 300 - 500 €/m³
In Russia: 400-500 €/m³
Thermal Modified Wood
Main international Companies

❖ In Oceania: 4 Companies of TMT -> > 15 000 m³/an

Main Wood Species

Japanese cedar
Australian-grown hardwoods
Radiata pine

Data from:
Publication: Review of new and emerging international wood modification technologies Project No: PNA350-1415
2015 Forest & Wood Products Australia Limited
www.fwpa.com.au
Thermal Modified Wood

Main international Companies

❖

In America:

8 Companies of TMT -> 30 000 m³/an

50% of TMW production designated to the exportation:
Mexico
Europe
Asia
Oceania

Main Wood Species

Southern Yellow pine
Eastern white pine
Western pine
Red oak
Ash
Sweet gum
Maple
Eucalyptus
...
Teck (R&D)

Data from:
Thermal Modified Wood
Main international Companies

❖ In Africa:

1 Companies of TMT + Start of R & D

Main Wood Species

Aleppo pine (R&D)
Radiata pine (R&D)
African alpine bamboo (R&D)
West African albizia [Nongo] (R&D)
West African albizia [Nongo] (R&D)
Funtumia elastica (R&D)
...
South African Radiata pine

http://www.rhinowood.co.za/
Thermal Modified Wood

Different processes

- **Thermal-modification kiln providers in US and EU**

- **Process cost:**
  100 à 200 euros/m³ of TMW (150 à 300 dollars)

- **Oven investment:**
  500 000 - 600 000 euros

<table>
<thead>
<tr>
<th>Company/Brand Name</th>
<th>Type of System</th>
<th>Country of Origin</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jartek</td>
<td>Open (ThermoWood®)</td>
<td>Finland</td>
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<td><a href="http://huber-holz.at/">http://huber-holz.at/</a></td>
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</tbody>
</table>
Thermal treatment is a good way to valorize local wood species with low properties around the world.

To produce a Thermally Modified Wood, we need to:
- Have good technological expertise and a reliable industrial process;
- Control the resource quality (humidity, density, species, etc.);
- Control the quality of the final products (mechanical properties, durability, etc.);
- Optimize the control of the process (mass loss, duration, etc.);
- Integrate criteria within a framework of economic, environmental and social systems.

In progress -> Improve the insect and fire resistance:
- Including various additives in combination with TMT (boron, sodium silicate, etc.)
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THANK FOR YOUR ATTENTION

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