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Your **hosts** for this call

Dispersing agents for water-based DTM Coatings

Lars Hoffmann
Manfred Jorna
Presenter

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Kerstin Schurig
Chat

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Technical Sales
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Manfred Jorna

Technical Sales
Formulation Additives
EMEA region

Dispersing agents for water-based DTM Coatings

Formulation Additives improving corrosion resistance properties

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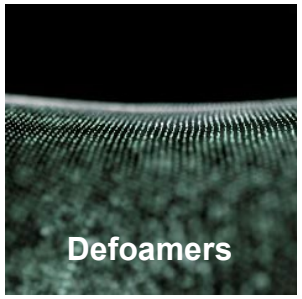
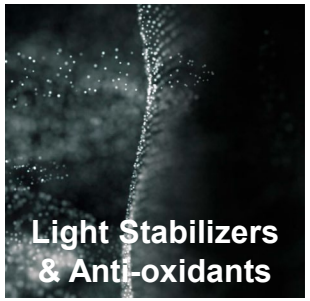
Agenda

1. Introduction
2. Corrosion protection: requirements and challenges
3. Case studies: Impact of dispersing agents
4. Summary

Our comprehensive portfolio enables solutions for various industries





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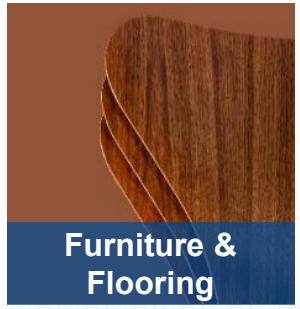
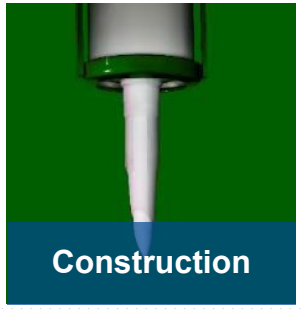
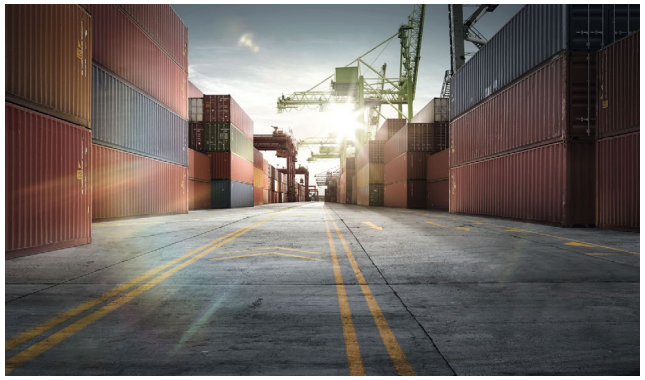




The use of coatings for corrosion protection



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Ecological and social-economical aspects are key drivers to fulfill environmental regulations

- Tin-free
- APEO-free
- Biocide free
- Solvent free or Low VOC
- Economical benefit: one layer only
- Improved durability (weathering and chemical resistance)

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Water based systems progressively used to fulfill environmental aspects ...

- VOC regulation
- Aquatic toxicity / water hazard class
- Occupational safety and health

…but for specific applications there is still a gap in performance.

- Longer drying time
- Storage stability (need for preservatives)
- Smaller application windows (sensitivity high / low temperature and humidity)
- Lower application robustness

BASF supports customers to develop environment friendly systems for anti corrosion and DTM systems

- Formulation additives for water based products:
  - Dispersing agents with low impact on corrosion resistance
  - Defoamers to prevent micro foam
  - Rheology modifiers to provide sag resistance for high film build
  - Wetting and Surface modifiers desire substrate wetting for improved adhesion
  - Film forming agents / coalescing agents to facilitate uniform film formation and early water resistance

- Dispersions e.g. Joncryl® PRO 1522, Acronal® PRO 770 X

Corrosion classification according to DIN EN ISO 12944

Paint systems for carbon steel

Corrosivity category	Durability ranges	ISO 6270-1 (water condensation) [h]	ISO 9227 (neutral salt spray) [h]	Total No. of coats	Layer thickness NDFT [µm]	Typical environment
C1		-	-			**Interior**
C2	Low	48	-	1-2	80	
	Medium	48	-	1-2	80	
	High	120	-	1-2	60-160	
	Very High	240	480	1-2	160-200	
C3	Low	48	120	1-2	100	
	Medium	120	240	1-2	60-160	
	High	240	480	2	160-200	
	Very High	480	720	2-4	200-260	**Interior / Exterior**
C4	Low	120	240	1-2	60-160	
	Medium	240	480	2-3	180-200	
	High	480	720	2-4	200-260	
	Very High	720	1440	2-4	260-300	
C5	Low	240	480	2	180	
	Medium	480	720	2-3	200-240	
	High	720	1440	2-4	260-300	
	Very High	-	-	3-4	320-360	

Reasons to use dispersing agents in waterbased paints and coatings

- Improved color strength
- Improved color acceptance
- Improved storage stability
  - Constant rheology
  - No settling / sedimentation
- Low mill base viscosity / high pigment load
- Newtonian rheology behavior
- Increased gloss

- On top on this: A dispersing agent should not influence the final film properties, e.g. corrosion resistance, salt spray test.

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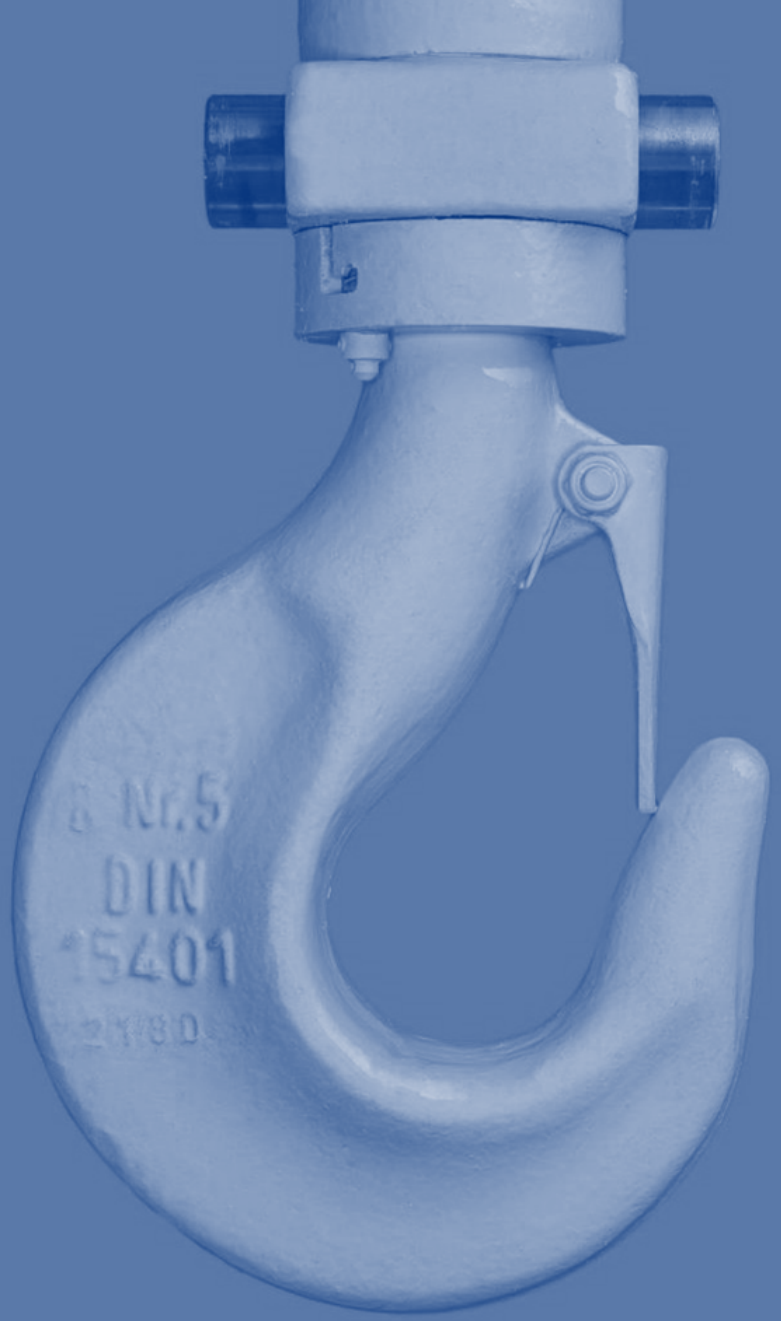

Case study 1:

Impact of dispersing agents on corrosion in a test system based on Joncryl® PRO 1522

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Dispex® Ultra PX 4575

HMW dispersing agent based on Controlled Free Radical Polymerization Technology (CFRP)

Application:

Dispex® Ultra PX 4575 offers high efficiency in stabilizing pigments and demonstrates wide compatibility with many water-based resin systems. The new Dispex® Ultra PX 4575 is a universal dispersing agent with particular good performance in inorganic pigments which complements Dispex® Ultra PX 4585 which has an excellent performance for organic pigments. This makes Dispex® Ultra PX 4575 ideally suited for the use of the concept of resin-free pigment concentrates.

Sustainability highlights:

- VOC-free acc. to EU 2004/42 method

Performance highlights:

- Especially suited for the dispersion of pigments in wb coatings and colorants
- Excellent performance with inorganic pigments
- High efficiency
- Broad compatibility with different water-based resins and pigments

Characteristic Values:

Appearance	Clear, slightly yellowish liquid
Active ingredients	~ 40%
Amine value	~ 32 mg KOH/g

Test formulation water based DTM coating (Joncryl® PRO 1522)

Coating Formulation

Grind

Water	7.83	
Dispersant	See table	
Hydropalat® WE 3650	0.07	(1)
FoamStar® SI 2210	0.12	(1)
Ammonia 25 %	0.07	
KRONOS® 2190	17.89	(2)

Grind 30 min at 3400 rpm to Hegman grind 7 (< 10 µm)

Let-down, add while stirring

Joncryl® PRO 1522	59.26	(1)

Add mix of

Water	1.86	
Solvenon® PnB	4.01	(1)
Solvenon® DPnB	4.01	(1)

Add

FoamStar® SI 2210	0.08	(1)
Halox® 515	1.88	(3)
Benzoflex™ 9-88	1.33	(4)
Ammonia 25 %	0.16	

Total	**app. 100**
pH	**app. 9**
Density in g/cm³	**1.21**
PVC in %	**14.1**
Solids in %	**47.8**
VOC in g/l	**200**

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Influence of dispersing agents on corrosion resistance

Product name	Composition	Solid content [%]
Dispersant A	Acid phosphoric ester of a fatty alcohol ethoxylate	100
Dispersant B	ammonium salt of a carboxylic acid copolymer in water	30
Dispex® Ultra PX 4575	acrylic block copolymer formulation in water	40
Dispersant C	Solution of a high molecular weight block copolymer with pigment affinic groups	40

Test methods	Norm
Corrosion tests in artificial atmospheres – Salt spray tests	DIN EN ISO 9227
Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance	DIN EN ISO 4628
Paints and varnishes – Determination of resistance to humidity	DIN EN ISO 6270

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Salt Spray Test according to DIN EN ISO 9227:

(on cold rolled steel (CRS); degree of blistering: ISO 4628-2, degree of rusting: ISO 4628-3)

Dispersant	Dispersant A	Dispersant B	Dispex® Ultra PX 4575	Dispersant C
DFT in µm	65	66	63	66
SST 48h				
Degree of blistering	0(S0)	2(S4)*	0(S0)	0(S0)
Degree of rusting	Ri 0	Ri 0	Ri 0	Ri 0
SST 120h				
Degree of blistering	0(S0)*	5(S5)*	0(S0)*	2(S3)*
Degree of rusting	Ri 0	Ri 5	Ri 0	Ri 2
SST 144h				
Degree of blistering	2(S2)*		0(S0)*	2(S4)*
Degree of rusting	Ri 3		Ri 0	Ri 3
SST 168h				
Degree of blistering			0(S0)*	2(S4)*
Degree of rustting			Ri 0	Ri 4
SST 216h				
Degree of blistering			0(S0)*	
Degree of rusting			Ri 2	
SST 288h				
Degree of blistering			0(S0)*	
Degree of rusting			Ri 2	

Dispex® Ultra PX 4575 provides by far best corrosion resistance.

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Photos of cold rolled steel panels (carbon steel) after 120 h salt spray test

Dispersant A

DFT = 65µm

Dispersant B

DFT = 66µm

Dispex® Ultra PX 4575

DFT = 63µm

Dispersant C

DFT = 66µm

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Water Spot Test / Condensation water test DIN EN ISO 6270-2

Dispersant	Dispersant A	Dispersant B	Dispex® Ultra PX 4575	Dispersant C
Wasser Spot Test (drop of demin. water, 24 h)				
Cross cut immediately	GT5	GT 5	GT5	GT5
24 h after exposure	GT5	GT 3	GT2	GT1
Comment	-	Small blisters	-	-
Condensation Water Test according to DIN EN ISO 6270-2				
Gloss @ 60° before exposure: 84-86				
24 h				
Degree of blistering ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Degree of rusting ISO 4628-3	Ri 0	Ri 0	Ri 0	Ri 0
336 h				
Degree of blistering ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Degree of rusting ISO 4628-3	Ri 0	Ri 0	Ri 0	Ri 0
Gloss @ 60°, 24 h after exposure	**75**	**23**	**36**	**51**

Gloss reduction observed for most of the dispersants.

No defects after 336 h condensation water test.

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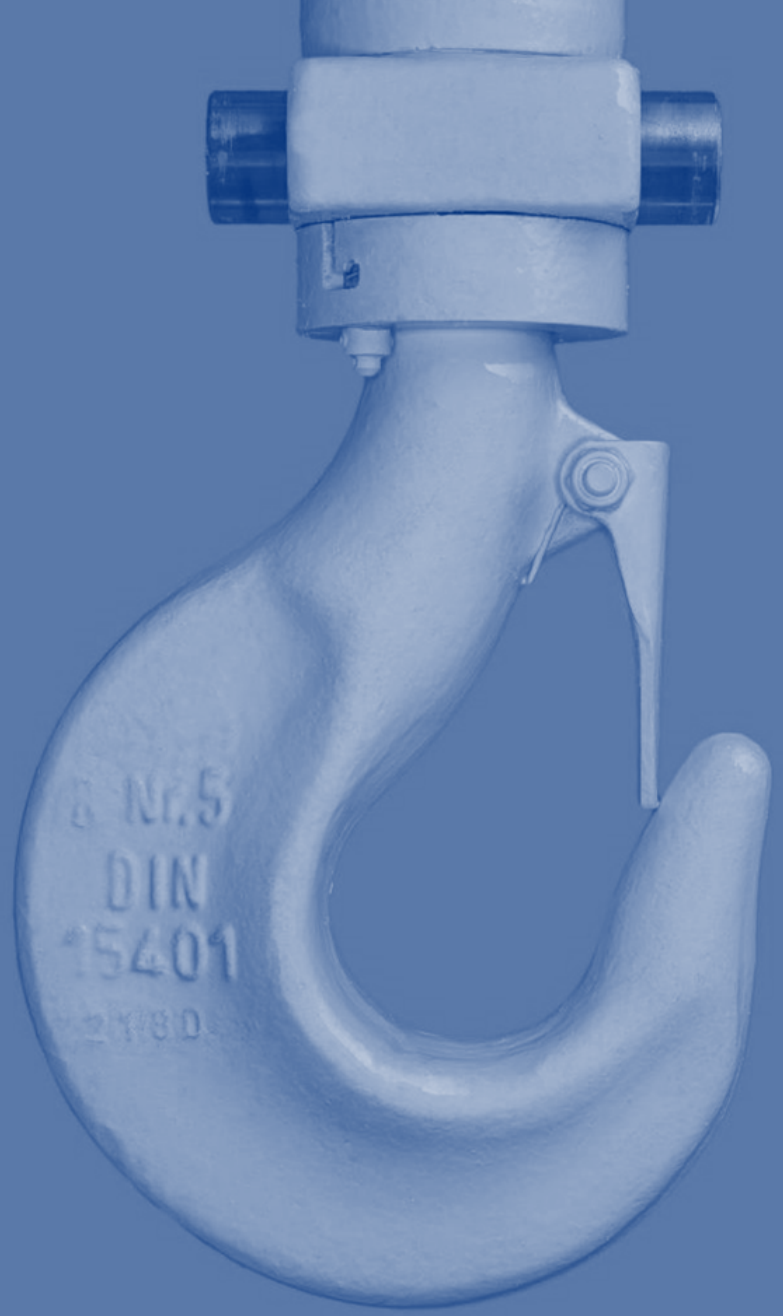

Case study 2:

Impact of dispersing agents on corrosion in a test system based on Acronal® PRO 770X

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Dispex® Ultra PX 4290

New high molecular weight dispersing agent for organic and inorganic pigments in aqueous coating systems, printing inks and adhesives.

Application:

Dispex® Ultra PX 4290 is a dispersing agent for organic and inorganic pigments in aqueous systems.

Due to the excellent stabilizing characteristics, outstanding color strength and excellent viscosity reduction can be achieved.

This allows also higher pigment loadings while excellent flow characteristics are maintained.

Sustainability highlights:

- Label-free
- Food Contact Compliance
- Suitable for a broad range of applications

Performance highlights:

- Designed to stabilize inorganic and organic pigments in aqueous formulations
- Improved color strength and transparency
- Improved gloss
- Anti-flooding behavior
- Excellent flocculation stability
- Solvent-free

Characteristic Values:

Appearance	Clear, yellowish liquid
Solvent	water
Density	~ 1.06 g/cm^3
Active content	~ 40%

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Test formulation water based DTM coating (Acronal® PRO 770X)

Coating formulation

Grind

Dispersant (40%)	0.6	(1)
Wasser	12.4	
FoamStar® ED 2522	0.3	
DMEA 50%	0.1	
Kronos 2190	20.3	(2)

Grinding time: 30 minute Skandex, Silibeads 1,2-1,4mm

Dispersion completion

	Add under stirring	
Acronal® PRO 770X	59.2	(1)

Additive completion

	Add each position under low shear forces	
Butyl diglykol	4.2	
Foamstar® ED 2522	0.2	(1)
Halox® 515	2.3	(3)
DMEA 50%	0.2	
Rheovis PU 1191	0.2	(1)
Total	**100**	

pH	**app. 8.5**
Density in g/cm³	**1.2**
PVC in %	**14**
Solid in %	**51**
VOC in g/l	**115 (ASTM D-3960-1)**
Dispersant-on-Pigment Ratio %	**1.2**

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Influence of dispersing agents on corrosion resistance

Product name	Composition	Solid content [%]
DA1	Solution of a high molecular weight copolymer with pigment affinic groups in water, nonionic	40
Dispex® Ultra PX 4290	High molecular weight dispersing agent	40
DA2	Solution of a high molecular weight block copolymer with pigment affinic groups	40
DA3	aqueous solution of a copolymer with groups ofhigh pigment affinity	40
DA4	aqueous solution of a copolymer with groups ofhigh pigment affinity	40
Dispex® Ultra PX 4575	acrylic block copolymer formulation in water	40
DA5	polymeric dispersant in water	40
DA6	Solution of a copolymer with pigment-affinic groups	40
DA7	polymeric block co-polymer based dispersing agent	40
DA8	Anionic, high-molecular weight polymer	40

Test method	Norm
Determination of gloss value at 20° and 60°	DIN EN ISO 2813
Paints and varnishes - Determination of viscosity using rotary viscometers	DIN EN ISO 2884
Corrosion tests in artificial atmospheres – Salt spray tests	DIN EN ISO 9227
Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance	DIN EN ISO 4628

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Gloss development and rheology behavior of various dispersing agents

Test formulation with coresponding DA	Viscosity				Gloss CRS	
	Shear rate 1s-1	Shear rate 10s-1	Shear rate 100s-1	Shear rate 1000s-1	20°	60°
DA1	11883	4260	666	71	61	84
Dispex Ultra PX 4290	14686	4693	695	77	58	82
DA2	13267	4638	729	78	54	82
DA3	15514	5103	771	81	56	82
DA4	13109	4679	734	80	51	81
Dispex Ultra PX 4575	16036	5071	725	79	63	84
DA5	14308	4912	761	80	59	84
DA6	11561	4517	706	77	54	81
DA7	12292	4515	707	79	53	82
DA8	16630	5517	804	83	46	80

All formulations show strong pseudoplastic flow behavior.

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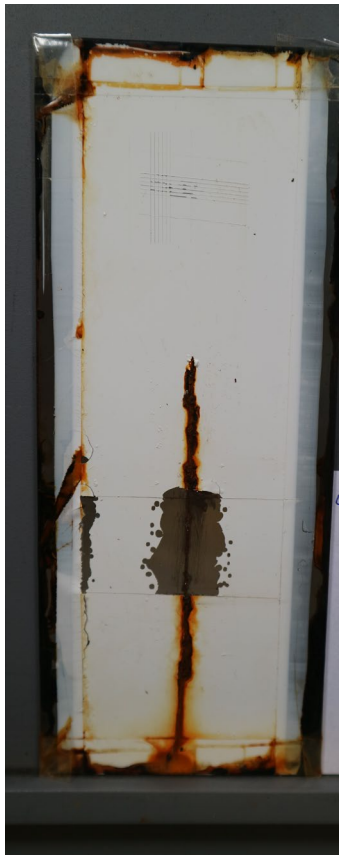
Photos of cold rolled steel panels after 240 h salt spray test

DA1



DFT = 58µm ± 2

Dispex® Ultra PX 4290

DFT = 61µm ± 3

DA2

DFT = 57µm ± 4

DA3

DFT = 57µm ± 3

DA4

DFT = 51µm ± 3

Dispex Ultra PX 4290 with benchmark performance at lowest rust creepage.

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Photos of cold rolled steel panels after 240 h salt spray test

Dispex® Ultra PX 4575

DFT = 60µm ± 5

DA5

DFT = 56µm ± 3

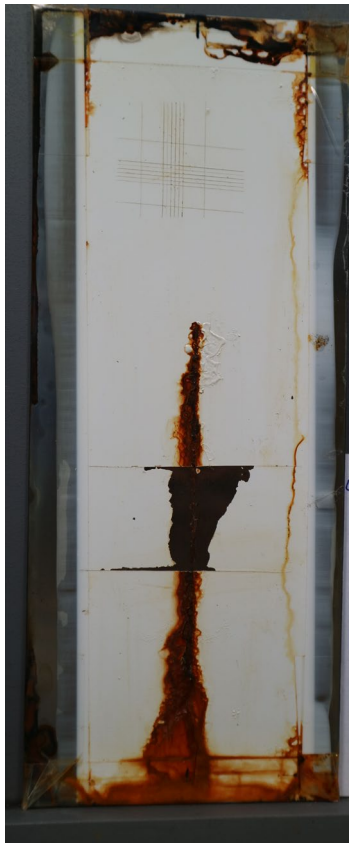
DA6

DFT = 48µm ± 1

DA7

DFT = 56µm ± 2

DA8



DFT = 52µm ± 4

Most tested dispersing agents showed blistering as descried.

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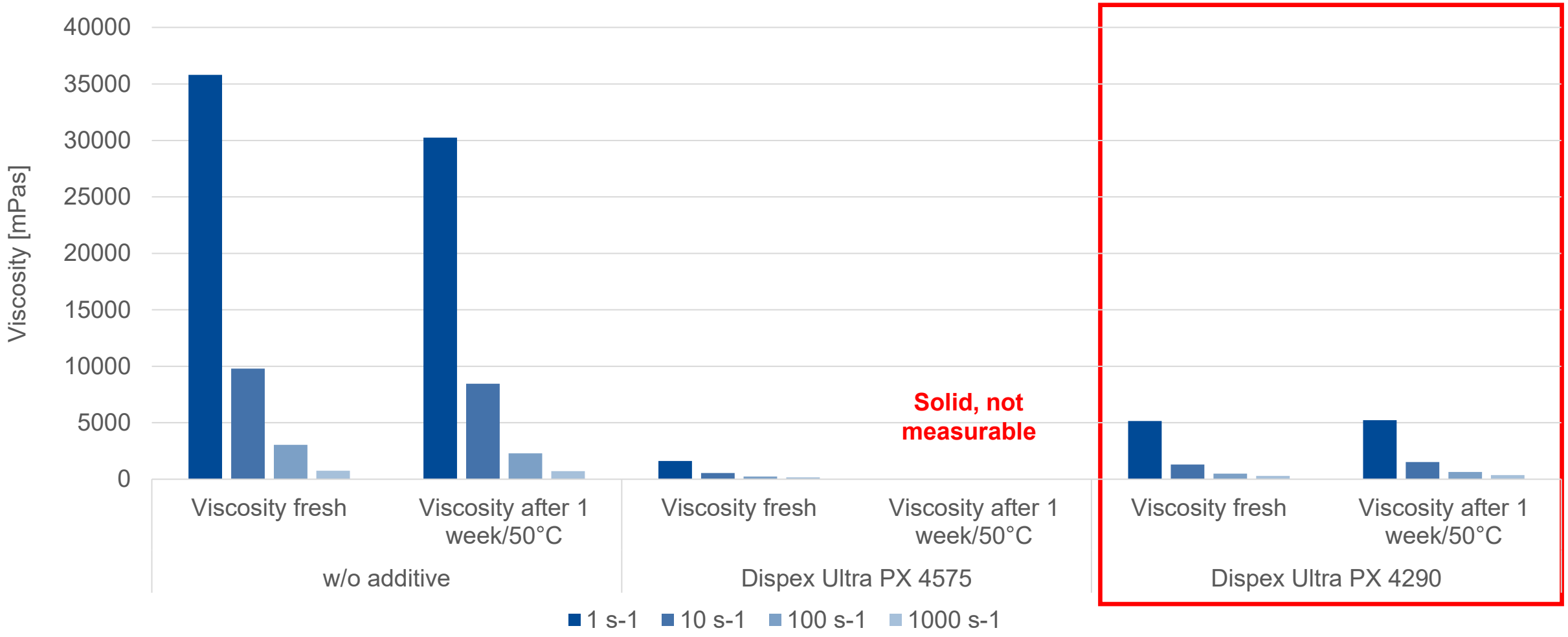
Storage stability of dispersing agents with water based epoxy dispersion Waterpoxy® 1455



Dispex® Ultra PX 4290 shows excellent storage stability with Waterpoxy®!

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Summary

Dispex® Ultra PX 4575 and Dispex® Ultra PX 4290 are our first choice of water based dispersing agents for anti corrosion and DTM systems:

- Dispex® Ultra PX 4575 is preferred for acrylic dispersions
- Dispex® Ultra PX 4290 is favored for wb epoxy dispersions

	Acrylic	2pack PUR	Alkyd	Epoxy
Dispex® Ultra PX 4575	✓	✓	✓	✗
Dispex® Ultra PX 4290	✓	✓	✓	✓

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