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Responsible Chemistry

Futureproofing waterborne epoxies with AQUAREOUS™ epoxy systems for ultra-low VOC formulations

Henning Vogt, Hexion Germany GmbH

SCLFC V-Gat 22-01, 2nd February 2022

VOCs play a significant role in the formation of smog

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Hexion has a responsibility to use chemistry in a way that make this world better, safer and cleaner

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Can we take waterborne epoxies all the way?

Why do we normally need solvents?

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Solvent-borne epoxy systems = high VOC (>450 g/l)

Solid Epoxy Resin (SER)

EPIKOTE™ 1001-X-75

Improved performance compared to liquid resins (LER)

+

High viscous polyamide

EPIKURE™ 3115-X-70

Dissolved in organic solvent

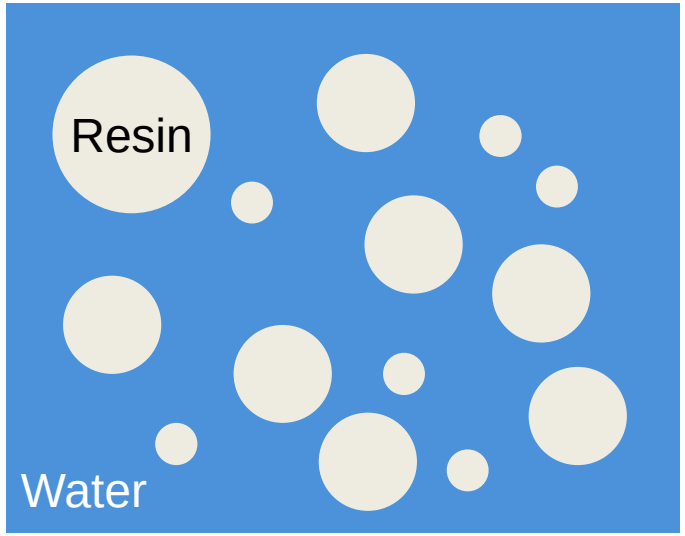
▶

Good coatings performance

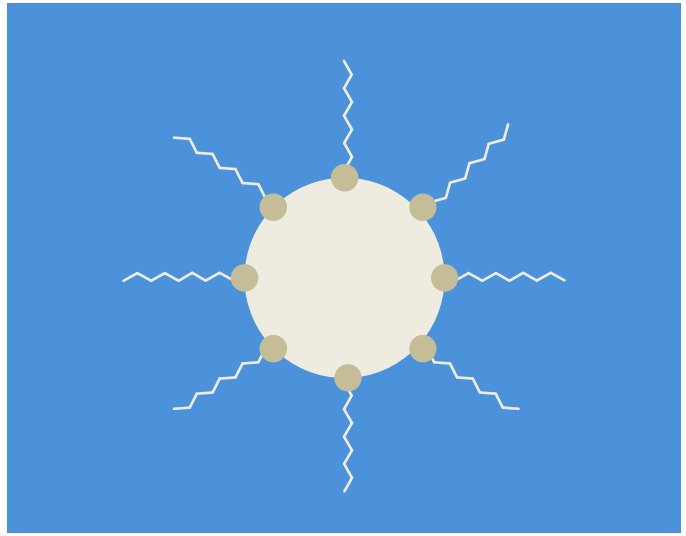
- Crosslinking
- Adhesion
- Flexibility
- Corrosion, humidity, chemical resistance
- Drying

Replace organic solvents with water

Waterborne dispersion technology for lower VOC



Waterborne
resin dispersion



Surfactant

But most waterborne systems still contain cosolvent

Completely eliminating cosolvents from waterbornes is difficult

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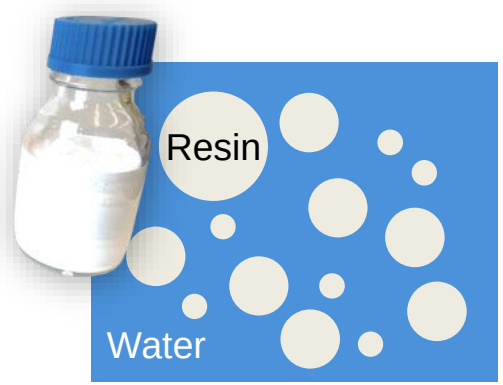
Our challenge: High stability and performance without cosolvent

Process



Dispersion

Paint application

Process aid
- Particle size
- Viscosity
- Cost (reactor cycle time)

Stabilizer
- Shelf life
- Surface skinning
- Temperature/
- Freeze-thaw stability

Drying Aid
- Avoid mud-cracking
- Dry-through
- Open time
- Drying time

Film Former
- Flow
- Wetting
- Coalescence
- Surface quality

Can we go all the way?

Achieve NewGen™ System performance at even lower VOC

Application and performance properties in formulated paints

Epoxy dispersion	Standard WB SER	NewGen™ WB
Example	ER3523-WH-53	ER6520-WH-53
Curing agent	Amine solution (e.g. EK8545-W-52)	Amine dispersion (e.g. EK6870-W-53)
Cosolvent in resin (%)	8-10	< 5
VOC formulated (g/l)	100-200	50-100
Drying	Good	Fast
Corrosion protection	Good	High
Wet adhesion	Good	High

Gardobond™ OC*

300 h salt spray

300 h cont. cond.

ER6520-WH-53 / EK6870-W-53

* Supplied by Chemetall GmbH

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Introducing:
EPI-REZ™ Resin 7723-W-53
AQUAREOUS™ Epoxy Dispersion

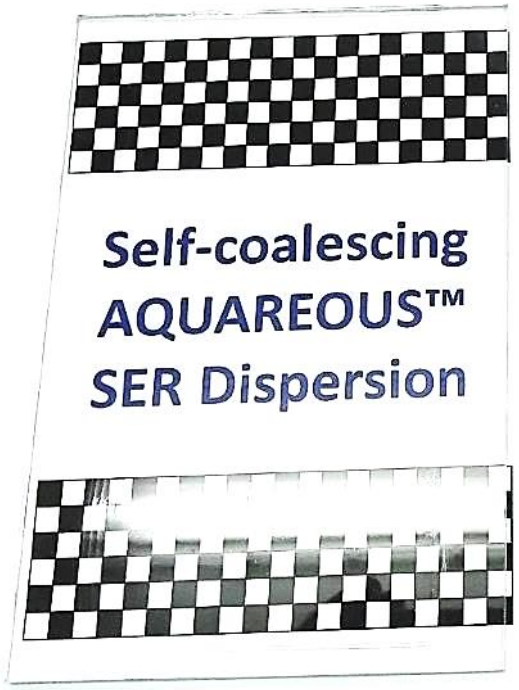
Preserve and protect with cosolvent free AQUAREOUS™ technology

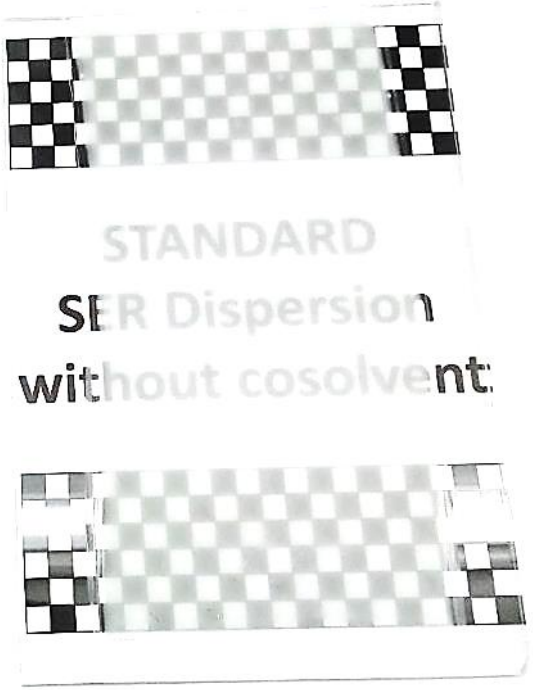
Self-coalescing solid epoxy dispersion

Good film formation without cosolvent

EPI-REZ 7723-W-53

Self-coalescing resin
Good film formation





Non-optimized
SER dispersion
without cosolvent

Poor coalescence
Poor film formation

Neat SER dispersions, no cosolvent, draw-down on glass, 150 µm WFT, dried 2 h at 23°C

Now you can develop paint without cosolvent

Taking waterborne epoxies all the way

AQUAREOUS™ epoxy =
Zero cosolvent in binder +
Zero cosolvent needed in formulation

Standard Waterborne

NewGen Waterborne

Solvent-free AQUAREOUS™ Resin

Preserve and protect with cosolvent free AQUAREOUS™ technology

HEXION™
Responsible Chemistry

Environment, Health & Safety

Versatile protection

Productivity

High performance

Cost benefits

Non-hazardous product

Good EH&S profile

No classification according to CLP/GHS

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Not classified.

See Section 16 for the full text of the H statements declared above.

2.2 Label elements

Signal word	:	No signal word.
Hazard statements	:	No known significant effects or critical hazards.

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II, as amended by Regulation (EU) No. 2015/830

SAFETY DATA SHEET

FOR INDUSTRIAL USE ONLY

EPI-REZ™ Resin 7723-W-53

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Product name	:	EPI-REZ™ Resin 7723-W-53
SDS Number	:	300000020733
Product type	:	Epoxy Resin

1.2 Relevant identified uses of the substance or mixture and uses advised against

Product use	Epoxy Resin Systems

1.3 Details of the supplier of the safety data sheet

Manufacturer/Supplier/Importer	:	Hexion B.V. Seattleweg 17 3195 ND Pernis - Rotterdam The Netherlands
Contact person	:	service@hexion.com
Telephone	:	General information +31 (0)10 295 4000

1.4 Emergency telephone number

Supplier	:	CARECHEM24
Telephone number	:	+44 (0) 1235 239 670

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Not classified.

See Section 16 for the full text of the H statements declared above.

2.2 Label elements

Signal word	:	No signal word.
Hazard statements	:	No known significant effects or critical hazards.

EPI-REZ™ Resin 7723-W-53

Emission tests by eco-INSTITUT

AQUAREOUS™ systems meet most common EU standards

Three AQUAREOUS™ System tested:
EPI-REZ 7723-W-53 + EPIKURE 6870-W-53/
EPIKURE 8545-W-52/ EPIKURE 8546-W-55

AgBB	French VO (A+)	Belgian VO	Emission Class M1	GEV Emicode (Classified EC 1 Plus)
✓	✓	✓	✓	✓

Preserve and protect with cosolvent free AQUAREOUS™ technology

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Environment, Health & Safety

Versatile protection

Productivity

High performance

Cost benefits

Protective metal coatings

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Substrate types

- Rough and smooth steel
- Non-ferrous

Benefits

- High corrosion protection
- Fast return to service

Concrete primers and sealers

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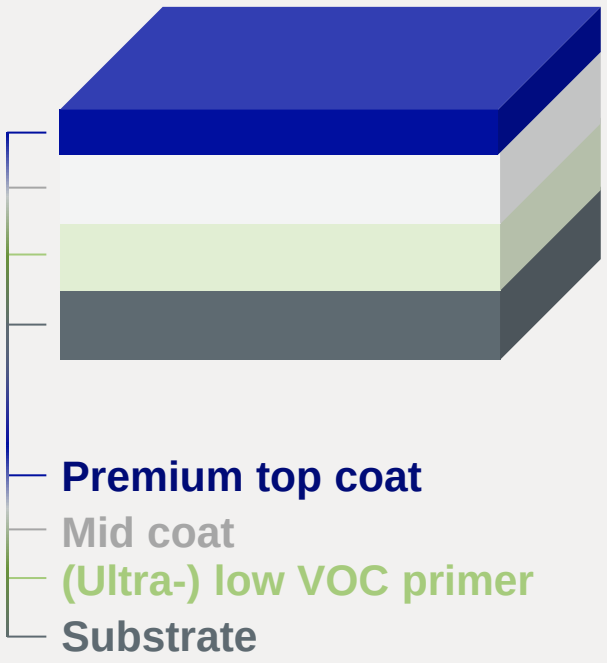
Benefits

- Excellent adhesion
- Fast walk-on time

Your choice

Freedom for formulators and paint makers



Reduce VOC of overall coating system

- Meet most stringent VOC regulations
- Create capacity where solvent is limiting

Save the cosolvent for where it matters

- No need to waste it on primers
- Make the best of your top coats instead

Take the cosolvent you need

- Choose type and level yourself
- Tune your coating properties
- Match your customers' preferences

Preserve and protect with cosolvent free AQUAREOUS™ technology

HEXION™
Responsible Chemistry

Environment, Health & Safety

Versatile protection

Productivity

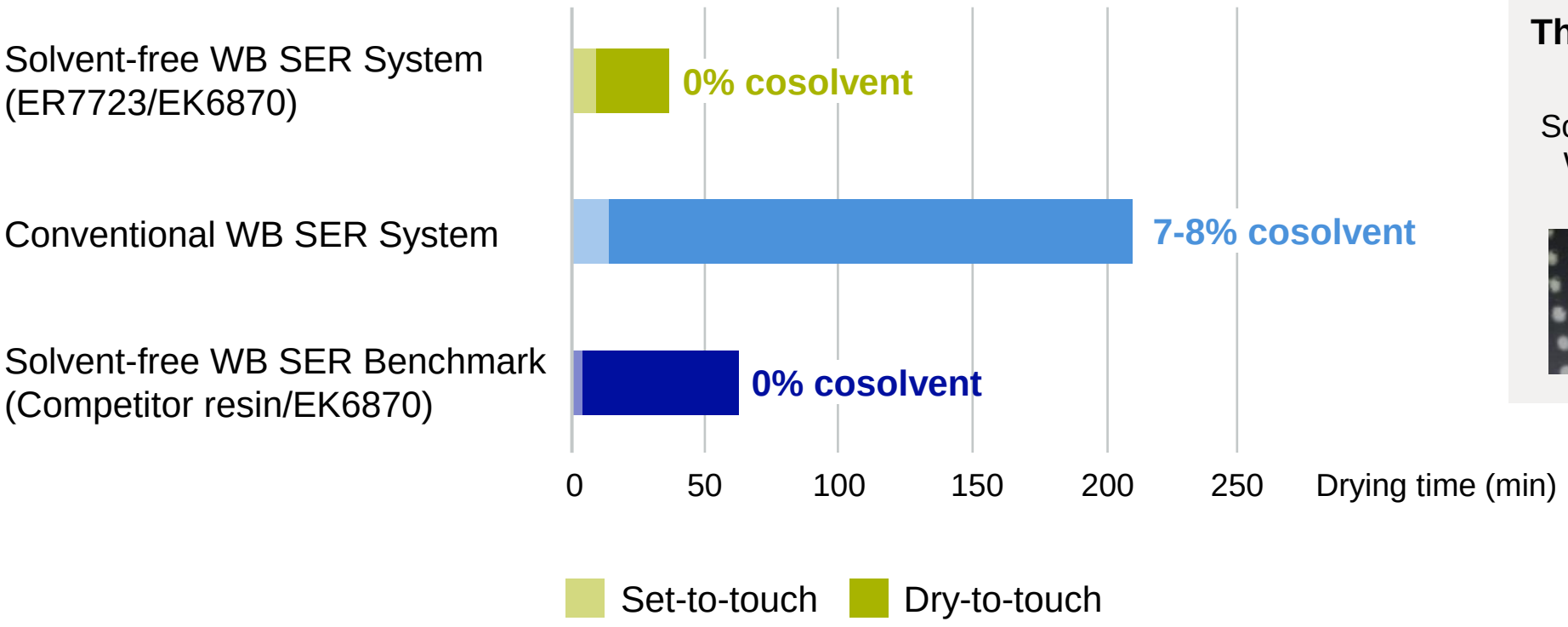
High performance

Cost benefits

Shorter drying time

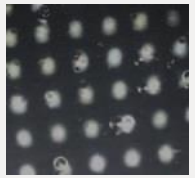
Faster return to service

Compared to existing waterborne coatings grades



Thumb test after 35 min

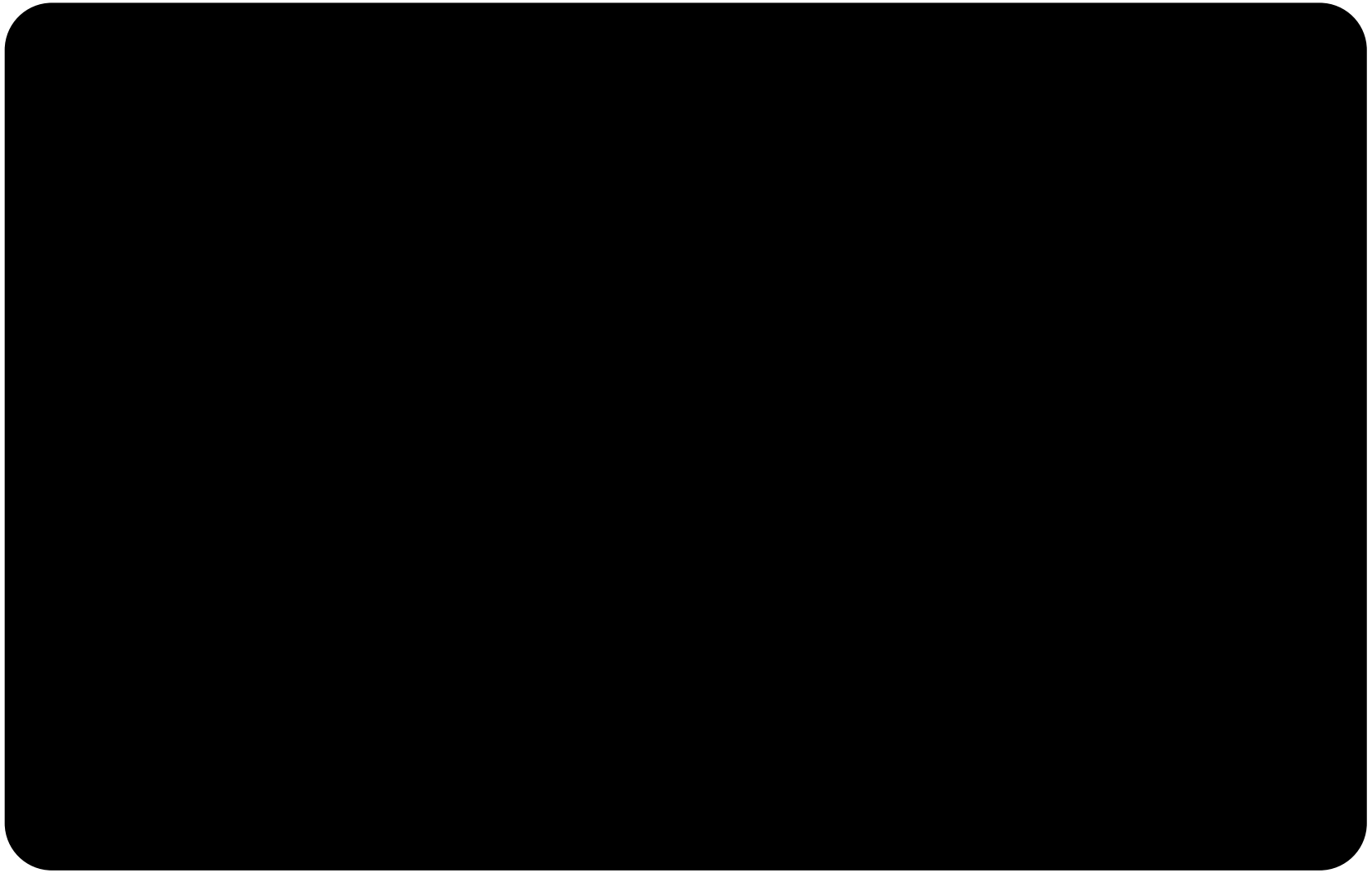
Solvent-free WB SER System



Conventional WB SER System

Shorter drying time

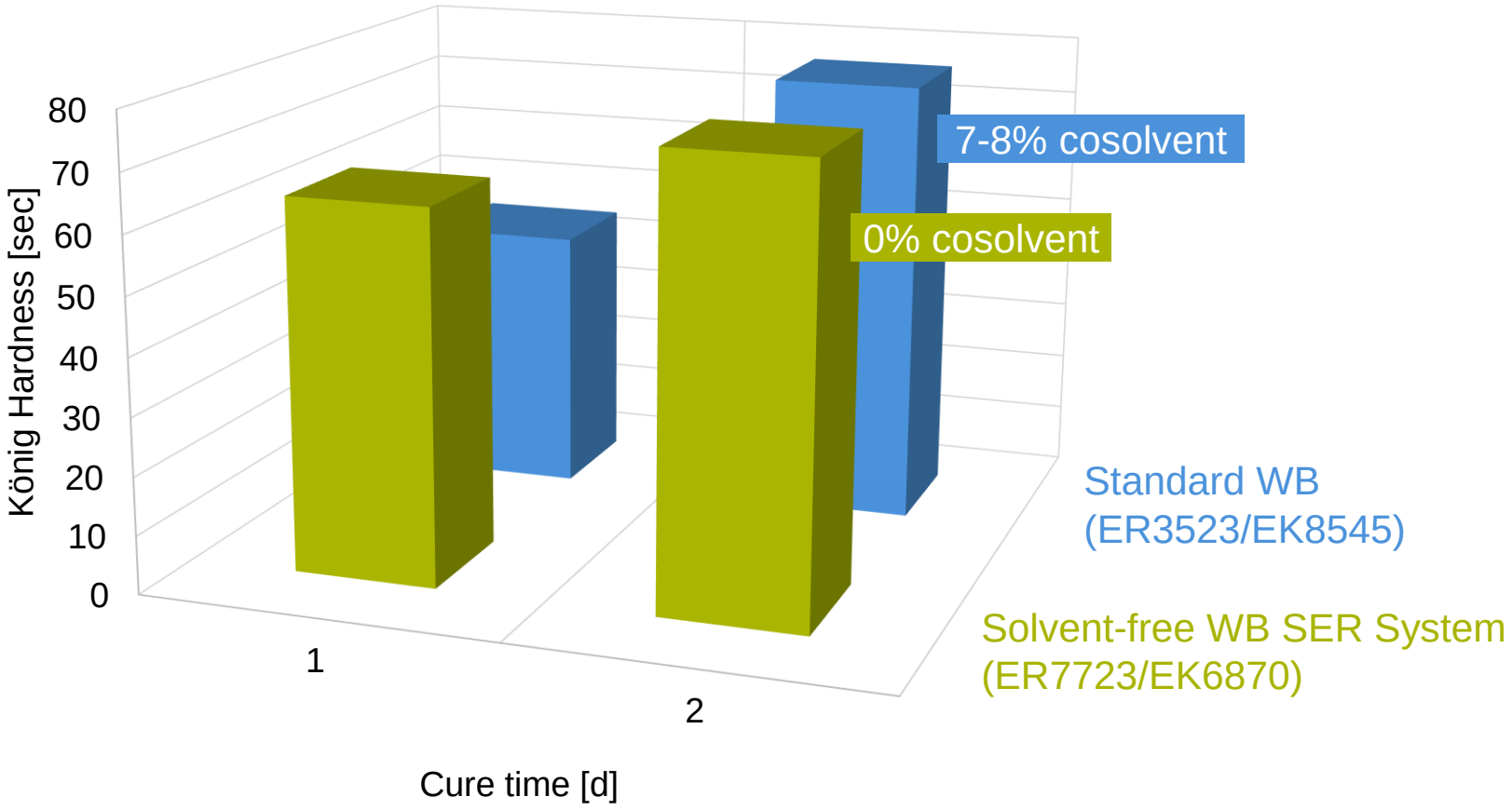
Faster return to service



Rapid hardness development

Faster return to service

Compared to conventional waterborne coatings system

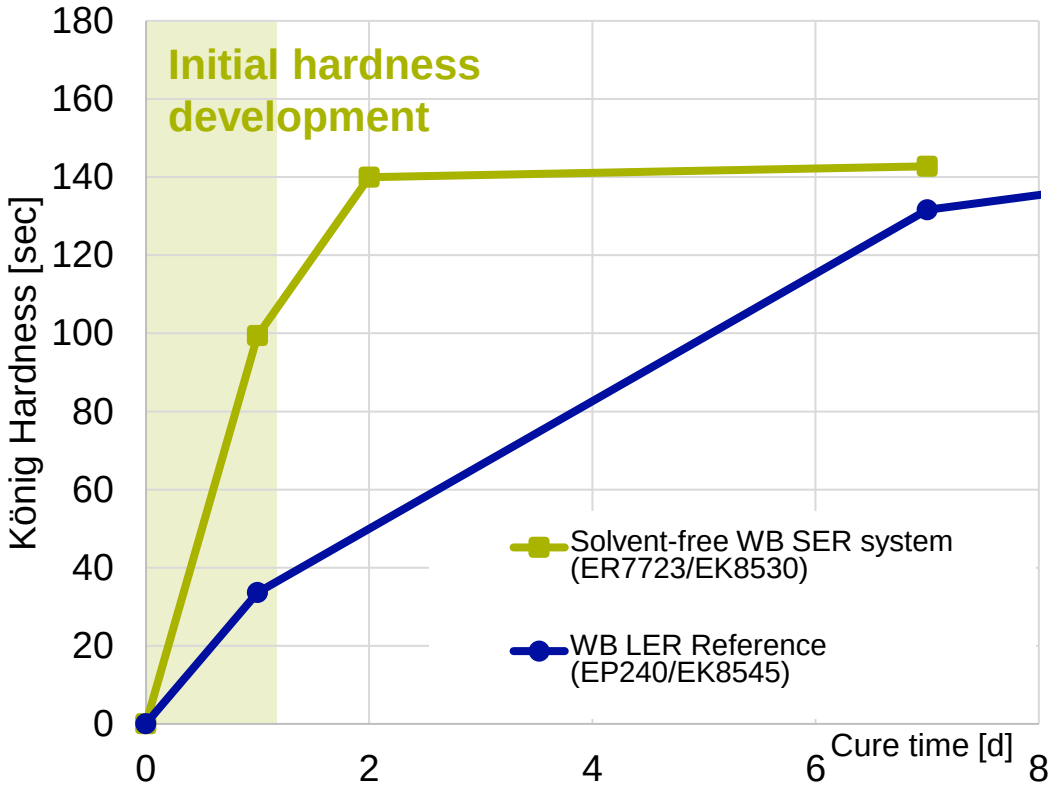


Clear coats, both systems applied at 50% solids content, 150 µm WFT on glass.

Faster initial hardness development

Faster walk-on time in concrete applications

Compared to standard waterborne LER system for concrete



EPIKURE 8530-W-75

- Low HEW, highly crosslinking curing agent
- Designed for waterborne SER systems

Solvent-free SER system reaches final hardness after 2 days

- More than 1 week with WB LER system

Preserve and protect with cosolvent free AQUAREOUS™ technology

HEXION™
Responsible Chemistry

Environment, Health & Safety

Versatile protection

Productivity

High performance

Cost benefits

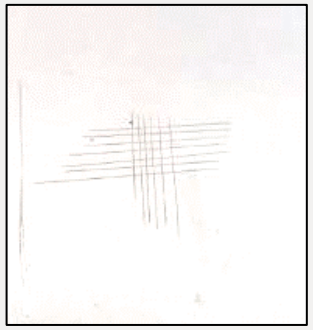
Solvent-free protective coatings

Excellent corrosion resistance without cosolvent

White primer formulation on smooth steel, based on EPI-REZ 7723-W-53 / EPIKURE 6870-W-53

Smooth QD,
500 h salt spray

70 µm



1000 h
cont. cond.

63 µm

Ingredients Part A	Weight, g
EPI-REZ 7723-W-53	326.01
Cosolvent	**0.00**
VOC-free plasticizer Defoamer Dispersant Water	27.94 2.42 16.95 72.93
Titanium dioxide Treated wollastonite Barium sulfate Anticorrosion pigment Mica	92.03 90.35 61.57 85.69 6.61
EPI-REZ 7723-W-53	67.62
Epoxy silane oligomer Defoamer	5.12 3.73
Ingredients Part B	
EPIKURE 6870-W-53	138.22
Corrosion inhibitor	2.79
Total A+B	1000

- Contains alcohol-releasing silane as adhesion promoter, VOC ~ 3 g/l

Epoxy : Amine = 1 : 0.7, PVC = 27.7%, VOC ≈ 3 g/l (from silane adhesion promoter)

No cosolvent needed for high performance

Self-coalescing AQUAREOUS™ resin works equally well without

White primer formulation on smooth steel (non-optimized), based on EPI-REZ 7723-W-53 / EPIKURE 6870-W-53

With cosolvent, **VOC ≈ 100 g/l**	With cosolvent, **VOC ≈ 50 g/l**	No cosolvent, **VOC ≈ 3 g/l**
		
52 µm	53 µm	48 µm

Cosolvent in paint

Equal performance

- Cosolvent: phenoxypropanol, post-added to formulation 1 day prior to spraying
- Virtually no difference between different cosolvent contents / VOC levels

Tested on Gardobond OC after 500 h salt spray

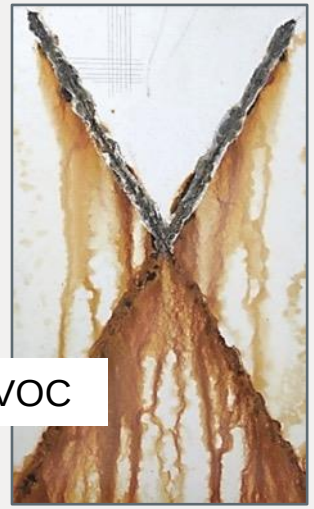
Benchmark Comparison

High performance with solvent-free primer based on EPI-REZ 7723-W-53

Comparison to high performance benchmark with cosolvent and solvent-free competitor

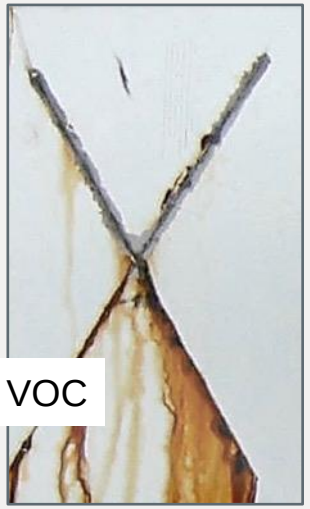
NewGen™ waterborne epoxy system
Gardobond OC, 500 hours salt spray

48 µm
~3 g/l VOC



AQUAREOUS™ System
ER7723 / EK6870

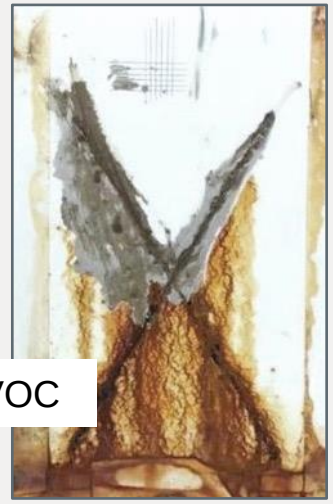
67 µm
~110 g/l VOC



Reference: NewGen™
ER6520 / EK6870

Solvent-free waterborne benchmark
Gardobond OC, 500 hours salt spray

64 µm
~3 g/l VOC



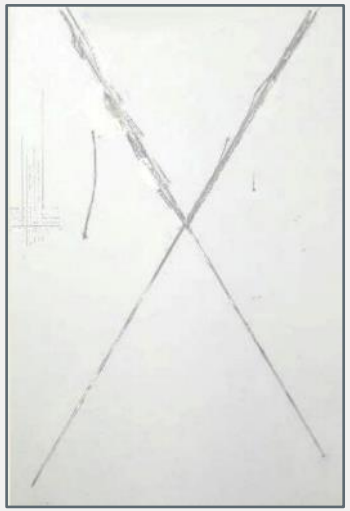
Solvent-free WB competitor
Resin & Curing agent

Solvent-free primer on aluminium

Excellent adhesion, no blisters

White primer formulation with EPI-REZ 7723-W-53 / EPIKURE 6870-W-53

AL 46,
500 h salt spray



50 µm

AL 46,
1000 h continuous condensation

43 µm

- Standard starting formulation, not optimized for aluminium
- Contains epoxy silane oligomer as adhesion promoter (VOC ≈ 3 g/l)

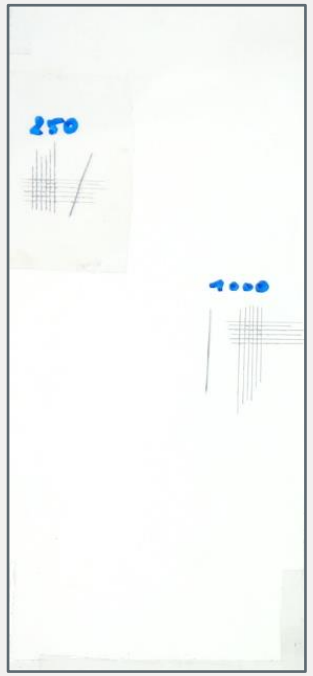
Ultra-low VOC primer

Excellent corrosion resistance on rough steel

Silane-free primer formulation for grit-blasted steel SA2.5, based on EPI-REZ 7723-W-53 / EPIKURE 6870-W-53

1000 h
salt spray

57 µm



1000 h cont.
condensation

61 µm

- No cosolvent, no alcohol-releasing adhesion promoter

Ingredients Part A	Weight, g
EPI-REZ 7723-W-53	327.28
Cosolvent	**0.00**
Defoamer Dispersant	2.58 19.09
Mica Titanium dioxide Treated wollastonite Anticorrosion pigment Barium sulfate	7.02 97.78 96.01 91.06 65.47
EPI-REZ 7723-W-53	82.27
Defoamer Water	3.97 45.35
Ingredients Part B	
EPIKURE 6870-W-53	161.22
Corrosion inhibitor	0.90
Total A+B	1000

Epoxy : Amine-H = 1 : 0.8, PVC = 27.70%, VOC ≈ 0 g/L

High performance on concrete

Excellent adhesive tensile strength with AQUAREOUS™ system

Pull-off test after 24h

AQUAREOUS™ SER system

EPI-REZ 7723-W-53 / EPIKURE 8545-W-52

Waterborne LER reference

EPIKOTE 240 / EPIKURE 8545-W-52

Applied at 440 g/m^2 on concrete C 40/50 (worst case scenario)

Preserve and protect with cosolvent free AQUAREOUS™ technology

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- Environment, Health & Safety
- Versatile protection
- Productivity
- High performance
- **Cost benefits**

Removing cosolvents can save costs

Cosolvents are cost-drivers

Hidden costs from cosolvents

Safety
- Insurance
- Equipment
- Training

Legislation
- VOC taxes
- Permits

Waste
- Removal
- Recycling

Capacity
- Solvent restrictions
- Ventilation systems
- Air recovery

AQUAREOUS™ Dispersion EPI-REZ™ 7723-W-53

Taking waterborne epoxies all the way

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Environment, Health & Safety compliance

- No cosolvent
- Non-hazardous product
- Minimum emissions

Versatile protection

- Metal protection
- Concrete primers
- Formulation freedom

Productivity benefits

- Fast drying times
- Fast hardness development
- Fast return to service

High performance

- High corrosion protection
- Good adhesion to concrete

Cost benefits

- Save solvent-associated costs

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Responsible Chemistry

For technical information and samples, please contact the Hexion Service Team:

service@hexion.com

18 WATER-BORNE COATINGS TECHNICAL PAPER

HIGH PROTECTION WITHOUT COSOLVENT

Novel water-borne epoxies for ultra-low VOC formulations. By Henning Vogl, Hexion GmbH, Germany.

Environmental pressures are driving a change from water-borne epoxy systems using cosolvents to systems that comply with strict VOC reduction targets. Water-borne systems without co-solvents often face drying and film-forming challenges. However, a novel epoxy resin dispersion seeks to address market needs and offer formulators high performance.

The need to reduce volatile organic compounds (VOC) is undoubtedly the main driver for the growth of water-borne epoxy coatings. As these conventional, water-borne epoxy technologies are becoming standard practice around the world and allow formulated paints to meet today's stringent VOC regulations, there is a developing global trend to further reduce, or even completely eliminate VOC content in water-borne coatings. While in past decades the European market had been the main driver for VOC reduction [1, 2], the Chinese market is now taking a lead role, targeting a reduction of VOC emission by at least 10 % (and up to 30 %) in 2020 vs. 2015 [3], as a direct reaction to the extreme inner-city air pollution and associated health impact.

Consequently, the next level of innovation is to completely remove VOC content from epoxy binders as well as the final formulated paints, and thus take the term "water-borne" to its true meaning. The ultimate challenge for a resin manufacturer is not only to supply material with low or zero cosolvent content, but also offering a resin dispersion with

Figure 1: a) Self-coalescing cosolvent-free water-borne SER dispersion. b) Standard WB SER dispersion without cosolvent.

EUROPEAN COATINGS JOURNAL 11 – 2019

AQUAREOUS™ Dispersion EPI-REZ™ 7723-W-53
https://www.hexion.com/en-GB/aquareous

European Coatings Journal, 11-2019, 18-23
Farbe und Lack, 09-2020, 44-49 (German version)

EPI-REZ™ Resin 7723-W-53 AQUAREOUS™ Epoxy Dispersion

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Preserve and protect with cosolvent free AQUAREOUS™ technology

Property	Unit	Value
Epoxy Group Content / Solids base	mmol/kg	1865 - 2165
Brookfield viscosity at 25°C	mPa·s	300 - 5000
Solids content	% m/m	52.0 - 55.0
Particle Size dv mean	µm	1.0 max

EPI-REZ™ Resin 7723-W-53