Discolouration of timber in connection with drying

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This leaflet is a summary of the most common discolouration which appears in the wood normally after drying.
The Fact Sheets will help the practitioner to distinguish discolouration and their cause and will give some hints how to reduce it.

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Introduction

Wood colour can vary much between species but within the same species the variations are normally smaller. Noticeable deviations in colour at timber surface or in the core from the same batch may cause problems in timber trading or in final product's appearance. Most undesirable discolouration often develops during wood drying process.

Definition of discolouration

As “discolouration” we consider undesirable colour changes developing during drying process, compared to the “common” colour of a species. They may be recognized in the whole board but also cover parts of the surface or the inner part of the boards. Discolouration appears in different shapes: streaks, spots, irregular bands, etc.

Discolouration of wood is caused by the action of living organisms (fungi, bacteria) or physiological reactions in living or freshly felled trees, chemical and biochemical reactions or combination of the above actions.

The existence of extreme conditions during drying (high temperature and high relative humidity) encourages its appearance. Prolonged storage of round timber or wet timber may also intensify this phenomenon.

Classification of discolouration

<table>
<thead>
<tr>
<th>Caused by</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungi</td>
<td>Pine: blue-stain in sapwood</td>
</tr>
<tr>
<td>Physiological reaction in living cells</td>
<td>Beech: formation of some particular compounds (e.g. droplet shaped) and tyloses (balloon-like growths) in still living cells</td>
</tr>
<tr>
<td>Biochemical reactions</td>
<td>Alder: orange discolouration</td>
</tr>
<tr>
<td>Chemical reactions</td>
<td>Oak: reaction between metals and tannin</td>
</tr>
<tr>
<td>Combination of reactions</td>
<td>Oak and chestnut: yellow discolouration due to a fungal infection and reaction of tannins</td>
</tr>
</tbody>
</table>

(Koch G., Skarvelis M. 2007-simplified)

Structure of fact sheets

1. Wood species
2. Occurrence:
   - fresh wood
   - after sawing/during air drying
   - during steaming
   - during kiln drying
   - after drying (not kiln drying related)
3. Caused by
4. Description
5. Minimizing
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References


Passialis C., Tsoumis G., 1984: Characteristics of discoloured and wetwood in fir. IAWA Bulletin, 5, 2, pp. 111 - 120
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FACT SHEET 1  
May 2010

Oak Brown Stain/ White Stain

Wood species:
European oaks (Quercus petraea (Matt.) Liebl., Quercus robur L., etc.)

Occurrence: (XXX highest risk)
- fresh wood (round wood) □
- after sawing / during air drying X
- during steaming □
- during kiln drying XXX
- after drying (not kiln drying related) □

Caused by:
Hydrolysis of ellagitannins and oxidative reactions

Description:
Irregular light coloured (white) streaks and stains that contrast the darker colour (brown) of dried oak wood. Note: in fact some authors prefer the term white stain rather than brown stain.

Minimizing:
Low temperature (<30°C) drying at least until Fibre Saturation is reached.
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FACT SHEET 2

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Metallic-tannate stain

Wood species:
European oaks (*Quercus petraea* (Matt.) Liebl., *Quercus robur* L., etc.)
Can be found also in other species with high amount of tannins (chestnut *Castanea sativa* Mill., walnut *Juglans nigra* L., *Juglans regia* L., some tropical species).

Occurrence:

- fresh wood (round wood)  
- after sawing / during air drying  
- during steaming  
- during kiln drying  
- after drying (not kiln drying related)

<table>
<thead>
<tr>
<th>Occurrence</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>fresh wood (round wood)</td>
<td></td>
</tr>
<tr>
<td>after sawing / during air drying</td>
<td>XX</td>
</tr>
<tr>
<td>during steaming</td>
<td>X</td>
</tr>
<tr>
<td>during kiln drying</td>
<td>XXX</td>
</tr>
<tr>
<td>after drying (not kiln drying related)</td>
<td>X</td>
</tr>
</tbody>
</table>

Caused by:
Water with iron ions in contact with tannins in the wood.

Description:
Dark irregular surface stains develop as a result mostly from a reaction between iron and tannins.

Minimizing:
Avoid steam condensate and water dripping from steel pipes, beams and other kiln components.
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Yellow Stain

Wood species:
European oaks (*Quercus petraea* (Matt.) Liebl., *Quercus robur* L., etc.)
chestnut (*Castanea sativa* Mill.)
walnut (*Juglans nigra* L., *Juglans regia* L.)

Occurrence: (XXX highest risk)
fresh wood  (round wood)  
after sawing / during air drying  X
during steaming  
during kiln drying  XXX
after drying (not kiln drying related)  

Caused by:
Metabolization of tannic acids by the fungus:
*Paecilomyces variotii.*

Description:
Yellowish streaks along the grain in
dried hardwood.

Minimizing:
Keep sufficient (e.g. 0.5 m / s) air circulation in the wood
stacks and relative humidity lower than 80%-85%.
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Wood Core Discolouration

Wood species:
Light-coloured wood species:
- beech (Fagus sylvatica L.)
- alder (Alnus glutinosa(L.) Gaertn.)
- lime (Tilia cordata Mill.)
- maple (Acer platanoides L., A. spp.)
- ash (Fraxinus excelsior L.)
- birch (Betula pendula Roth)
- etc.

Occurrence:
- fresh wood (round wood)
- after sawing / during air drying
- during steaming
- during kiln drying
- after drying (not kiln drying related)

Caused by:
Enzymatic oxidation of accessory phenolic compounds

Description:
Darkening of light coloured wood species in the core (sandwich);
higher risk for boards thicker than 40 mm.

Minimizing:
To keep the natural colour, dry green wood as quickly as possible at low temperature (<30°C) down to about 20% MC.
Wood should be loaded in the kiln soon after sawing.

Attention:
For thick dimensions (>40 mm) do not over-dry the wood surface (<18% MC) during initial drying phase.
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FACT SHEET 5

Blue stain

**Wood species:**
- Pine (*Pinus sylvestris* L.)
- Spruce (*Picea abies* (L.) Karst.)
- Fir (*Abies alba* Mill.)

**Occurrence:** (XXX highest risk)
- Fresh wood (round wood) XXX
- After sawing / during air drying XXX
- During steaming □
- During kiln drying X
- After drying (not kiln drying related) X

**Caused by:**
Metabolization products of blue stain fungi (*Ophiostoma minus*, etc.).

**Description:**
A bluish or greyish discolouration of sapwood caused by presence of metabolites of the fungus in the wood cell.

**Minimizing:**
To keep the natural colour, dry as quickly as possible at high temperature (> 40°C), use air humidity <70% and good air-circulation down to about 20% MC.
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FACT SHEET 6  
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Sticker staining

Wood species:
Appears in lot of species but mainly in light-coloured hardwoods and softwoods, both from the temperate and tropical zone
e.g. ash (*Fraxinus excelsior* L.), maple (*Acer platanoides* L., *A. spp.*), iroko (*Milicia excelsa* (Welw.) C.C. Berg, beech (*Fagus sylvatica* L.), etc.

Occurrence:  (XXX highest risk)
- fresh wood  (round wood)  □
- after sawing / during air drying  X
- during steaming  X
- during kiln drying  XXX
- after drying (not kiln drying related)  □

Caused by:
Mainly enzymatic oxidation of accessory phenolic compounds; fungus growth (e.g. blue stain) can also appear.

Description:
Darker or lighter stripes on the wood surface. Can also appear several mm beneath the surface.

Minimizing:
Use moulded stickers in order to minimize the contact surface with wood.
Use dry stickers.
Recommended wood species for sticker are spruce, hornbeam and ash.
## Water stains

<table>
<thead>
<tr>
<th>Wood species:</th>
<th>Appears on the surface of all kind of wood species.</th>
</tr>
</thead>
</table>

### Occurrence:
- **fresh wood** (round wood): 
- after sawing / during air drying: 
- during steaming: 
- during kiln drying:  
- after drying (not kiln drying related): 

### Caused by:
Condensation of water vapour or liquid water on wood surface, when drying in concrete or brick kiln constructions (alkaline discolouration); but also in other kilns when water spraying is not adequate and the mineral content in water is too high.

### Description
Lighter or darker irregular surface stains, developed as a result from water stagnation.

### Minimizing:
- Keep kiln chamber in good condition: avoid thermal bridges, use water resistant coatings in masonry kilns, maintain humidification system.
- Check water quality.
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FACT SHEET 8

Brown stain in Pine

Wood species:
Appears mainly under the surface in Radiata Pine (*Pinus radiata* D.Don) and some other conifers (*Pinus strobus* L., *Pinus ponderosa* Laws.)

Occurrence: (XXX highest risk)
- fresh wood (round wood)
- after sawing / during air drying
- during steaming
- during kiln drying XXX
- after drying (not kiln drying related)

Caused by:
During kiln drying, sugars are deposited 0.5-1 mm below the surface; at this depth, an oxidisation reaction generates a 1-2 mm thick brown coloured band.

Description
A brown colour variation appears on the boards when lightly (<2 mm) planed.

Minimizing:
More severe planing (3-4 mm) or ripping of the boards eliminates the discolouration. Otherwise dry at temperatures <50°C.