



Coatings Trends & Technologies SUMMIT



Novel Waterborne Resin

Low VOC binder for high temperature resistant coatings

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Apps.

Wood stoves



Exhaust pipes



Industrial pipes



Industry drivers

Regulatory aspects

Safety aspects



Sustainability
Replace VOC with water & retain performance

Novel Waterborne Resin offers desirable regulatory & performance attributes

Environment, Sustainability & Regulations



- US:
- (VOC) emission standards for certain categories of consumer products pursuant of the Clean Air Act.
 - Goal: Reduce VOC emissions by 90,000/y by manufacturers, importers, and distributors to limit the VOC content to customers.
- EU & China:
- More info available upon request

Basic Information

Legal Authorities

- 42 U.S.C. §7511b(e)

Federal Register Citations

- 63 FR 52319
- 63 FR 48819
- 61 FR 14531

Code of Federal Regulations Citations

- [40 CFR Part 59 Subpart C](#)

TABLE 1 TO SUBPART C OF PART 59—
VOC CONTENT LIMITS BY PRODUCT
CATEGORY

Product category	VOC content limit (weight-percent VOC)
Air fresheners:	
Single-phase	70
Double-phase	30
Liquids/pump sprays	18
Solids/gels	3
Automotive windshield washer fluid	35
Bathroom and tile cleaners:	
Aerosols	7
All other forms	5
Carburetor and choke cleaners	75
Cooking sprays— aerosol	18
Dusting aids:	
Aerosols	35
All other forms	7
Engine degreasers	75
Fabric protectants	75
Floor polishes/waxes:	
Products for flexible flooring mate-	

Relevant benchmarks contain solvents

Benchmark A

Technical information	
Delivery form	Emulsion
Appearance	White, turbid liquid
Non-volatile content	Approx. 50%
Solvent	Isobutanol/Xylene 1:3
Ionic charge	Non-ionic
Efflux time DIN 6 mm/23 ° C	Approx. 38 s
pH value (as supplied)	Approx. 6
Water content (%)	Approx. 38%
Suitability for	
Waterborne	●
Clear coat	◐
Pigmented	●

12% solvents

Benchmark B

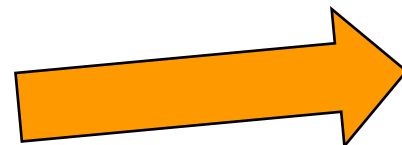
Typical general characteristics	
Appearance	White milky emulsion
Solvent content (xylene)	<8.0%
Solid content	50 ± 2%
Viscosity, dynamic at 25 ° C	-100 – 200 mPa.s
Density at 25 ° C	1.08 g/cm ³
Emulsifier	Nonionic
Flash point	45° C
Ignition temperature (liquids)	450° C

8% solvents

Benchmark C

Product data		
Typical general characteristics	Inspection method	Value
Appearance		White milky emulsion
Solids content		52-63%
Viscosity, dynamic at 25 ° C	Brookfield	20-300 mPa.s
Density, dynamic at 25 ° C	DIN 51757	1,105 g/cm ³
Emulsifier		Nonionic
Flash point	ISO 3679	60 ° C
Ignition temperature (liquids)	DIN 51794	458 ° C
pH – Value at 20 ° C	Indicator strips	4-9

Toluene





Breakthrough innovation of Si resin technology

Novel low VOC silicone resin emulsion for high temperature resistant coatings

Main features:

- Low VOC (<1% VOC), low cyclics (<0.1%), non-flammable
- Enables solvent-free paint formulations without sacrificing film aesthetics & performance
- Potential for air drying with a condensation catalyst (tin-free options)
- High temperature resistance up to 500-600°C
- Can be applied directly on metal (i.e. cold rolled steel, etc)
- Performance can be modified with paint formulation
- Hydrophobic



“First solvent-free waterborne silicone resin emulsion providing this performance”

Novel Waterborne Resin

- Appearance: white liquid
- Actives content: $60 \pm 2\%$
- pH: 9-10
- Particle size Malvern – $Dv50 < 1.0 \mu\text{m}$
- Conditions of handling: avoid freezing, gently mix before use
- Conditions of storage: 5-40°C
- Shelf life: 365 days
- Viscosity at 25°C: 18 cP (spindle 1 at 20 rpm - viscosimeter LVDVI+ - torque 40%)





Performance profile in Dow model paint

	Curing conditions	
	200°C / 1 h	230°C / 1 h
Film visual appearance	Good	Good
Pendulum hardness Persoz (oscillations)	119	112
% adhesion loss (before exposure to heat)	0%	0%
% adhesion loss (after exposure to heat)	0%	0%
HT resistance – cohesion failure level	Slight material loss	No material loss
HT resistance - discoloration (ΔE)	2.8	3.4
HT resistance – chalking resistance	Slight chalking	No chalking

High temperature resistance in Dow model paint

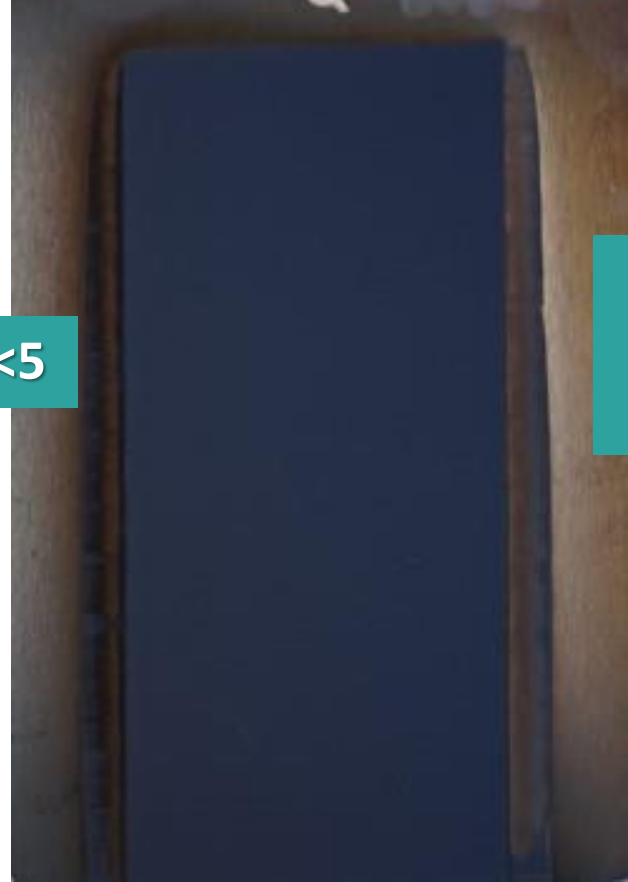
After curing before exposure to heat

After exposure to heat (500°C, 2 h, hot plate)

No visual defects after curing at 200°C (1 h)



$\Delta E < 5$



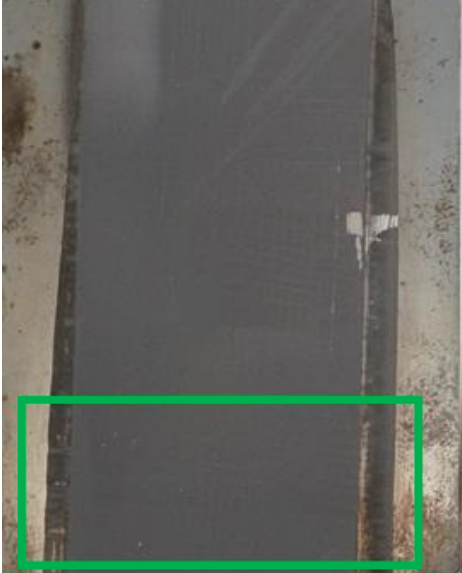


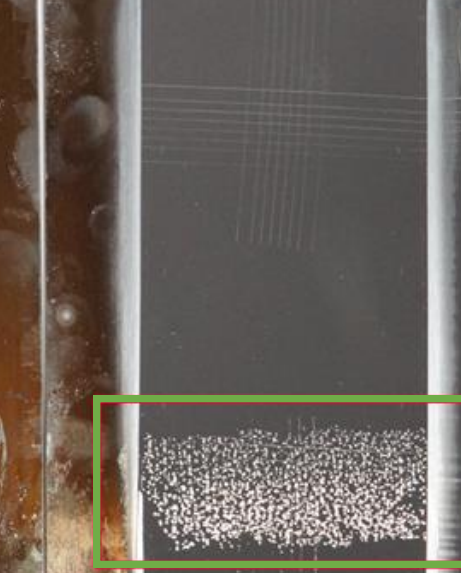




No chalking upon rubbing of the coating surface



No visual defect, no chalking, only slight discoloration after HT exposure



Novel Waterborne Resin vs. 'benchmarks'

	Novel Waterborne Resin	Benchmark 1	Benchmark 2	Benchmark 3
				
% loss of adhesion				
Chalking resistance	No chalking	Chalking	Slight chalking	Slight chalking
Hardness (Persoz)	113	108	84	105
Solvent	None	12% (9% xylene)	8% Toluene	



Dow model paint for oven cure application

Dow model paint	Amount (%)
Black pigment dispersion	40-60
Filler	4-8
Defoamer	1-2
Rheology modifier	0.5-1.5
Binder	27-45
Wetting agent	1-2
Total	100

Suggested curing conditions:

- ~200°C for 1hr (180-200°C okay)

Application:

- Draw down (lab)
- Film thickness:
 - Wet: ~ 150 μm - 6 mils
 - DFT: ~ 25 μm - 1 mil (measured)

Substrate:

- Cold Rolled Steel (CRS)

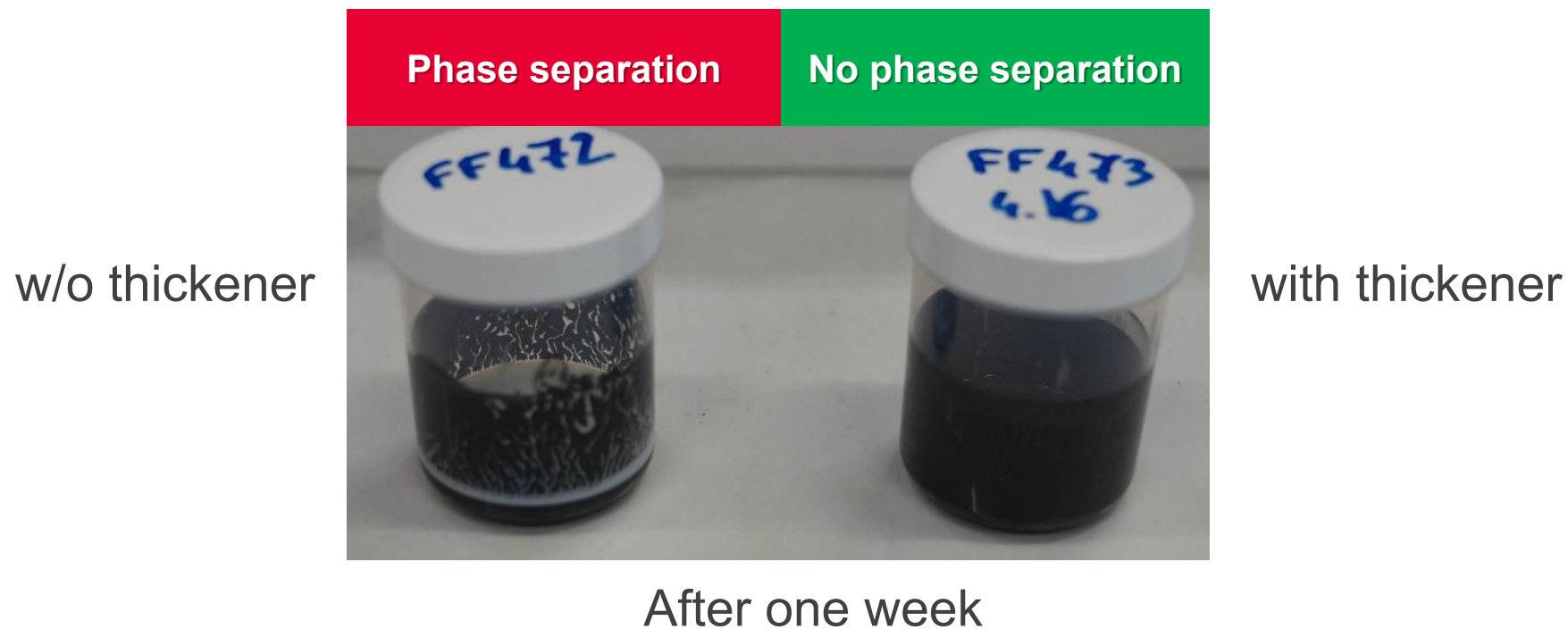
Formulation guidelines available upon request



Starting formulation – High Heat resistance

Paint component	NVC (%)	%
Pigment	65	32
Filler	100	6
Defoamer	100	1
Binder	60	24
Wetting Agent	100	2
Thickner	28	0
Water		35

Impact of viscosity in Dow model paint



The optimization of the rheology profile can improve the paint shelf life and the film aesthetics upon curing in oven.



RECENT INTEREST/NEW APPLICATIONS

Novel WB & high-temp (HT) pigment testing

Pigments	Main Components	HT suggestion
Pigment 1	Co + Al	600°C
Pigment 2	Co + Ti	600°C
Pigment 3	Fe + Mn	500°C
Pigment	FeO	500°C

**Novel Waterborne Resin + HT-resistant pigments exhibits
no chalking & good color retention**



NOVEL WB & HIGH-TEMP PIGMENT

Novel WB Resin +
pigment 1

Novel WB Resin +
pigment 2



Samples were cured at 200°C
then exposed for 300°C,
400°C, and 500°C for 1 h.
(Oven took 12hrs to warm up
&
24hrs to cool down)

**New options for excellent
post-heat color retention!**



NOVEL WATERBORNE RESIN – CONCLUSIONS

Dow launched a novel silicone resin emulsion for high temperature coatings which:

- Eliminates EHS concerns related to the use of existing solvent borne products
- Reduces tax & costs associated with VOC emission and handling
- Delivers comparable performance to solventborne market standards
- Can provide tailored performance & compatibility with acrylic emulsions



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