# DOWSIL™ 8016 Waterborne Resin

Low VOC binder for ultra high temperature resistant coating

# OUTLINE

- Background
- Product description & positioning
- Performance & formulation guidelines
- Conclusions
- Questions & answers

# Main applications & drivers

| Applications | Wood stoves | Exhaust pipes | Industrial pipes |
|---|---|---|---|
| |  |  |  |

| Main drivers | | |
|---|---|---|
| | Regulatory aspects | Sustainability<br>Replace VOC with water & retain performance |
| | Safety aspects | Clear trend |

**Waterborne silicone resins are suitable products offering the desired performance**

# DOWSIL™ 8016 WATERBORNE RESIN - DOW'S RESPONSE TO VOC REGULATIONS

## Environment, Sustainability & Regulations

**EU:**

- 2004: introduction of the Directive 2004/42/CE
- EU member states may define their own regulations to achieve sustainability goals
- Some countries created penalty systems to control the VOC levels emitted in the air

**China:**

- 2018: introduction of the Environmental Protection Tax
- 2018-2021: three-year action plan to fight air pollution
- 2017: most of the freight container coating market must switch to waterborne coatings
- Local initiative: the Guangdong province has banned the use of solventborne coatings in the city of Shunde.

# Quiz #1

**What proportion of industrial coatings used in the world are waterborne in terms of revenues?**

1. About 8%
2. About 17%
3. About 35%

# RELEVANT BENCHMARKS CONTAIN SOLVENTS

## Benchmark A

12% solvents

| 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 | ● |

## Benchmark B

8% solvents

| 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 |

## Benchmark C

Toluene

| 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 |

# QUIZ #2

**Which top challenge are you facing with the high temperature coatings which you are currently developing / selling / handling / applying?**

1. EHS concerns restricting product handling easiness in production (smell, flammability…)
2. Existing or upcoming legislation (associated with VOCs, EU Green Deal …)
3. Performance – in regard of temperature of use resistance
4. Other

# DOWSIL™ 8016 – 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
- Enabling solvent free paint formulations without sacrificing film aesthetics & performance
- Heat cure with potential for air drying in presence of a (Tin free) condensation catalyst
- High temperature resistance up to 500-600°C
- Can be applied directly on metal (CRS)
- Performance can be modulated with paint formulation
- Hydrophobic
- Compatibility with organics (acrylates)

*"First ever truly waterborne silicone resin emulsion providing this performance"*

# DOWSIL™ 8016 WATERBORNE RESIN – CUSTOMER FEEDBACK

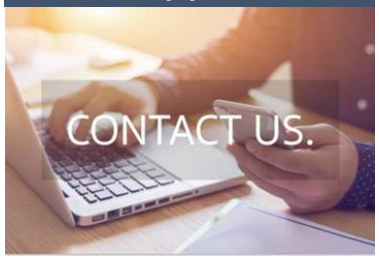
**Once formulated, our customers appreciated:**

- The fully waterborne nature of the product
- The high temperature resistance up to 500°C
- The good corrosion resistance (after 1 day – wood stove application)
- The curing conditions of at least 180°C up to 220°C (1 h)
- The defect free film aspect generated by the binder
- The high compatibility with organic binders such as acrylates
- The product stability

# DOWSIL™ 8016 WATERBORNE RESIN – PHYSICAL PROPERTIES

- Appearance: white liquid
- Actives content: 60 ± 2%
- pH: 9-10
- Particle size Malvern – Dv50<1.0 µm
- Conditions of handling: avoid freezing, gently shake 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%)

# WE MAKE COATINGS WORK BETTER – DOW WILL PROVIDE

| Raw materials | Performance | Formulation Expertise* | Problem solving | Customer support |
|---|---|---|---|---|
|  |   |  |  |   |

*: The performance of DOWSIL™ 8016 Waterborne Resin can vary with the paint formulation.

# 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 60 min

**Film thickness:**

- Wet: ~ 150 µm - 6 mils
- DFT: ~ 25 µm - 1 mil (measured)

**Substrate:**

- Cold Rolled Steel

**Application:**

- Draw down (lab)

Formulation guidelines available upon request

# 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

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

After curing before exposure to heat

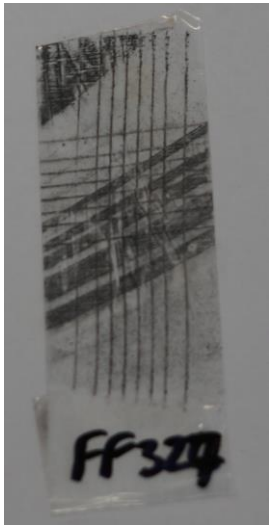
ΔE<5

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

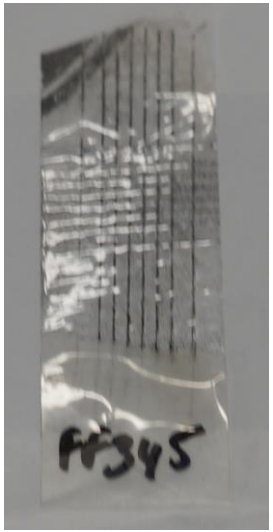
No chalking upon rubbing of the coating surface

# Film cohesion in Dow model paint

Cure at 200°C / 1 h

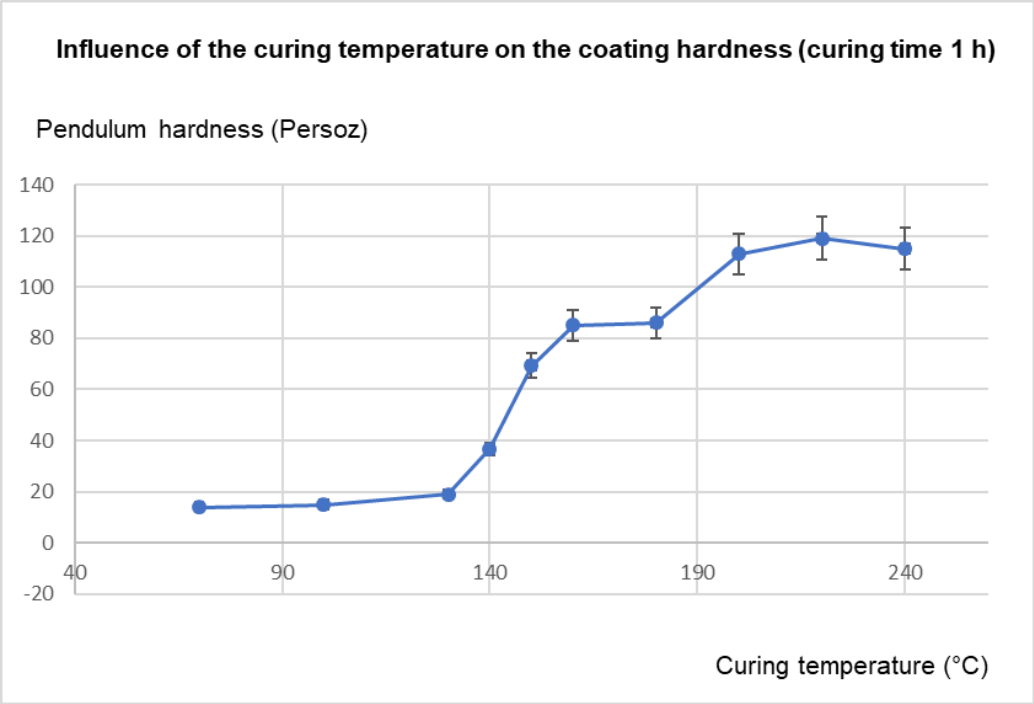


Cure at 230°C / 1 h



Samples were cured at 200°C for 1 h then exposed to high temperature (500°C, 2 h, on hot plate).

# IMPACT OF CURING CONDITIONS IN DOW MODEL PAINT (1)

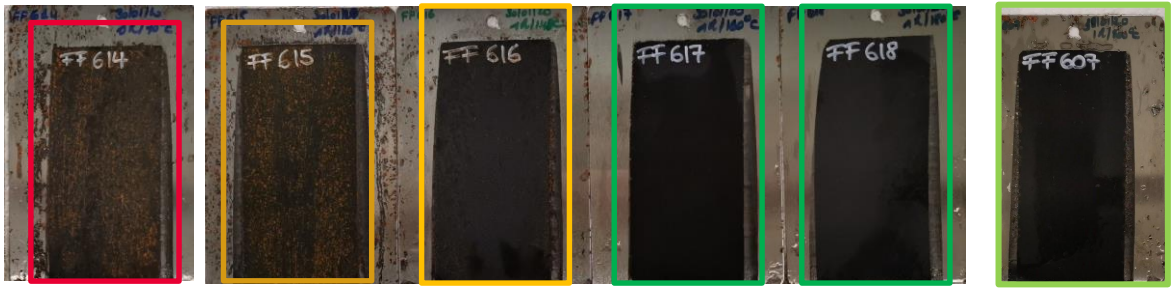
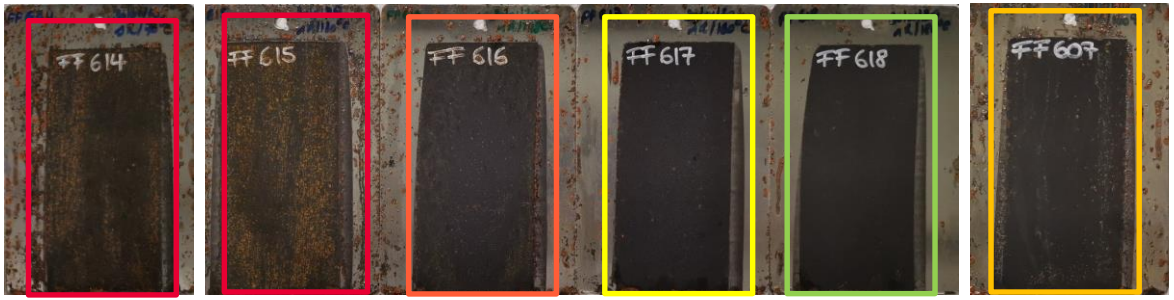



Curing recommendation = 200°C (1 h) or above to ensure maximum coating hardness

# IMPACT OF CURING CONDITIONS IN DOW MODEL PAINT (2)

Condensation test (40°C, 100% RH)

w/o corrosion inhibitor

| | 70°C* | 120°C* | 140°C* | 160°C* | 180°C* | 200°C* |
|---|---|---|---|---|---|---|
| T0 + 24 h |  | | | | | |
| T0 + 250 h |  | | | | | |



*: curing time = 1 h

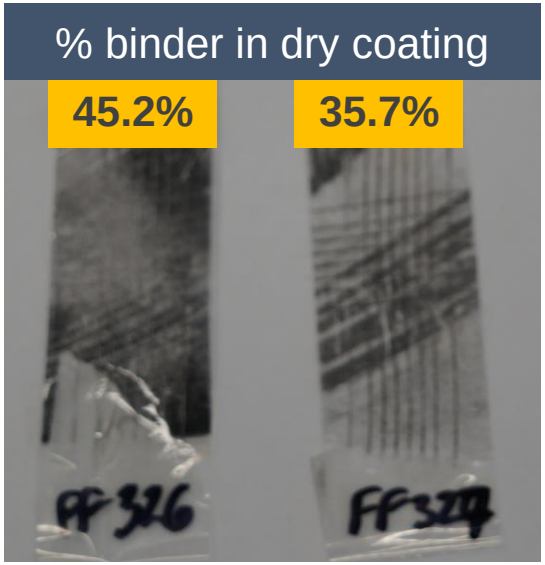
Curing recommendation = 180-200°C (1 h) to ensure sufficient resistance to water

# Impact of binder content in Dow model paint (1)

| % binder in dry coating | 45.2% | 35.7% | 26.4% |
|---|---|---|---|
| HT resistance - discoloration (ΔE) | 3.3 | 3.8 | 3.6 |
| HT resistance - adhesion | Good | V. good | V. good |
| HT resistance - chalking | No chalking | No chalking | Severe chalking |
| HT resistance - film cohesion | Severe cohesive failure | Low cohesive failure | Very low cohesive failure |

Samples were cured at 200°C for 1 h then exposed to high temperature (500°C, 2 h, on hot plate).

# IMPACT OF BINDER CONTENT IN DOW MODEL PAINT (2)




Samples were cured at 200°C for 1 h then exposed to high temperature (500°C, 2 h, on hot plate).

A suitable binder content is needed to ensure appropriate film cohesion

# Impact of binder content in Dow model paint (3)

w/o corrosion inhibitor

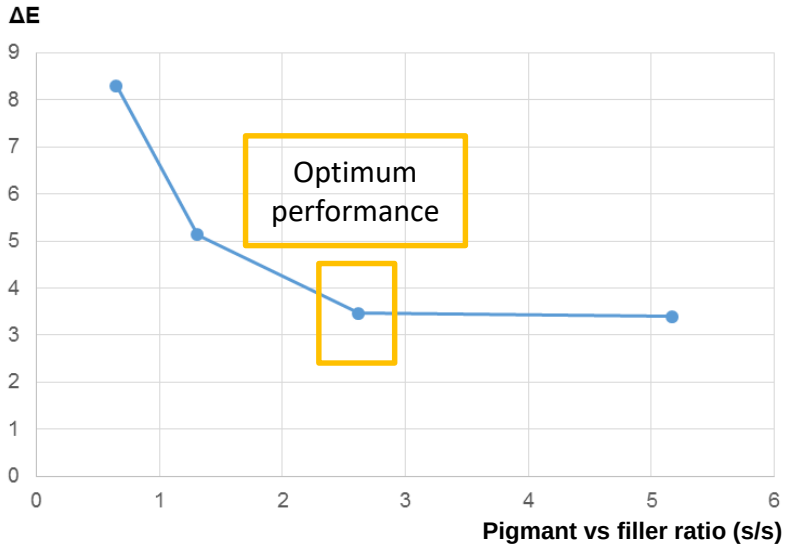
Condensation test (40°C, 100% RH)

| T0 + 24 h | | | T0 + 250 h | | |
|---|---|---|---|---|---|
| 45.2%* | 35.7%* | 26.4%* | 45.2%* | 35.7%* | 26.4%* |
|  |  |  |  |  |  |



A higher binder content leads to improved resistance to water

# IMPACT OF PIGMENT / FILLER RATIO IN DOW MODEL PAINT



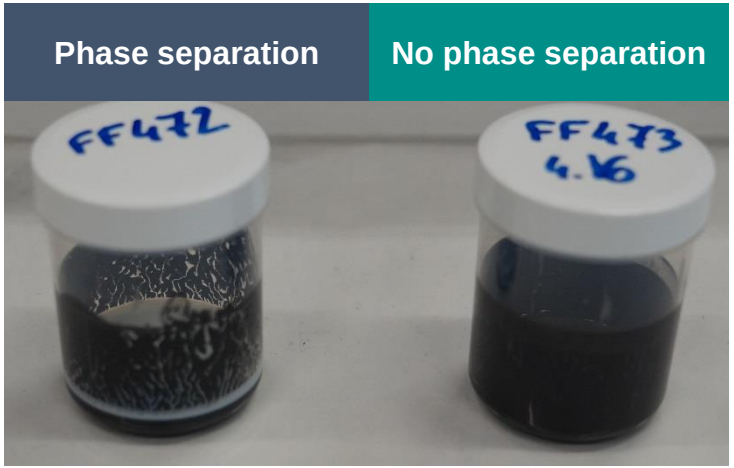

*: the filler is needed to ensure a proper adhesion on the substrate

Samples were cured at 200°C for 1 h then exposed to high temperature (500°C, 2 h, on hot plate).

A proper “pigment to filler” ratio is needed to achieve low film discoloration upon exposure to heat + sufficient adhesion on metal after exposure to heat

# IMPACT OF VISCOSITY IN DOW MODEL PAINT

w/o thickener

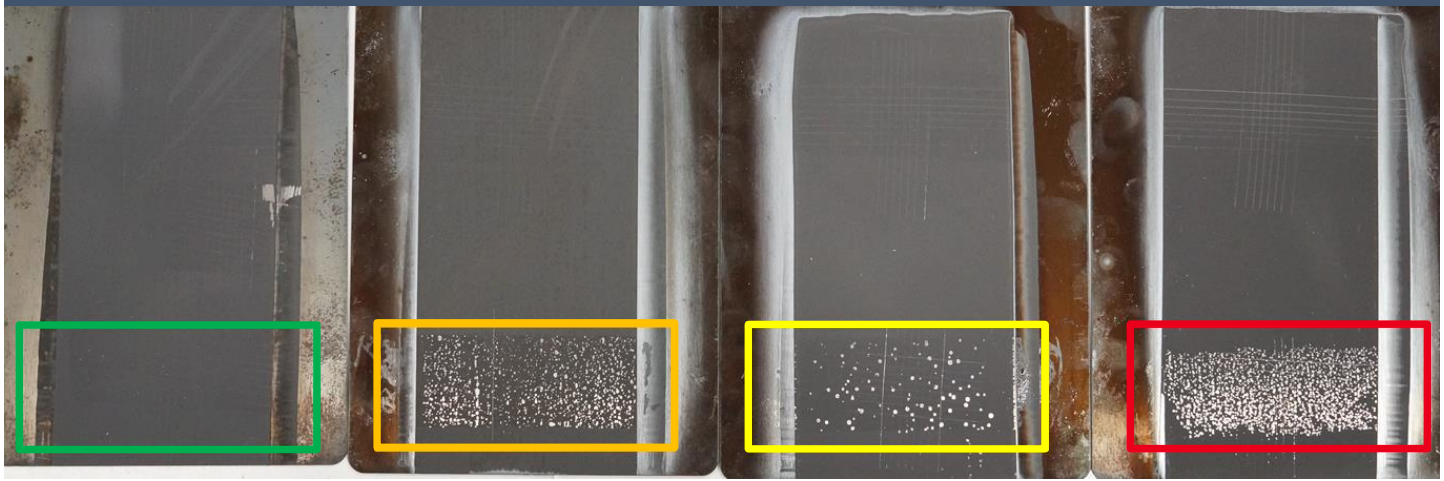



with thickener

After one week

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

# DOWSIL™ 8016 WATERBORNE RESIN VS BENCHMARKS

| | DOWSIL™ 8016 WB 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 |

Samples were cured at 200°C for 1 h then exposed to high temperature (500°C, 2 h, on hot plate).

# DOWSIL™ 8016 waterborne resin – conclusions

**DOW is launching a novel silicone resin emulsion for high temperature coatings which:**

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

**DOW wants to position itself as:**

- Preferred partner for the development of innovative and sustainable solutions
- Expert in coating formulation & technical support

**Literature and samples available upon request. Please contact our Technical Customer Service:**

the web 'Contact Us' form

**Please visit us on www.dow.com/coatings to discover new product launches & events!**

# We make coatings work better – two new product launches!

## DOWSIL™ 8016 Waterborne Resin

Novel low VOC silicone resin emulsion for high temperature resistant waterborne coatings

## DOWSIL™ 107F Additive

New generation foam control agent with improved compatibility & optimal performance for waterborne coatings

# Thank you & stay safe

# Q & A session


Seek

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