How to make a successful C4 waterborne anticorrosion paint

Hereafter is a mean to make a C4 waterborne anticorrosion paint based on alkyd technology.

- **Producing a C4 water based paint**
- **Hardness at H-HB at 7 days, stabilizing at 3H after 28 days**
- **VOC < 25 g/L**
- **Hardness can reach 2H within 24h in 2K**

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 emulsions, 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 3304	**36**	**50%**	**< 2,5%**	**Colorless hybrid resin for top coat or DTM**
Inokem UR 3305	39	52%	< 2,5%	Hybrid resin for primer anticorrosion coating
Inokem UR 3306	38	61%	< 2,5%	Versatile hybrid resin

Paint formulation

Moving from solvent-borne to waterborne binder requires the paint formulation to be modified accordingly. Here below is a starting DTM (Direct-To-Metal) paint formulation based on customer feedbacks and Ecoat's experience (Figure 1).

Ingredients	Weight (g)	Chemical function
Prepare the millbase		
Water	4,20	Water
Tego dispers 750W (40%)	0,80	Dispersing agent
Mix under low stirring (lowest speed to avoir foam introduction)		
AMP 95	0,16	Neutralizing agent
Byk 024	0,20	Defoamer
When you add the titanium dioxyde and fillers, you need to increase the speed gradualy to 2000-3000 rpm to have a good mixing (doughnut)		
Kronos 2360	15,10	Titanium dioxyde
Omyacoat 850 OG	2,40	Calcium carbonate
Steashield 10 (= Luzenac HAR T84)	0,80	Talcum
Coapur 830W	0,07	Rheology Modifier
Disperse at high speed-check the millbase at 3000-3500 rpm for 30 minutes with a cover then add:		
Asconium 114	1,51	Anticorrosive
Disperse at high speed the millbase (3000-3500 trs/mns) for 5 minutes then cool down the mixture by deacreasing the agitation between 500 and 700rpm. Keep the cover during this step. Then add:		
Water	10,70	Water
Inokem UR 3304 (40%)	63,50	Alkyd PU-Emulsion
BorchiOxyCoat 1101	0,16	Iron based drier
Ascotran H10	0,30	Anti flash rust
Coapur 830W	0,14	Rheology Modifier
Mix 5mn at maximum 1000-1400 rpm		
Total	**100,04**	

Paint Characteristics:	
Theoretical values	
Density (g/cm^3)	1,20
Solids in weight (%)	45,77
Solids in volume (%)	35,1
Binder content (%)	25,4
PVC (%)	16,6
PVC/CPVC	0,297

Figure 1: DTM formulation based on Inokem UR 3304.

Key success factor is to use hydrophobic ingredients.

The application

Alkyd binders dry through an oxidative mechanism, in which the surface drying is to be balanced with the core drying. The ticker the film, the longer it will take to reach a full drying.

The film will perform only if the drying is completed, either by applying multiple thin layer, or by giving drying time. In Europe, 28 days are used to reach the best performances.
Air force drying (80-140°C) might also be used and will help with the film build-up.

Therefore the recommendation is to apply 3 layers of 20-25 µm DFT/layer each reaching a 75 microns film (DFT = Dry Film Thickness). 24h minimum in between layer will provide the optimum performances.
To be noted that spray applications will deliver the best salt spray resistance.

Key results

Down below is the paint performances on Qpanel R substrate according to European mostly used standards (Table 2).

Table 2: Paint performances on QPanel R substrate.

Item	DFT (µm)	Drying time	Inokem UR 3301	Inokem UR 3304
Gloss 60°	23±3	72h	87	75
Surface Drying Time (h) - Touch Dry	23±3	——	2h	≤1h
Hard Drying Time (h) (Cotton ball method)	23±3	——	4h	3h
Pencil & Persoz (sec) Hardness	23±3	24h	3B / 55	2B / 66
		168h	HB / 95	H / 111
Adhesion - Cross Cut Test	23±3	48h	0	0
Water Resistance (Immersion)	3x25±5	168h	3 days	> 5 days
Salt Water Resistance (3% NaCl, 48h)	3x25±5	168h	48h	>48h
Acid Resistance 50g/L H_2SO_4, 24h	3x25±5	168h	>24h	>24h
Salt Spray Resistance	3x25±5	168h	550h	480h

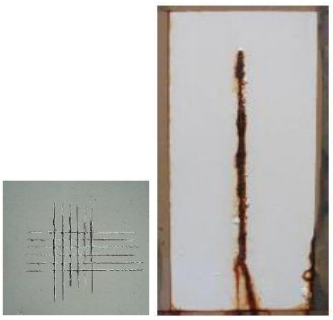


Figure 2: DTM paint after 1000h in salt spray test.

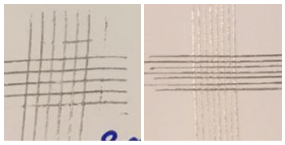
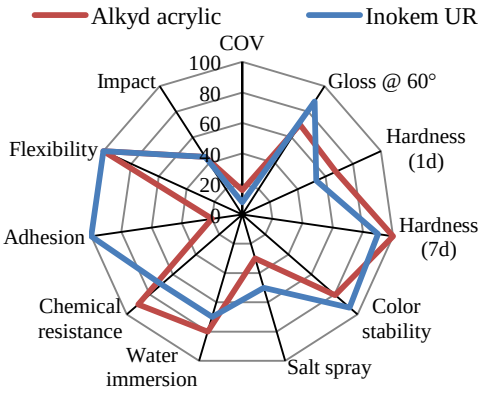


Figure 3: Adhesion of DTM paint on aluminium (2mm and 1mm cross-cut test).

Inokem UR alkyd dispersions present residual hydroxyl value (around 1%) and can therefore be blended with water soluble isocyanate, such as Bayhydur XP2655, to improve the overall drying performances. This blend works then as a 2K technology **and can reach a pencil harness of 2H within 24h.**

Benchmarking the APU from Ecoat

Inokem UR vs water-based alkyd-acrylic



Compared to acrylics emulsions, the Inokem UR will outperform in gloss, adhesion as any alkyds, but also in the balance hardness versus salt spray.

Only alkyds enable both hardness (after 7 days or more) and C4 anticorrosion class.

Inokem UR vs solvent-based urethane alkyd paint from the market

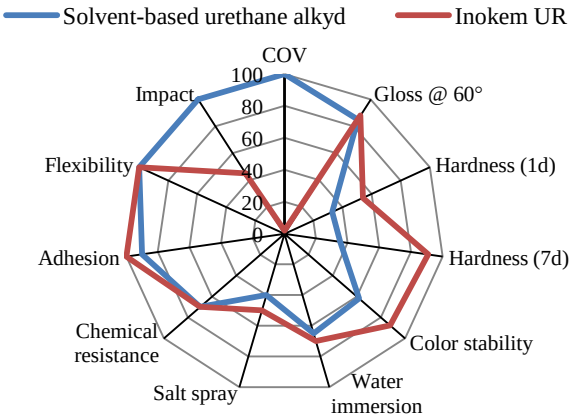


Figure 4: Paint after 240h in QCT test (ISO 6270) - Left side: Inokem UR 3301 - Right side: Solvent-based urethane alkyd paint.

Compared to solvent-based urethane alkyd resins, the Inokem UR will outperform in hardness, adhesion, color stability, but also in salt spray and QCT resistance.