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How to improve environmental profile of wall paints and keep indoor air quality as fresh as possible

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The increasing demand for more environmentally friendly interior paints is going hand–in-hand with more strict regulations of Volatile Organic Compounds, VOC, Semi Volatile Organic Compounds, S-VOC and biocides in the final products. The proposed new requirements of Ecolabel states that the total level of residual monomers in polymers may not be more than 100 ppm. Furthermore there is a discussion about reducing the allowed amount of 2-methyl-2H-isothiazol-3-one, MIT, to be used to 15 ppm.
As a producer of water borne polymer binders for indoor paints we have to consider all these proposals and discussions. Therefore an acrylic binder, which meets even the proposed requirements regarding reduced levels of residual monomers and biocides has been developed.

Introduction

As consumers have become more aware of the impact of coatings on indoor air quality there has been a demand for more environmentally friendly paints. To get a paint eligible for the EU Ecolabel or Nordic Ecolabel several criteria of the paint must be fulfilled. The amount of used white pigment has to be low enough but concurrently the spreading rate or hiding power should be high enough. The amounts of allowed volatile organic compounds, VOC, and semi volatile organic compounds, S-VOC, are restricted not to talk about the amount of in-can biocides. Carcinogenic, mutagenic, toxic or otherwise hazardous components are for sure not allowed to be used. In Table I the most important criteria of today for indoor paints are briefly summarized.

On March 15th 2016 the Committee for Risk Assessment, RAC, adopted an opinion on harmonized classification and labelling for 2-methylisothiazol-2(2H)-one, MIT. RAC proposes that the concentration limit for H 317 will be decreased to 15 ppm and the EU H208 labelling limit to 1,5 ppm. If this classification will enter into force MIT will not be allowed at concentrations of 15 ppm and above in products intended for general public, i.e. DIY market. Furthermore for the Nordic Ecolabel criteria there is a suggestion that the allowed total amount of residual monomers in the binder shall be limited to 100 ppm. To be able to meet all these proposed limits in the future a novel water borne acrylic binder has been developed.

Environmentally friendly interior paints can be formulated with the novel acrylic binder

Low MFFT is needed for low VOC and S-VOC

For producing a paint with low amount of Volatile Organic Compounds, VOC (Boiling point ≤ 250 °C) and Semi Volatile Organic Compounds, S-VOC (boiling Point > 250 °C) content, the paint has preferably to be formulated without coalescing agents. To achieve a good film formation without coalescing agents the minimum film formation temperature, MFFT, and the glass transition temperature, Tg, of the binder have to be low enough. But with a low Tg of the binder there is a risk that the polymer film of the binder or the paint becomes quite soft or even tacky which means that the blocking resistance of the paint becomes poor. By producing polymer particles in a two-stage process combining two different Tg to a core-and-shell morphology the hardness of the polymer film can be increased although the MFFT is kept on a low level. Although the novel binder has an MFFT < 0 ^{o}C the blocking resistance is good enough for interior wall paints. Furthermore the pigment binding capacity of the binder is excellent and high performance paints with outstanding scrub resistance can be produced.

Low residual monomers for fresh indoor air quality

Water borne polymer dispersions are produced by free radical emulsion polymerization, which rarely proceeds to completion. Depending on the monomer composition the total amount of residual monomers can be quite high even up to 1000 ppm. As monomers used for producing polymer dispersion binders usually are classified harmful to health and toxic or even acute toxic they are highly undesirable in the final paint. Their presence in the paint may create hazards to painters as a result of long-term exposure during painting. Therefore the suggestion for Nordic Ecolabel is that the total amount of residual monomers in the final product will not be allowed to exceed 100 ppm in the future.

There are several techniques for reducing residual monomer content. Using a combination of these techniques and optimizing the process conditions allow the best performance to be reached. Knowing how various volatile components can be removed is a result of many years' experience and gives total residual monomer content well below 100 ppm.

Ecolabel Criteria for Indoor Paints			
White Pigment Content	**Limit (g/m^2)**		
Scrub Class 1	40		
Scrub Class 2	36		
Wall and ceiling without claim	25		
Other Paints	36		
Sreading Rate	**Hiding Power (%)**	**Spreading Rate (m^2 / l)**	
Applied to white and light colors	≥ 98	≥ 8	
VOC ans S-VOC content	**VOC limit (g/l)**	**S-VOC (g/l)**	
		White Paints	Tinted Paints
Mat walls and Ceilings (G60 < 25)	10	30	40
Glossy Walls and Ceilings	40	30	40
Preservatives	**Limit (ppm)**		
Totally	600		
MIT	100		
BIT	400		
2-OIT	400		
CMI/MIT	15		
Zinc pyritione	500		
Formaldehyde	**Limit (ppm)**		
Residuals level	10		

Table I. Some of the Ecolabel criteria of today

Low biocide levels guarantee non allergic products

To increase the level of protection for persons who are sensitized to chemical substances the European authorities introduced a new additive labelling from the 1st of June 2015 according to the EUH208 statement. Several important in-can biocides like CIT/MIT, MIT and BIT are classified as sensitizing substances and the concentration limits for labelling were decreased to 15 ppm, 100 ppm and 50 ppm, respectively. Only nine months later the Committee for Risk Assessment has come up with a proposal to further reduce the European limit EUH208 of MIT to 1,5 ppm and the H317 limit to 15 ppm. As MIT is very effective and has been broadly used the proposal causes headache for the binder and paint producers, who have to find alternative biocides and solutions.

MIT can of course be replaced both in the binder and in the paint by other in-can biocides. However the alternatives like BIT or OIT are not as efficient as MIT and have to be added in higher amounts, which means that the product has to be labelled according to EUH208. To avoid labelling our novel binder is biocide free but with a pH of 10. The high pH preserve the binder from bacterial activity during the delivery and during storage at the customer. Accordingly the paint producers can then themselves choose the most suitable in-can biocide package for the paint.

Formulation of environmentally friendly paints

By optimizing the composition of the binder we have got the desired properties of the binder, Table II. The total residual monomer content is less than 100 ppm, total VOC less than 300 ppm, total S-VOC less than 700 ppm and no biocide added. This makes it possible for the paint producer to formulate an environmentally friendly paint fulfilling the Ecolabel criteria or even the more demanding proposed Nordic Ecolabel criteria.

An interior paint with PVC 25 has been made according to the formulation in In Table III. The scrub resistance of the paint is outstanding and applies to class 1 according to EN 13300. As the formulation is made without coalescing agents the total VOC and S-VOC of the paint are very low. The contrast ratio fulfills the requirement of 98 % at spreading rate 8 m^2/l. This means that the white pigment content is 29 g/m^2 i.e. well below the required 40 g/m^2. As no biocide has been added to the binder the paint producer can freely choose a suitable in-can biocide package for the paint.

Properties of the novel acrylic binder

Solids	%	50
pH		10
Brookfield Viscosity 60 rpm	cP	1000
Average Particle Size	nm	100
Minimum Film Formation Temperature	°C	0
König Film Hardness, RH 50%, 14 d	s	7
Total rest monomer content	ppm	< 100
Total VOC	ppm	< 300
Total Semi VOC	ppm	< 700
No added biocide or carcinogenic, mutagenic, toxic or otherwise hazardous components		

Table II. Properties of the novel acrylic binder

PVC 25 Interior Ecolabel Paint

Raw Materials:		**P397-4**
Pigment grind:		
Water		18,2
HMHEC		0,2
2-amino-2-methyl-1-propanol		0,1
Disepsing Agent		0,2
Wetting agent		0,2
Defoamer		0,0
In-can biocides		0,1
TiO_2		18,2
$CaCO_3$ 5 µm		7,3
Defoamer		0,1
Let down:		0,0
Water		2,2
HEUR Rheology Modifier		0,5
Novel Acrylic Binder		47,0
HASE Rheology Modifier		0,3
Water		5,3
Total		100,0
Paint Properties:		
Solid Content	weight-%	49,7
	volume-%	23,3
PVC	%	25,3
VOC	g/l	< 0,5
S-VOC	g/l	< 0,2
Density	kg/dm^3	1,26
Krebs Stormer Viscosity	KU	110
pH		9,5
MFFT	°C	0
Paint Film Properties:		
Gloss 20°/ 60°/ 85°	GU	4/22/35
Opacity	%	96
König Hardness, 14 d	s	14
Scrub Resistance:	28 d drying	
-ISO 11998	µm	4
-EN 13300	Class	1
Full Opacity Test		
White pigment content	g/m^2	29
Contrast Ratio at 8 m^2/l	%	98
Spreading rate @ CR 98 %	m^2/l	8

Table III. An interior ecolabel PVC 25 paint formulated with the novel acrylic binder.

Summary

By using the novel acrylic binder environmentally friendly paints maintaining fresh indoor air quality can be produced. Furthermore the paints will fulfill the Ecolabel criteria and even the proposed more strict Nordic Ecolabel requirements.

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