How to make a successful waterborne wood stain

Hereafter is a mean to make a waterborne wood stain based on alkyd technology.

- Good penetration and wood fiber saturation
- Film forming properties
- Good chemical resistance
- Good wood firing
- VOC < 25 g/L & biobased content 53% to 69%
- Limited grain raising

Binder characteristics

Ecoat has developed water-based cost competitive and high quality binders that can meet today’s requirements by shifting towards VOC < 25 g/L resins through the development of water-based alkyd resins: Inokem UR range (Table 1). They are internally emulsified alkyd emulsion, where the alkyd resin is modified with polyurethane chemistry.

Table 1: Internally emulsified alkyd emulsions.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Oil length (%)</th>
<th>Biobased content (%)</th>
<th>VOC content (%)</th>
<th>Positioning and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inokem UR 3301</td>
<td>39</td>
<td>53%</td>
<td>&lt; 2,5%</td>
<td>Conventional hybrid resin for indoor/outdoor coatings</td>
</tr>
<tr>
<td>Inokem UR 3308</td>
<td>57</td>
<td>69%</td>
<td>&lt; 2,5%</td>
<td>Penetrating hybrid resin for primer or impregnation</td>
</tr>
</tbody>
</table>

Paint formulation

Here below are a starting wood stain formulation based on customer feedbacks and Ecoat’s experience (Figure 1).

**Inokem UR**

A transparent iron oxide and an UV-absorber are added into this starting wood stain formulation to improve the UV protection and weathering (1,5-3 wt.%).

The application

Alkyd binders dry through an oxidative mechanism, in which the surface drying is to be balanced with the core drying.

A light ginning (sanding paper > 80), brushing and dusting before the first layer will improve the penetration and adhesion of the first layer. A light sanding between each coats will improve the general finish.

General rules are that the wood to be painted should be dry and clean, and the application temperature of at least 5°C and maximum 35°C, in order to allow proper water evaporation. The relative humidity of the air has also a big impact on the application properties and the drying.
recommendation is that the relative humidity should be within the range of 20-70%.

**Key results**

Down below are the paint performances according to European mostly used standards (Table 2).

![Table 2: Paint performances on pine wood substrates.](image)

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness</th>
<th>Drying time</th>
<th>Inokem UR 3301</th>
<th>Inokem UR 3308</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloss 60°</td>
<td>200±10</td>
<td>96h</td>
<td>13,5</td>
<td>21</td>
</tr>
<tr>
<td>Surface Drying Time (h) - Touch Dry</td>
<td>200±10</td>
<td>—</td>
<td>&lt;2h</td>
<td>&lt;2h</td>
</tr>
<tr>
<td>Recoatability (h)</td>
<td>107g/m²</td>
<td>—</td>
<td>4h</td>
<td>4h</td>
</tr>
<tr>
<td>Adhesion wood - Cross Cut Test</td>
<td>2x107g/m²</td>
<td>48h</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Benchmarking the APU from Ecoat**

**Inokem UR vs water-based acrylic emulsion & alkyd emulsion**

*Figure 2: Features of alkyd, acrylic and alkyd polyurethane.*

**Inokem UR vs water-based acrylic emulsion**

Inokem UR 3301, Inokem UR 3308 and a waterborne acrylic wood stain from the market are compared and down below are their drying performances on pine wood substrates.

The water drop test achieved after each layer highlights the **better penetration** properties of the Inokem UR 3308 and to a less extend of the Inokem UR 3301 compared to the acrylic benchmark (Table 2). This property can be linked to their long oil lengths and lower molecular weight.

Two layers of Ecoat's formulations enable to saturate the wood fibers and the formation of a film-forming coating with a **hydrophobic surface.**