EFFECTS OF NATURAL WEATHERING ON SURFACE COLOUR AND CRACKING OF THERMALLY MODIFIED EUCALYPТUS WOOD

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Motivation


BEFORE

AFTER

Light exposure and natural weathering
Motivation

Increased added-value

Minimize possible effects of natural weathering

Darkening of wood

Source: www.tocadacotia.com

Source: Mold Rup System

Source: www.americanwoodworker.com
Introduction

1. Is Thermal modification improving the colour stability and/or the surface cracking appearance of the wood over the time?
2. If so, which treatment temperature leads to the smallest colour change and the best surface appearance in outdoor conditions?

Quantify the colour changes ($\Delta E^*$) and surface cracking:
- Blue gum wood ($Eucalyptus globulus$)
- Thermal modification (140, 160, 180, 200, 220ºC)
- 12 months of outdoor exposure;
- Benchmarking unmodified against thermally modified samples
- Focus on the surface (just for aesthetic purposes);
Materials and Methods
Materials and Methods

Blue gum Wood – *Eucalyptus globulus*

Age of trees: 25 to 35 years-old

Density (12%): 650 to 900 Kg/m³

Renewable resource
Possibility to replace less sustainable products

Main specie planted in Spain
CIEDE2000

\[ \Delta E_{00} = \sqrt{\frac{(\Delta L')^2}{k_1 S_2} + \frac{(\Delta C')^2}{k_2 S_2} + \frac{(\Delta H')^2}{k_3 S_2} + R_\gamma \left( \frac{\Delta C' S_1}{k_1 S_1} \right) \left( \frac{\Delta L'}{k_5 S_2} \right) + R_\beta \left( \frac{\Delta C'}{k_1 S_1} \right) \left( \frac{\Delta L'}{k_5 S_2} \right)} \]

CIELab
9 measurements per sample

UNE-EN 927-3
Duration: 1 year
From May 2015 to April 2016

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Duration: 6h

140 °C
160 °C
180 °C
200 °C
220 °C
(+ control)
Results and discussion
ΔE₀₀ = 6.87 (50% reduction)
Surface cracking analysis

<table>
<thead>
<tr>
<th>Rating</th>
<th>Quantity of cracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None, i.e. no detectable cracks</td>
</tr>
<tr>
<td>1</td>
<td>Very few, i.e. small, barely significant number</td>
</tr>
<tr>
<td>2</td>
<td>Few, i.e. small but significant number of cracks</td>
</tr>
<tr>
<td>3</td>
<td>Moderate number of cracks</td>
</tr>
<tr>
<td>4</td>
<td>Considerable number of cracks</td>
</tr>
<tr>
<td>5</td>
<td>Dense pattern of cracks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Size of cracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not visible under x 10 magnification</td>
</tr>
<tr>
<td>1</td>
<td>Only visible under magnification up to x 10</td>
</tr>
<tr>
<td>2</td>
<td>Just visible with normal corrected vision</td>
</tr>
<tr>
<td>3</td>
<td>Clearly visible with normal corrected vision</td>
</tr>
<tr>
<td>4</td>
<td>Large cracks generally up to 1 mm wide</td>
</tr>
<tr>
<td>5</td>
<td>Very large cracks generally more than 1 mm wide</td>
</tr>
</tbody>
</table>

DIN ISO 4628-4

CRACK RATING

>50% reduction
After 1 year of outdoor exposure

Surface cracking far greater in:
- control samples;
- 140 °C;
- 160 °C;
- 180 °C.
<table>
<thead>
<tr>
<th>Temperature</th>
<th>Control</th>
<th>140 °C</th>
<th>160 °C</th>
<th>180 °C</th>
<th>200 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>No natural weathering</td>
<td><img src="#" alt="Control" /></td>
<td><img src="#" alt="140 °C" /></td>
<td><img src="#" alt="160 °C" /></td>
<td><img src="#" alt="180 °C" /></td>
<td><img src="#" alt="200 °C" /></td>
</tr>
<tr>
<td>Wood</td>
<td><img src="#" alt="Control" /></td>
<td><img src="#" alt="140 °C" /></td>
<td><img src="#" alt="160 °C" /></td>
<td><img src="#" alt="180 °C" /></td>
<td><img src="#" alt="200 °C" /></td>
</tr>
<tr>
<td>1 year of outdoor exposure</td>
<td><img src="#" alt="Control" /></td>
<td><img src="#" alt="140 °C" /></td>
<td><img src="#" alt="160 °C" /></td>
<td><img src="#" alt="180 °C" /></td>
<td><img src="#" alt="200 °C" /></td>
</tr>
<tr>
<td>Wood</td>
<td><img src="#" alt="Control" /></td>
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<td><img src="#" alt="160 °C" /></td>
<td><img src="#" alt="180 °C" /></td>
<td><img src="#" alt="200 °C" /></td>
</tr>
</tbody>
</table>

\[ \Delta E_{\infty} = 14,38 \text{ (1,44)} \quad 13,11 \text{ (1,70)} \quad 11,52 \text{ (1,55)} \quad 11,58 \text{ (2,39)} \quad 10,38 \text{ (1,49)} \]

\[ \Delta E_{\infty} = 6,87 \text{ (1,30)} \]

*Source: [http://www.easyrgb.com](http://www.easyrgb.com) (Converts colour data to image).
Conclusion

1. Thermal modification can help to improve colour stability and surface appearance of wood samples exposed outdoor.

2. Thermally modified wood at 220 °C showed a more homogenous distribution of the colour and surface appearance presenting the smallest $\Delta E_{00}$ (before x after weathering) of the experiment.

Next steps

1. Further explore the region of temperatures close to 220 °C, and apply different durations of TMT.
COLOUR CHANGES OF THERMALLY MODIFIED Eucalyptus grandis WOOD AFTER WEATHERING

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