

# 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.

Ref.	Oil length (%)	Biobased content (%)	VOC content (%)	Positioning and use
Inokem UR 3301	39	53%	< 2,5%	Conventional hybrid resin for indoor/outdoor coatings
Inokem UR 3308	57	69	< 2,5%	Penetrating hybrid resin for primer or impregnation

## Paint formulation

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

Ingredients	Weight (g)	Weight (g)	Chemical function
<i>Prepare the millbase</i>			
Water	4,50	4,50	Water
Disperbyk 190	0,80	0,80	Dispersing agent
AMP 95	0,20	0,20	Neutralizing agent
Byk 024	0,40	0,40	Defoamer
Acticide MBS	0,2	0,2	Biocide
Butyl glycol	1,00	1,00	Butyl glycol
BG 838M	1,50	1,50	Semi-transparent iron oxide pigment
Durcal 2	11,00	11,00	CaCO <sub>3</sub>
Microtalc IT Extra	2,00	2,00	Talcum
Byk 420	0,11	0,11	Anti-settling agent
<i>Disperse at high speed during 30 minutes with a cover. Then cool down the mixture by decreasing the agitation between 500 and 700rpm. Keep the cover during this step. Then add:</i>			
Inokem UR 3308 (40%)	38,25	0,00	Alkyd-PU emulsion
Inokem UR 3301 (40%)	0,00	38,18	Alkyd-PU emulsion
Byk 3455	0,30	0,30	Leveling agent
Borchi oxycoat 1101	0,11	0,11	Iron based drier
Water	35,90	36,20	Water
Tinuvin 5333-DW	2,00	2,00	Blend of UV absorber and a HALS
Byk 420	0,47	0,47	Anti-settling agent
Acrysol RM 8W	1,26	1,03	Rheology modifier
<i>Mix 5mn at maximum 1000-1400 rpm</i>			
<b>Total</b>	<b>100,00</b>	<b>100,00</b>	

<b>Paint Characteristics:</b>		
<b>Theoretical values</b>		
Density (g/cm <sup>3</sup> )	1,13	1,13
Solids in weight (%)	30,97	30,97
Solids in volume (%)	22,3	22,3
Binder content (%)	15,3	15,3
PVC (%)	30,4%	30,4%
PVC/CPVC	0,482	0,482

Figure 1: Starting wood stain formulation based on Inokem UR 3308 and Inokem UR 3301.

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. The

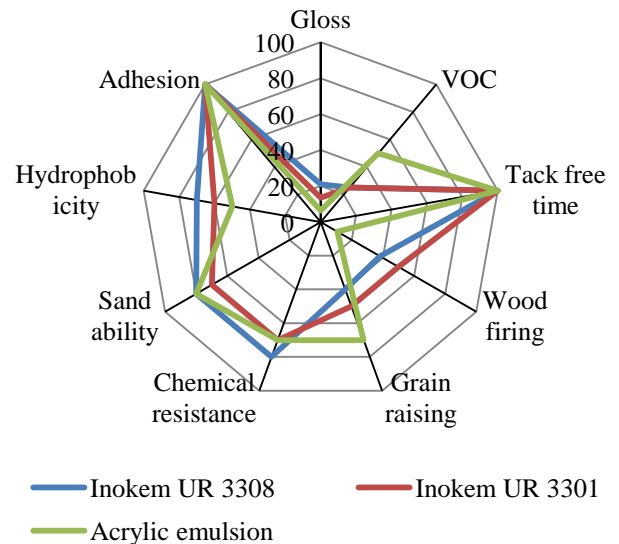
recommendation is that the relative humidity should be within the range of 20-70%.

### Key results

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

Table 2: Paint performances on pine wood substrates.

Item	Thickn ess	Drying time	Inokem UR 3301	Inokem UR 3308
Gloss 60°	200±10	96h	13,5	21
Surface Drying Time (h) - Touch Dry	200±10	—	<2h	<2h
Recoat ability (h)	107g/m <sup>2</sup>	—	4h	4h
Adhesion wood - Cross Cut Test	2x107g/m <sup>2</sup>	48h	0	0



Compared to a waterborne acrylic, the Inokem UR will outperform in penetration, gloss, hydrophobicity, and last but not least in wood firing and ease of application. Moreover, the Inokem UR range doesn't require any coalescing agent reducing the VOC and the price of the overall paint formulation.

### Benchmarking the APU from Ecoat

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

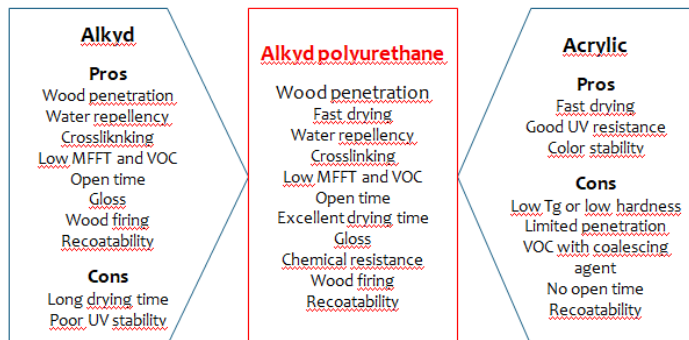


Figure 2: Features of alkyd, acrylic and alkyd polyurethane.

#### 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**.