From the Sublime to the Ridiculous: Life in the Fast Coatings Lane

Vijay Datta MS and Dr. Mike ODonoghue, International Paint LLC

MARTS meeting 4th Oct , 2016

AkzoNobel

AkzoNobel

Sublime – Ridiculous Agenda

- Faster, Faster, Faster?
- Sublime to the Ridiculous
- Problems
- Solutions

International

AkzoNobel

Why Line Tanks?

Corrosion protection

- Crude oil tanks: bottom and ≈ 1 meter up the side
- Corrosive chemicals (e.g. aqueous): Whole tank

Protection of product purity

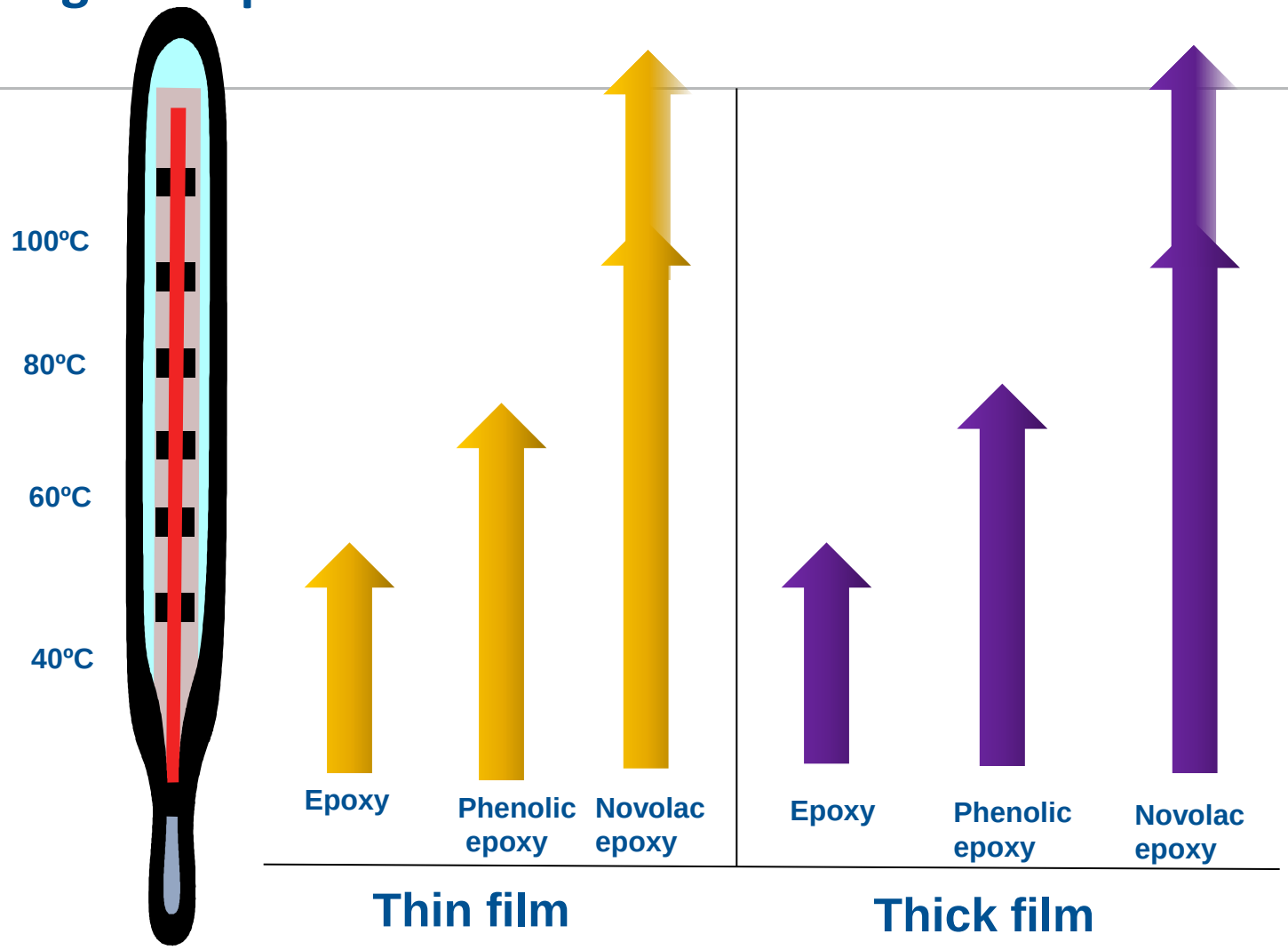
- Finished products: Line whole tank to prevent contamination with e.g. rust particles

Materials Integrity

- Some chemicals e.g. ethanol, may cause stress corrosion cracking of welds → line whole tank

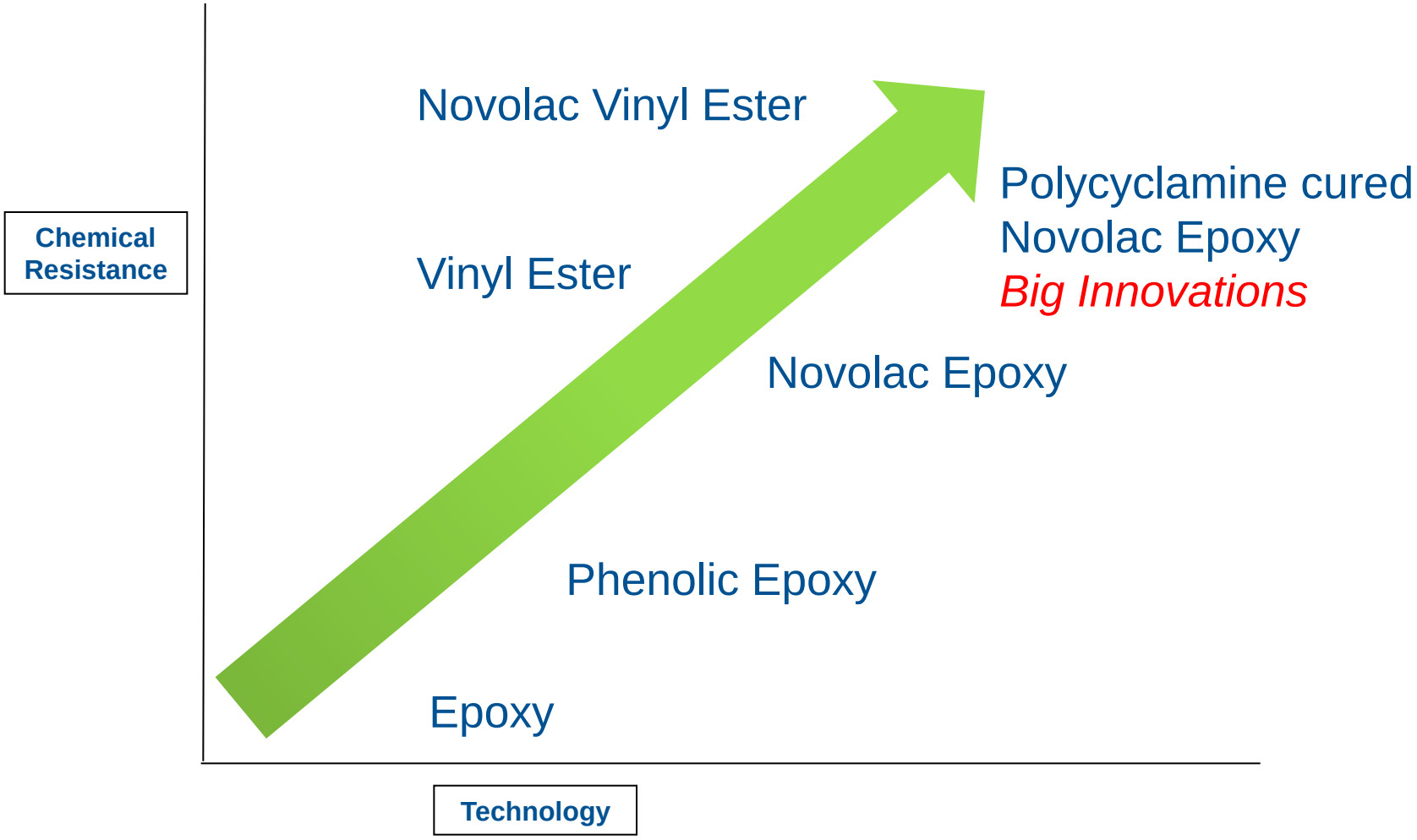
AkzoNobel

Cargo Storage Temperatures



AkzoNobel

Chemical Resistance - Lining History



AkzoNobel

Faster, Faster, Faster: Solvent-Free Epoxy Advantages

- Quick return to service
- Usually a one-coat lining system
- Can be applied at high film builds
- No risk of solvent entrapment
- No inter coat adhesion issues
- Can save a great deal of time and labour
- Excellent adhesion to prepared steel substrate

AkzoNobel

Sublime to Ridiculous - Solvent-Free Epoxy Advantages

- Minimal OH&S issues
- No worker exposure or solvent LEL concerns
- Seen as being environmentally friendly
- Edge Retention

AkzoNobel

Solvent-Free Epoxy Disadvantages

- Higher viscosities of one or both components
- Difficulty in mixing
- Shorter pot life
- More complicated equipment:
  - paint heaters
  - proportioning pumps
  - static mixers, etc.
- Not for use in vessels with complex geometry
- Lower chemical resistance

AkzoNobel

Murphy's Law of Fast Linings – En Route to The Ridiculous

"The more complicated the equipment and the shorter the pot life, the greater the chance that things will go wrong with Solvent-Free Epoxies in the field"

Mark Dromgool, KTA Tator Australia

AkzoNobel

Application Equipment: Plural Spray

AkzoNobel

Point to Ponder

A good rate of success of some facility owners with Solvent-Free Epoxy linings, does not always translate well to other regions, contractors or owners

Always be ready for any surprises in life...

AkzoNobel

Value of Stripe Coating and Possible Issues

- Very important for tank and vessel linings
- SFE materials are not very tolerant to stripe coating
- Film thickness control
- Too viscous to mix properly and apply correctly
- Elevating the temperature shortens the pot life
- Mix ratio errors are magnified

AkzoNobel

AHA – Perhaps Solvents are Really Good?

AkzoNobel

We all love solvents

AkzoNobel

Chemistry - Solvent

- The absence of solvent denies the coating of lubricity
- Solvent provides many advantages during the mixing, induction, application, reaction, drying and curing phases
- Solvents lower the surface tension of the coating which means better wetting of the substrate
- Slower gelling times often lead to higher wet and dry adhesion

Catalyzed Polymerization

- Coating cure is not simple and uniform as often depicted. Rather, it is nucleated and autocatalytic
- Like a crossword puzzle, having something makes it easier to fill-in

AkzoNobel

Solvent-Based Epoxy Features

- Easier to mix and have a longer and more usable pot life
- Can accept some site-added solvent to help make the coating system adjust for different climatic or substrate conditions and to suit the available application equipment
- Usually result in more uniform film build and less chances of overbuild
- Can achieve higher crosslink densities and more complete cure due to the lower viscosity, more lubricity and hence better molecular mobility of the reactive species
- Are much more easily handled by coating application contractors with a variety of skill levels

AkzoNobel

Solvent-Based Epoxy Features

- Have a slower gel time after application which aids flow into the surface profile and assists release of air from the film
- Quite tolerant of a variety of weather, substrate and other application conditions
- Multiple coats minimise the chances of concurrent pinholes or defects
- Have superior wetting due to the lower surface tension that the solvent brings to the resin binder
- Apply well as stripe coats without the compromises to their chemistry and integrity due to variations in the effective induction time

AkzoNobel

Solvent-Based Epoxy Disadvantages

- Relatively low volume solids
- Multiple coats usually required.
- Ventilation mandatory
- Hazardous solvents - an OSHA issue, etc.,
- Danger of solvent entrapment
- Longer cure times
- Poor productivity

AkzoNobel

Where Do We Go Now?

AkzoNobel

Shift to New Technology Solvent-Free Epoxy Technology

The Tour De Force Solutions

AkzoNobel

Next technology Solvent-Free Epoxy Lining

Solvent-Borne Epoxy

- Multiple coats (2-3)
- Longer cure time
- Low film build

Traditional: Solvent-Free Coating

- High viscosity
- Poor wetting
- Short pot life
- Plural Equipment

New Technology Solvent-Free Coating

+ Low Viscosity
+ Long Pot Life
+ Fast cure
+ *Single Coat*
+ Film build 15-35 mils
+ No Blushing
+ High Performance
+ High Heat resistance
+ Excellent wetting
+ *Single Leg Equipment*

…the Best of Solvent-Free and Solvent-Borne in 1 easy to use Lining

AkzoNobel

Balancing Act – Judicious Lining Selection

Next Generation lining Technology

Single Leg Airless or Plural Component spray applied

- ❖ No thinning required
- ❖ No heating required
- ❖ Pot life of 70 minutes @ 77˚F/25˚C

Single Coat application

- ❖ Typical 10-14 mils DFT
- ❖ Flexible Lining
- ❖ No Amine Blush

Services Excellent

- ❖ FDA Approved
- ❖ Benzyl Alcohol and BPA Free
- ❖ High Temp Crude Oil

Fast Cure

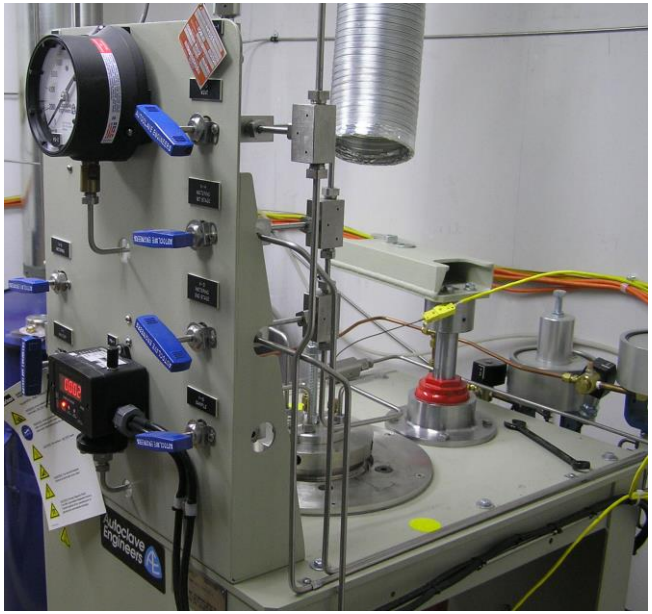
- ❖ Holiday test 5 hours @ 77˚F/25˚C
- ❖ Bake Schedule @150F is 2 hours

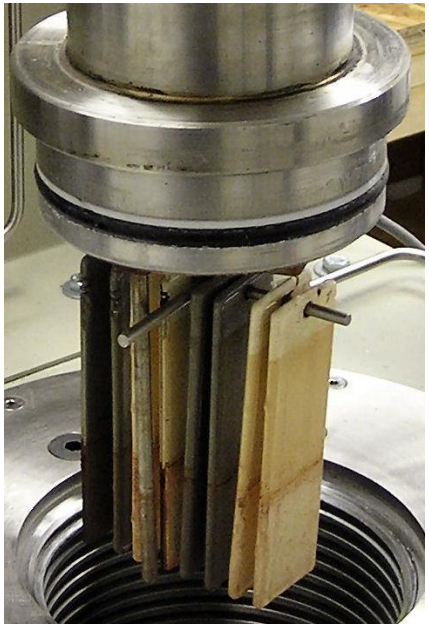
High solids, Ultra Low VOC

- ❖ 96% ±2% Volume solids
- ❖ 0.37lb / gal (45 g./Litre)

AkzoNobel

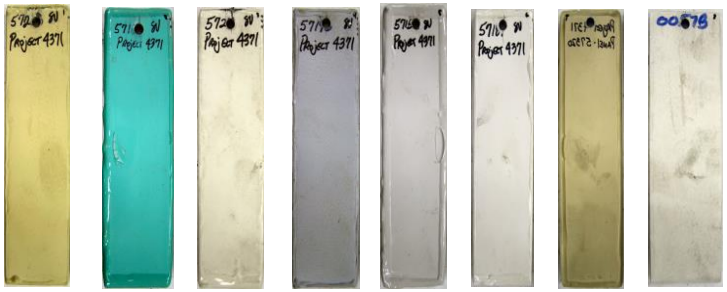
3RD Party Independent Laboratory Testing





300 ^{0}F

250 psi



AkzoNobel

Autoclave Test Results

Project Number:	0014-13-07 (Autoclave #1)	**Gas Phase :**	50% H_2S and 50% CO_2	**Date:**	Jan 13 – Feb 12 , 2014
Pressure at Normal Temp.:	145±15 psi @ 120±3°C	**Hydrocarbon Phase:**	Toluene Kerosene @ 1:1 by Volume	**Duration:**	30 Days
Pressure at Spike Temp:	210±15 psi @ 146±3°C	**Water Phase:**	75 ppm Cl^- in Water with pH of 3.5	**Tested by:**	J. Cortes, S. Rao

Coatings	Sample ID	Testing Phase	Pre-Test				Post-Test						
			Thickness (mils)	Adhesion*	EIS* Ohms·cm²	Colour	Thickness (mils)	Colour Change	Blisters	Cracks	Delamination	Adhesion	EIS Ohms·cm²
International Paint Enviroline® 2405	E - 1	Gas	24.1 – 24.8	A	1.06×10^{12} (Log Z: 12.02)	Near White	21.5 – 22.9	M	No	No	No	A	Not Rated
		Hydrocarbon	26.0 – 27.0				28.3 – 29.5	M	No	No	No	A	
		Water	24.7 – 26.1				29.6 – 35.9	N	No	No	No	A⁻	
	E - 2	Gas	20.4 – 20.9				20.1 – 20.6	M	No	No	No	Not Rated	2.70×10^{9} (Log Z: 9.43)
		Hydrocarbon	20.6 – 22.2				22.9 – 24.8	M	No	No	No		5.23×10^{9} (Log Z: 9.72)
		Water	23.0 – 23.5				26.6 – 31.3	N	No	No	No		1.13×10^{6} (Log Z: 6.05)

*Pre-test adhesion and EIS was conducted on the un-tested reference panels.

Note: After test, the pH of the water solution was about 6.0.

Rating Key:

Blistering: Rated as per ASTM D714				
Size				**Density**
				Few (F)
#2	#4	#6	#8	Medium (M)
Large <---> Small				Medium-Dense (MD)
				Dense (D)

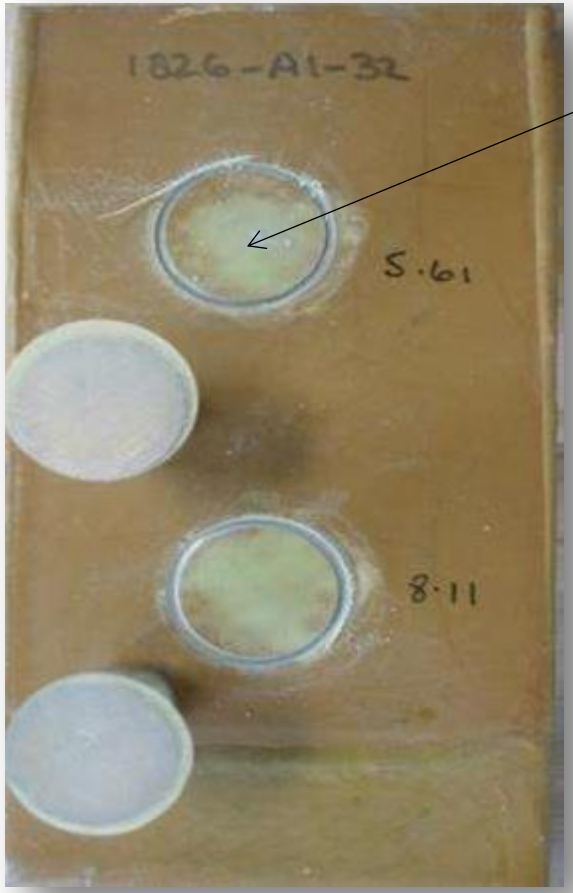
Adhesion: Rated as per parallel scribe
A - Coating may shear within itself but does not release from substrate
B - Some metal is visible but more than 50% of the coating remains adhered
C - More than 50% of the coating is removed
D - All coating releases between scribes but remains firmly adhered adjacent to cuts
F - No bond exits between coating and substrate

Colour Change
None(N)
Slight(S)
Moderate(M)
Severe(SE)

Laboratory Testing
Deionized Water Immersion for 12 Months @ 212F/100C

Pre Test Adhesion:
1522 psi/10.5 MPa

.



Post Test Adhesion:
1261 psi/8.7 MPa

Laboratory Immersion Testing
High Temperature Crude Oil for 6 Months

AkzoNobel

Crude Oil Phase

Water Phase

Established Product Comparison

RESULTS:
Performed as a liner for crude oil and water. Absolutely no corrosion.

Crude + 3% NaCl @ 203ºF/95ºC

Crude + 3% NaCl @ 203ºF/95ºC

AkzoNobel

Chemical Resistance

Test Type	Test Method	Specification Details	Typical Results
Immersion	ISO 2812 Part 2 – "Resistance to Corn Syrup @ 80C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to Molasses @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to Vegetable Oil @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to Lard @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to PP and HDPE Plastic Pellets @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to Dry Flour, Sugar, Starch @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to 5% Beers @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.
Immersion	ISO 2812 Part 2 – "Resistance to 5% Vodka @ 60C"	1×300µm/500µm dft applied directly to $Sa2^1/_2$ blasted steel.	No film defects following 3 months exposure.

Easy Maintenance Use – Complex Geometry

AkzoNobel

Applicators Comments: “One of the easiest 100% solids material I have sprayed, it has a great pot life for brushing out the welds and hard to coat areas.”

The End