Gun Lundsten, CH-Polymers OY, reports on a study into the improvement of the chemical resistance of waterborne binders, while maintaining excellent early block resistance

Improved chemical resistance of waterborne industrial acrylics

Industrial coatings are used for several areas like furniture, kitchen cabinets and building products. The requirements of the coatings are dependant on the application but stackability or early block resistance and good chemical resistance are usually desirable.

Traditionally this was achieved by using reactive two-component chemistries, often solventborne. Nowadays there are one component waterborne self-crosslinking acrylics with excellent stackability properties on the market. But improved chemical resistance and especially coffee and red wine resistance are still desirable. In this investigation, the improvement of the chemical resistance of waterborne binders has been studied, while maintaining the excellent early block resistance.

INTRODUCTION

A large sector of the interior industrial market is the furniture industry. Different binder technologies like solventbornes, polyurethanes and UV crosslinking based have been used during the years. Due to increasing regulations for lower VOC and formaldehyde emissions, environmentally friendly coatings are now in demand. Waterborne self-crosslinking acrylic binders for furniture coatings with excellent stackability properties have been used for several years already.

However, outstanding resistance to solvents and aggressive household chemicals is still a challenge to these waterborne acrylics. As the Finns are world leaders in drinking coffee, we decided to especially concentrate on coffee resistance in this study. Also, ethanol and grease resistance have been paid attention to.

FACTORS INFLUENCING STAIN RESISTANCE

One approach to solve the problem with stained surfaces is to completely prevent the stains from wetting the surface and furthermore, prevent them from interacting with the surface – or at least minimise the wetting of and the interaction with the surface. The wetting of a surface by a liquid is determined by the spreading coefficient or the contact angle, 0, between the liquid and the surface, **Figure 1**[1]. When 0 <90° the liquid is wetting the surface: if 0 is close to 0°C the liquid is wetting the surface completely. When the contact angle is >90° the liquid is non-wetting.

Coffee is a complex chemical mixture consisting of more than 700 components. Several of the components are coloured ones. The coloured species are of acidic nature, water soluble and with strong affinity towards amine end-groups[2]. To minimise staining the coffee amine end-group containing raw materials should be avoided in the formulation. Furthermore, the contact angle between coffee and the paint surface should preferably be bigger than 90° to minimise wetting and staining of the paint surface. As coffee is an aqueous liquid this means that a hydrophobic paint surface is desirable.

EXPERIMENTAL APPROACH

To achieve a hydrophobic paint surface also the acrylic self cross-linking binder used has to be hydrophobic. The hydrophobic tendency of acrylic monomers has been determined and reported in the literature in different ways[3,4,5]. In **Table 1** you can find one comparison of the hydrophobicity of some acrylic monomers. The longer the carbon chain of the alcohol is the more hydrophobic is the monomer but the lower the Tg. However, to achieve an excellent block resistance a fairly high Tg is needed. By combining different hydrophobic monomers and by tailoring different particle morphologies we have tried to optimise the coffee resistance, while keeping the excellent block resistance.

TEST PROCEDURES

The developed acrylic binders were tested in a white paint at a pigment volume

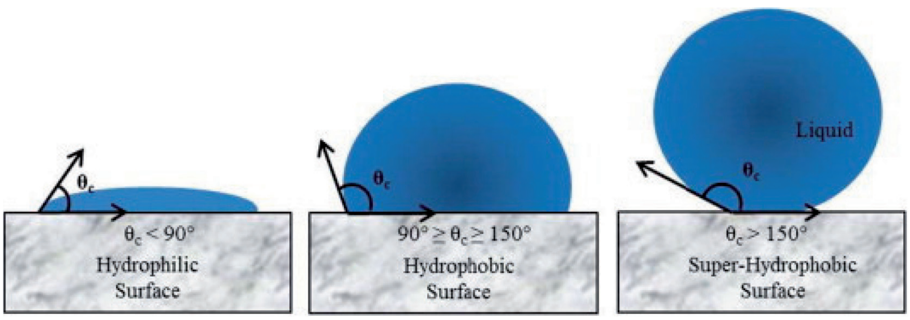

Figure 1. Wetting of surfaces by a hydrophilic liquid[1]

Table 1. Values of hydrophobicity of some acrylic monomers

Monomer	Hydrophobicity contribution	Glass transition temperature (°C0
2-ethyl hexylacrylate	5.2	-90
Iso-bornyl methacrylate	5.0	110
Butyl methacrylate	3.5	20
Butyl acrylate	3.2	-57
Methyl acrylate	1.9	105
Methacrylic scid	-2.2	185
Acrylic acid	-2.5	101

Table 2. Formulation of test paint used, PVC 26

Raw materials		
Pigment grind:		
Water		56.2
Associative thickener 1		8.5
Dispersing agent		10.4
Ammonia 25% (aq)		0.8
Wetting agent		1.9
In-can preservative		1.9
Defoamer		0.6
Titanium dioxide		169.3
Na-K-Alumina silicate		84.7
Let down:		
Acrylic self x-linking binder		549
Coalescing agent		11.3
Defoamer		0.3
Associative thickener 1		4.2
Associative thickener 2		4.2
Water		96.8
Total		1000.00
Paint properties:		
Solid content	Weight -%	49.0
PVC	%	26.3
MFFT	°C	0

Table 3. Rating of sticking tendency

Rating	Sticking tendency	Surface damage
10	Paint films do not stick at all	No marks
9	Paint films slightly stuck together	No marks
8	Paint films stuck together	No marks
7	25% of paint films stuck together	Marks on paint films
6	50% of paint films stuck together	Marks on paint films
5	75% of paint films stuck together	Marks on paint films
4	Paint films completely stuck together	Marks on paint films
3	Paint films completely stuck together	25% wood breakage
2	Paint films completely stuck together	50% wood breakage
1	Paint films completely stuck together	100% wood breakage

Table 4. Properties of the tested binders and paints

Paint number		1	2	3
Binder used in test paint		CH Polymers' commercial architectural acrylic	Commercial competitor's industrial self cross-linking acrylic	CH Polymers' novel industrial self cross-linking acrylic
Binder properties				
MFFT	°C	8	7	10
König hardness after 1 day	s	25	73	75
Paint properties				
MFFT	°C	<0	<0	<0
Paint film properties				
Block resistance at +23°C		8	10	10
Block resistance at +50°C		3	8	9
Coffee contact angle	°	95	81	105
Chemical resistance (IKEA)				
Water 24hr	5-best	4	2	3
Paraffin oil 24hr	5-best	5	5	5
Ethanol 1hr	5-best	4	2	4
Ethanol 6hr	5-best	3	2	3
Coffee 1hr	5-best	4	3	3-4
Coffee 6hr	5-best	3	2	3
ΔE coffee 1hr	The lower the better	1.8	6.0	4.4
ΔE coffee 6hr	The lower the better	4.7	9.2	7.8

concentration of 26%, PVC 26, shown in **Table 2**. Wood test panels were prepared by applying two layers of paint approximately 300µm wet film thickness. The panels were dried for four days at standard conditions (23°C and 50% relative humidity) before testing. The chemical resistance was evaluated according to the IKEA standard (IOSMAT- 0066) by applying the chemicals for 1hr, 6hr or 24hr and then evaluating the staining by using a visual rating scale from 1 (poor) to 5 (excellent). To get an objective evaluation ΔE values of the stained areas compared to the unstained were measured. As a reference a widely used commercial self-crosslinking acrylic binder was used. Furthermore, the properties were compared to our easy-to-clean binder developed for architectural interior wall paints.

The stackability test used to determine the tendency of the paint surfaces to stick to each other (block) was determined by an internal procedure derived from the standard method SFS 3771. Two layers (100µm wet + 200µm wet) of the paint were applied on wooden veneer pieces (25 x 50 x 3.5mm) and dried for three days at standard conditions (23°C and 50% relative humidity). At ambient temperature (23°C) the test pieces were placed in contact with each other face to face and a pressure of 0.1MPa was applied for 60min. After that the test panels were taken apart in order to assess their tendency to stick together. The strength needed to take apart the test pieces and the surface damage were evaluated using the following scale from 1 to 10, **Table 3**. The same test procedure was done at 50°C but after 60min under pressure, the test pieces were cooled down to ambient temperature during 90min and then taken apart and evaluated.

Contact angles of coffee on the paint surfaces were determined by a Krüss DSA100E instrument.

TEST RESULTS

To get a binder with excellent block resistance and optimal chemical resistance, the monomer composition and the polymer particle morphology of the binder were optimised by trying to maximise the hydrophobicity of the polymer, while maintaining the good block resistance. The test results are summarised in **Table 4**, which shows that it is really a challenge to achieve an excellent balance of early block and chemical resistance. The commercial architectural binder brings the best chemical resistance at the expense of an early block resistance at elevated temperatures. On the other hand, early block resistance at elevated temperatures is not a critical feature for architectural binders.

By optimising the particle morphology and increasing the hydrophobicity of the novel industrial binder a good balance of early block resistance and chemical resistance in the test paint is achieved.

Compared to the competitor industrial binder the early block resistance at elevated temperatures is better as the paint films stuck only slightly together. Overall, an improved chemical resistance is achieved with the novel industrial binder; the water and ethanol resistances are fairly better compared to the reference. Especially the coffee resistance is higher, which is partly a result of a more hydrophobic paint surface leading to a high contact angle of coffee.

SUMMARY

The novel self-crosslinking acrylic binder shows low coalescing agent demand and the early block resistance is good. Furthermore, it brings improved chemical resistance compared to the commercial competitor industrial self cross-linking binder. Water and ethanol resistances are better and especially coffee resistance is higher. However, an even higher chemical resistance is desirable. The focus next will be in optimising the paint formulation to show the full potential of the novel industrial binder. **PPCJ**

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Axalta's Industrial Liquid business strengthens portfolio

Axalta, a leading global supplier of liquid and powder coatings, has added new environmentally-responsible coatings, including VOC-free and low VOC waterborne products, to its Industrial Liquid Coatings portfolio. The new products are: Corroless® VOC Primer – a High Performance 2K water-based epoxy primer, PercoHyd® 433 – a 2K WB structure topcoat, and PercoTop® CS306 – a chrome VI-free 2K wash primer.

Whether it's agriculture, construction and earth moving equipment, automotive components, or general industrial applications, all Axalta's Industrial Liquid coatings are designed to satisfy demanding specifications from customers, industry and governmental bodies alike.

Percohyd 433

Dr Koen Linsen, Axalta's Product Manager for its Industrial Coatings business in Europe, the Middle East and Africa (EMEA), explained: "We constantly strive to strike a balance between a fantastic, durable coating and the various other demands required of it. With the introduction of these new products, we know our customers and end-users are getting environmentally-responsible coatings that will do their job perfectly."

CORROLESS VOC PRIMER – HP 2K WATER-BASED EPOXY PRIMER

This 2K water-based epoxy primer is a VOC-free coating designed to offer high-corrosion protection – more than 1000hr in the salt spray test with impressive results. It can be overcoated with Axalta's water-based topcoats after 30min at room temperature, which optimises throughput and energy costs. Thanks to its excellent filling properties, it is particularly suitable for use on blasted steel. The primer is very easy to apply and has very good sagging resistance. Parts can be assembled after 24 hours of drying. Spray guns only need to be cleaned with water.

PERCOHYD 433 – 2K WATERBORNE STRUCTURE TOPCOAT

This 2K waterborne structure topcoat produces an even and homogeneous structure effect and can be used over all PercoTop and PercoHyd primers and fillers. It has a very low VOC content – <240g/lit. Parts can be handled after three hours and can be assembled after 16hr. For added flexibility, PercoHyd 433 is available in all RAL colours.

PERCOTOP CS306 – CHROME VI-FREE 2K WASH PRIMER

Formulated to be used on a variety of metallic substrates including stainless steel and sanded aluminium, this chromate-free wash primer provides exceptional corrosion protection. It can be overcoated with any PercoTop filler.

For more information, please visit www.axalta.com/industrial-emea.

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