ANGUS®
CHEMICAL COMPANY

Rediscovering the unique versatility of alkanolamines to optimize next-generation paint formulations

Dr. Romain Severac

DISCOVER A **BETTER** WAY™

Dedicated to Performance

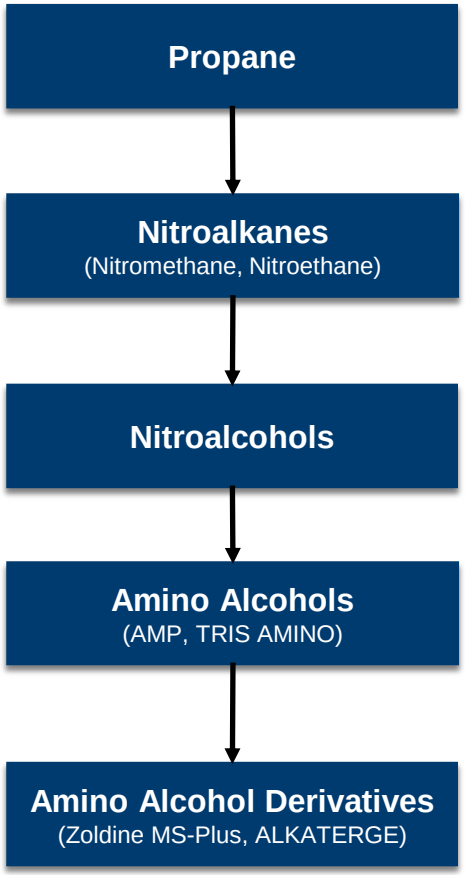
We develop and produce a **unique portfolio of multifunctional chemistries** that deliver **value** and **performance** across a broad range of applications and markets

- The **world's only company** dedicated to nitroalkanes and their derivatives
- Extensive track record of **industry innovation** and **leadership**
- 6 Regional Customer Application Centers to address the **local needs of our customers**
- Strong focus on **Responsible Care®** and **product stewardship**

ANGUS

ANGUS CHEMISTRIES

ANGUS is the only manufacturer in the world that uses propane nitration technology to create a unique set of products.



Technology innovator with over 70 years of nitration expertise

Nitration of propane yields our Nitroalkane products

Nitroalcohols are formed via the reaction of nitroalkanes and aldehydes

Amino alcohols are formed via the reduction of nitroalcohols

Amino alcohols are converted to derivatives via reactions with aldehydes or carboxylic acids

Key Market Focus

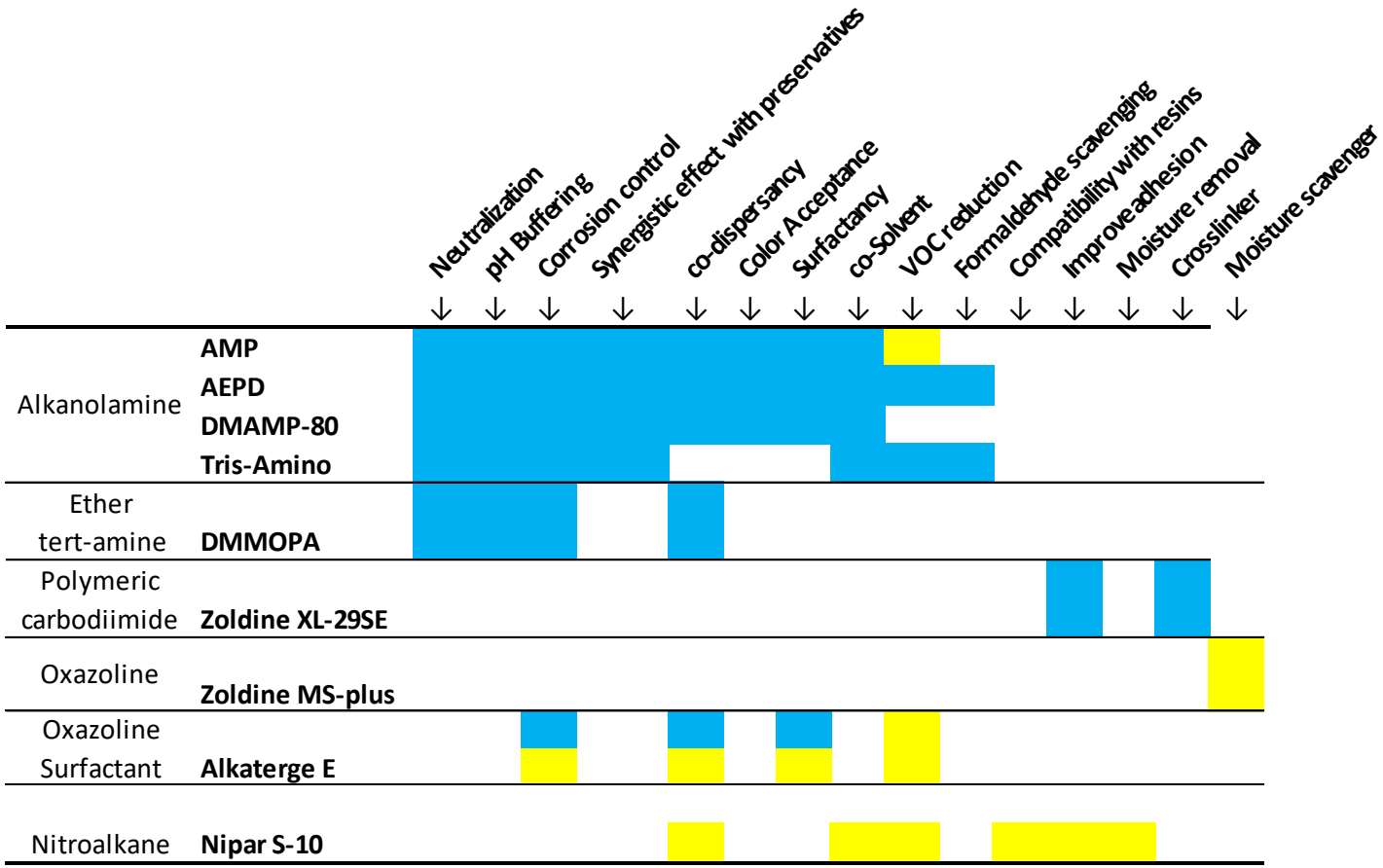
ANGUS is focused and aligned to drive innovation, enabling

ANGUS and our customers to deliver sustainable growth.

Life Sciences

Personal Care

Industrial Specialties



MULTIFUNCTIONAL BENEFITS

Multiple Applications

- Waterborne and solvent-borne architectural paints
- Wood coatings
- Industrial coatings
- Pigment / slurry dispersions
- Powder coatings
- Automotive OEM and refinishing
- Emulsion polymerization
- Leather and textiles
- Infrastructure and marine coatings
- Inks and packaging coatings

ANGUS®
CHEMICAL COMPANY

Multifunctional

Additives
Neutralizers
Stabilizers
Co-dispersants
Corrosion Inhibitors
Amino Alcohols

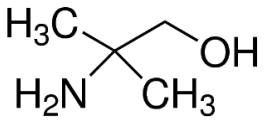
DISCOVER A **BETTER** WAY™

An Industry Standard

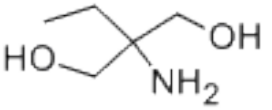
ANGUS Amino Alcohols

- I and III amino alcohols with amine group bonded to tertiary carbon
- Effective pigment co-dispersant
- Highly efficient neutralization
- Enables formulation optimization

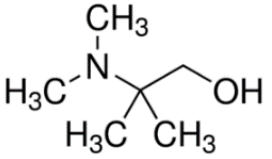
AMP™
2-Amino-2-methyl propanol



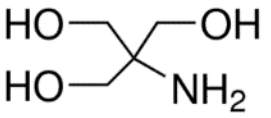
AEPD™
2-Amino-2-ethyl-1,3-propanediol



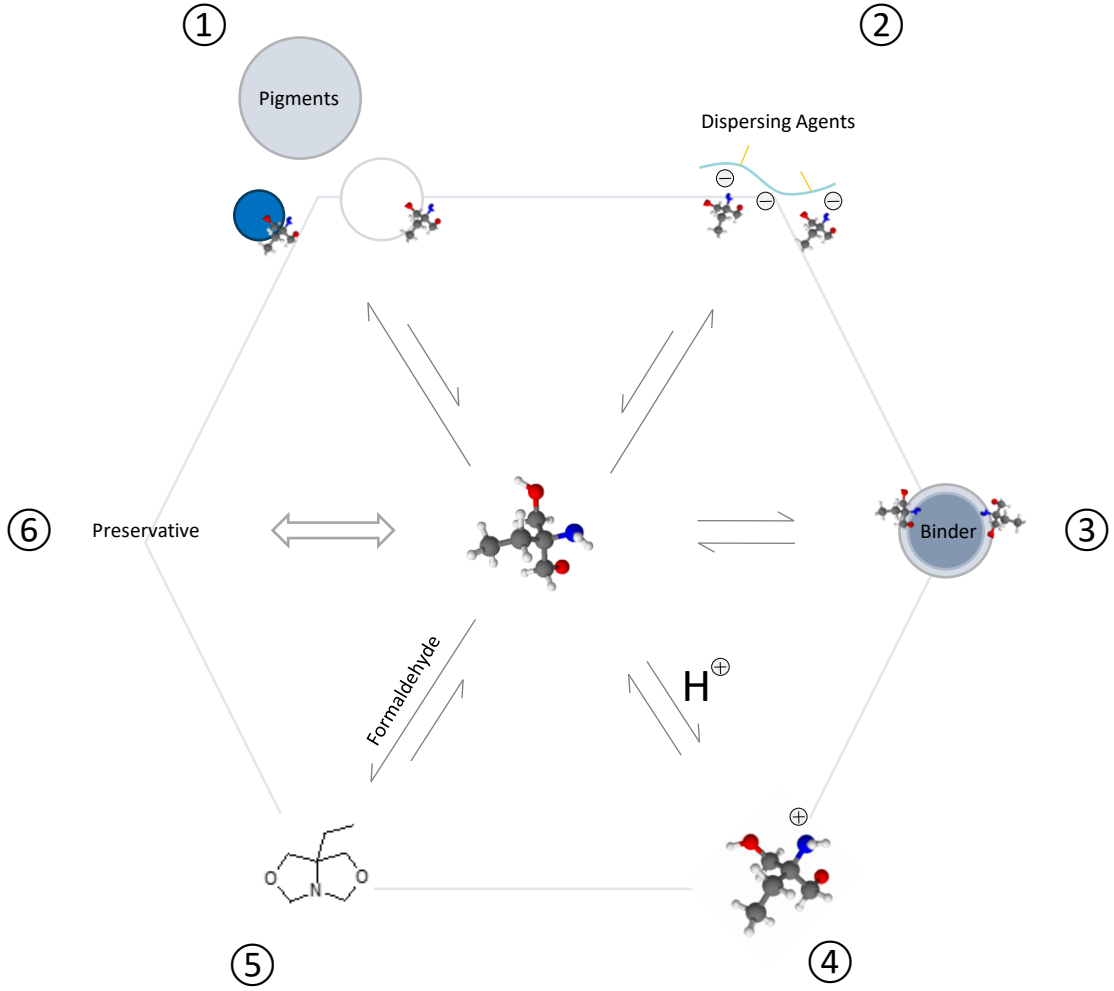
DMAMP™
2-Dimethylamino-2-methylpropanol



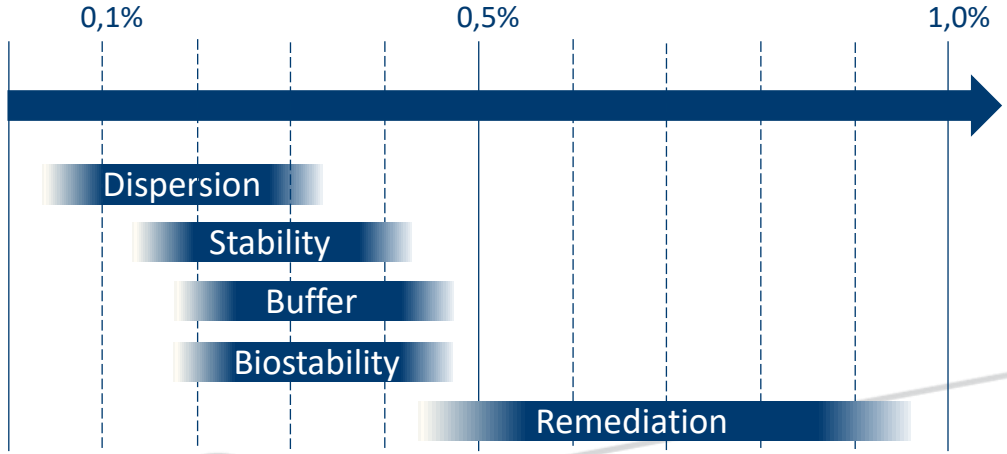
TRIS AMINO™
Tris(hydroxymethyl)aminomethane



How much and Where?



Effect	Cause	Dispersion	Let Down
Dispersion	①②	X	
Stability	①②③④	X	X
Buffer	④		X
Remediation	⑤		X
Biostability	⑥	X	X



Unique Performance Benefits

Throughout the Entire Paint Lifecycle

Improving Processing

Manufacturing Performance

- Superior neutralization efficiency
- Excellent pigment dispersion and improved grind efficiency
- Reduced processing foam
- Low odor and easy to handle

Improving Application

Application Performance

- Consistent rheology and improved flow and levelling
- Color uniformity
- Reduced foam
- Low odor

Improving Properties

In-Can Performance

- Improved pH stability and rheology control
- Enhanced color development
- Reduced in-can corrosion
- Improved bio-stability

Improving Appearance

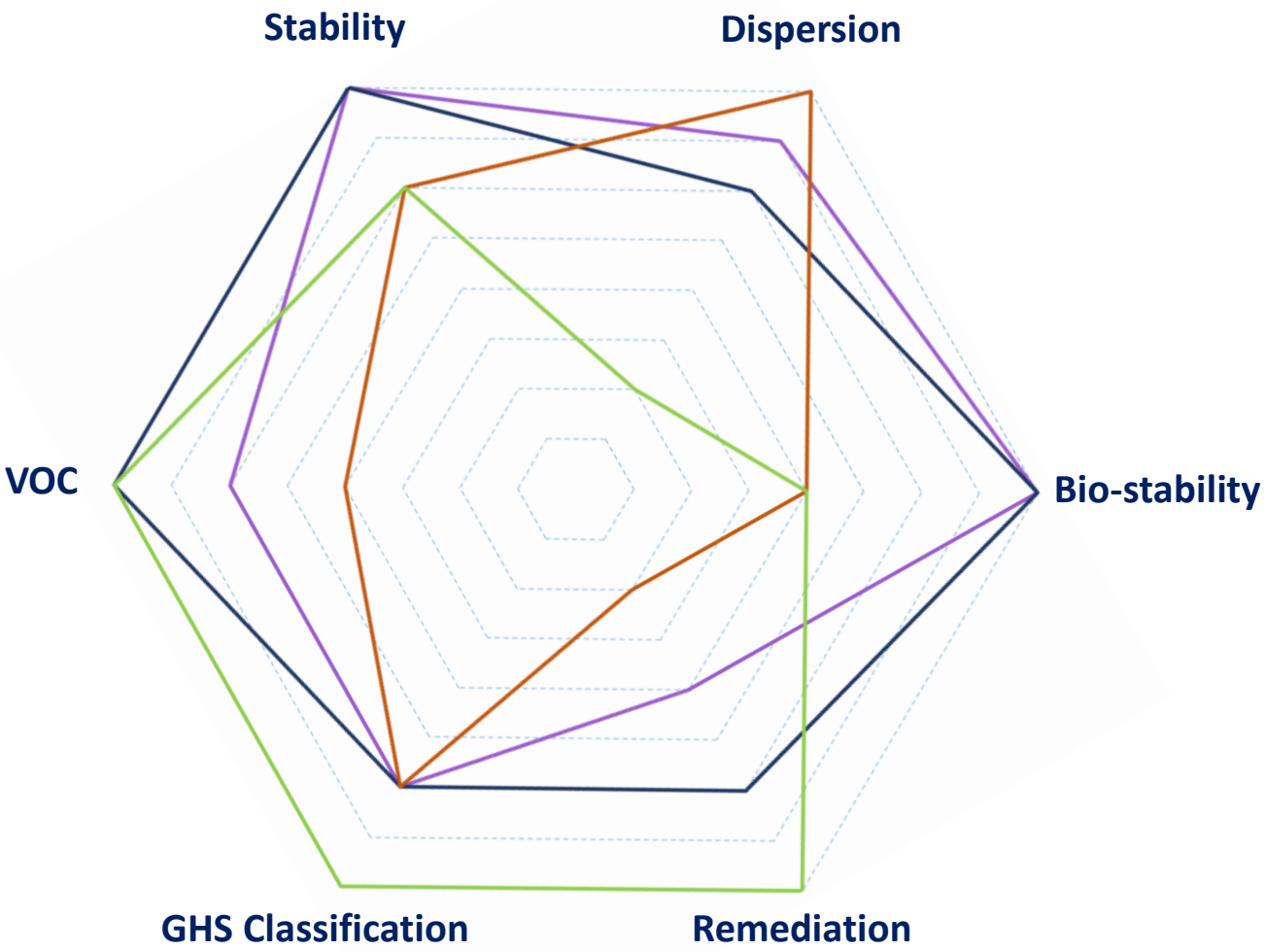
Dry Film Performance

- Enhanced film integrity and dispersion
- Superior scrub, stain and block resistance
- Improved color acceptance

Unique Physical-Chemical Properties

	MW (g.mol-1)	Active Ingredient (%)	pKa	pH of 1% amine solution	Reserve Alkalinity	Boiling point (°C)	Melting point (°C)	Flash point (°C)	Density @ 20°C	Refractive index n20
AMP-90	**89,13**	90%	9,7	**11,69**	**5,015**	165	-11	85,6	0,934	1,4455
AEPD VOX 1000	119,16	85%	8,8	10,98	3,525	**283**	-24	>100	1,080	1,4861
TRIS AMINO	121,14	**100%**	8,1	10,40	-	**>300**	170	>100	1,353	-
DMAMP-80	117,19	80%	**10,2**	**11,90**	3,505	160	-20	67	0,950	1,4470

Which product fit my need?

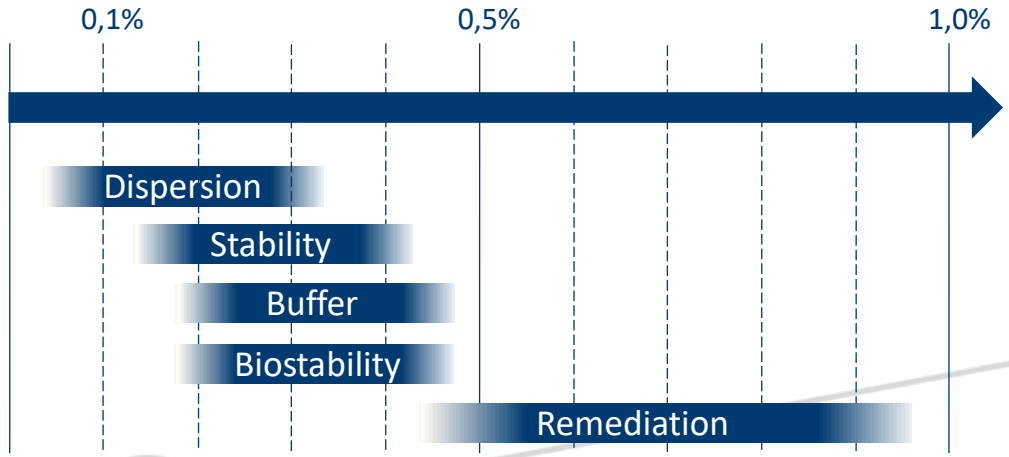


AMP™
2-Amino-2-methyl propanol

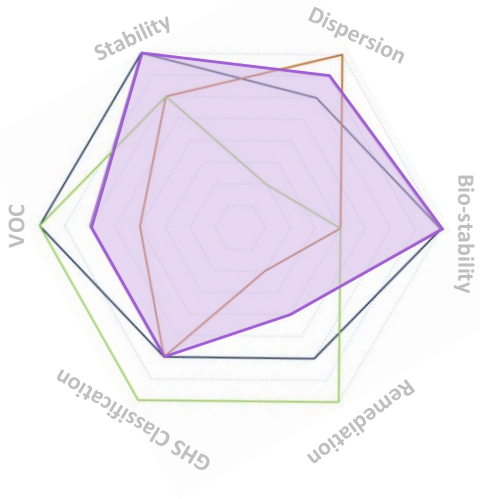
AEPD™
2-Amino-2-ethyl-1,3-propanediol

DMAMP™
2-Dimethylamino-2-methylpropanol

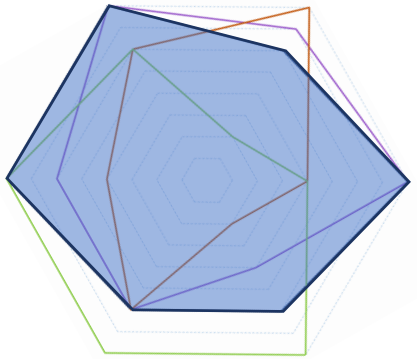
TRIS AMINO™
Tris(hydroxymethyl)aminomethane



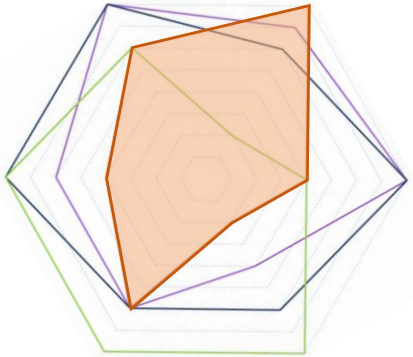
Which product fit my need?



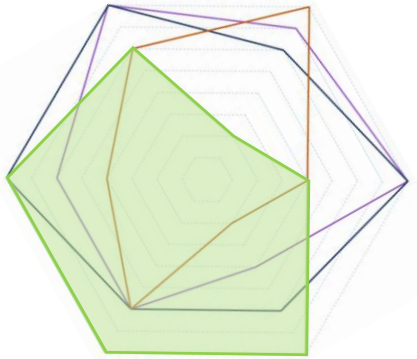
AMP™
2-Amino-2-methyl propanol



AEPD™
2-Amino-2-ethyl-1,3-propanediol



DMAMP™
2-Dimethylamino-2-methylpropanol



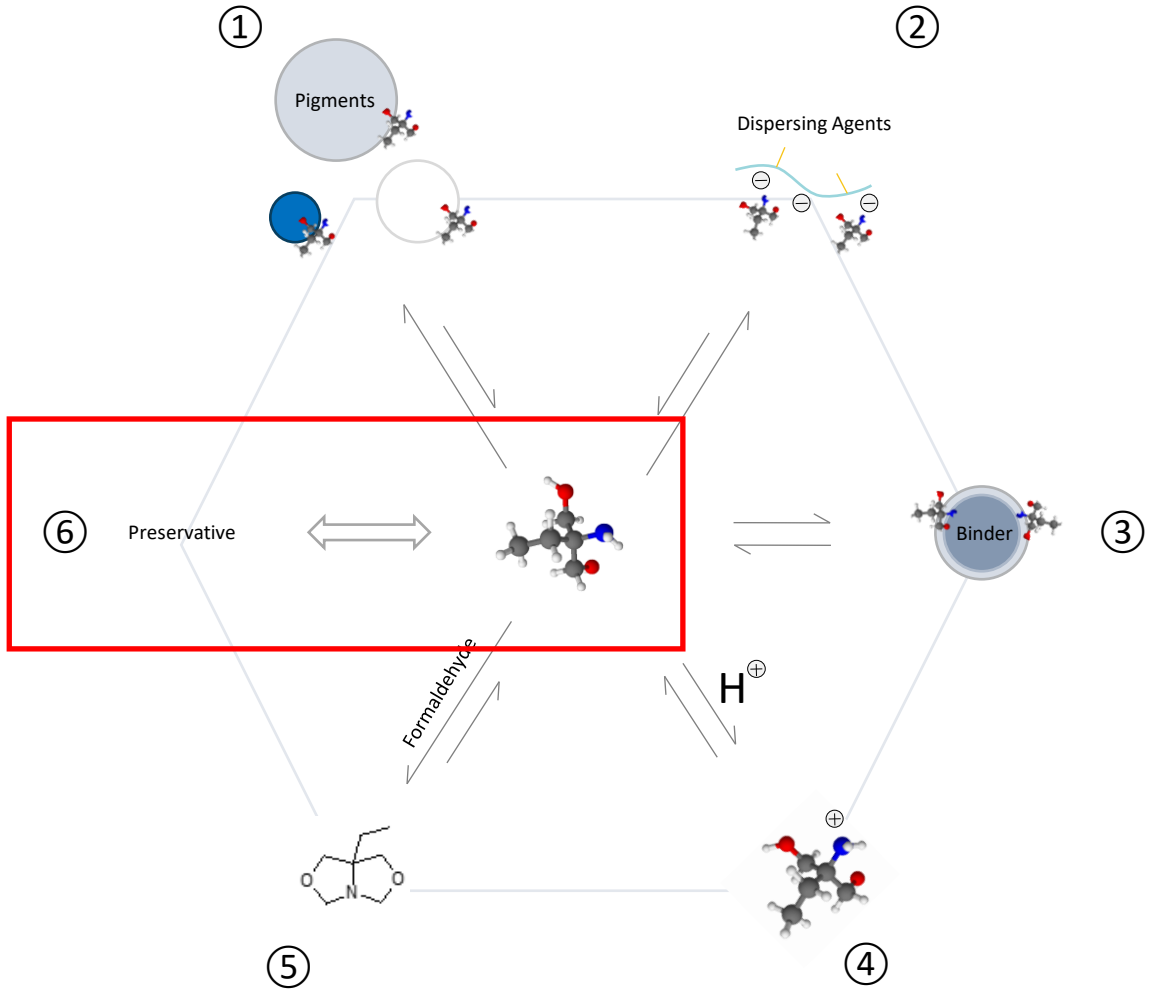
TRIS AMINO™
Tris(hydroxymethyl)aminomethane

ANGUS®
CHEMICAL COMPANY

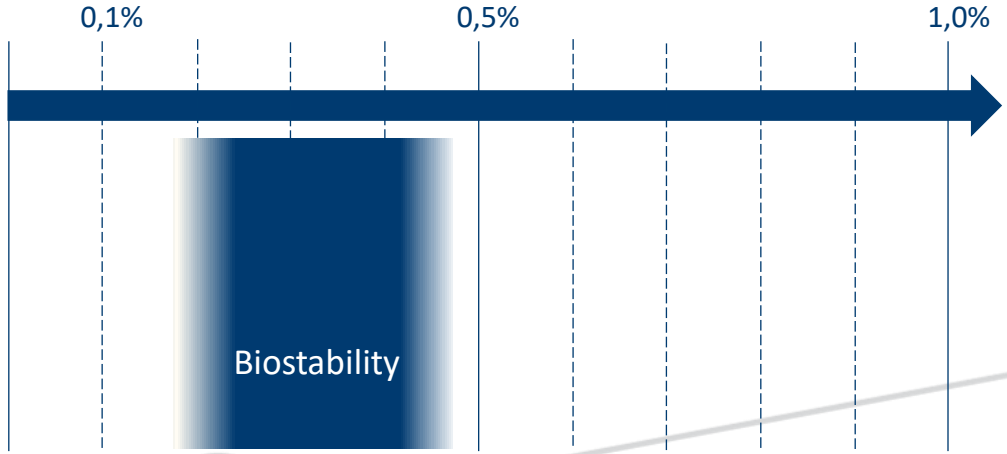
Synergystic effect with registred Biocides

DISCOVER A **BETTER** WAY™

Synergistic Effects with Biocides



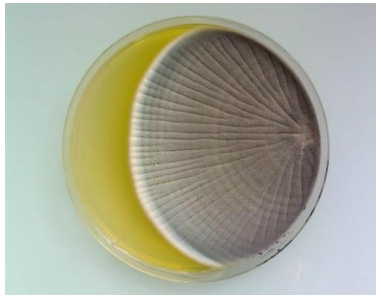
Effect	Cause	Dispersion	Let Down
Dispersion	①②	X	
Stability	①②③④	X	X
Buffer	④		X
Remediation	⑤		X
Biostability	⑥	X	X

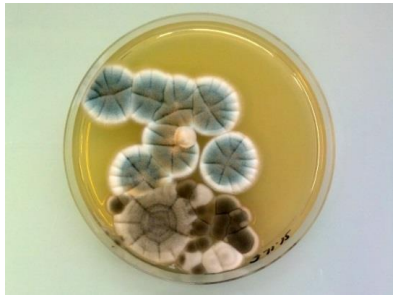


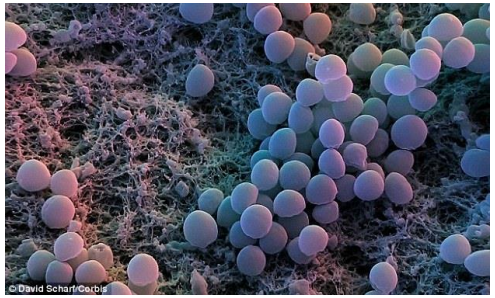
Biostability Control

Bacteria are the main causative organisms for the spoilage of water-based paints, although occasionally yeast and fungi cause biodeterioration in the wet state. Contamination in industrial systems can have the following consequences on the quality of the paint and on the safety of workers and final users of the paint:

- Malodor
- Gassing
- Discoloration
- Loss of viscosity
- Phase separation
- pH drop







Benchmark ANGUS Alkanolamines, and Inorganic Neutralizers for biocide synergy in a low VOC Semi Gloss paint

LOW VOC (< 50 g/L) SEMI GLOSS FORMULATION

- **Latex**: Acrylic
- **Total Solids by wt**: 50.5%
- **PVC**: 23.7%
- **Biocides**

BIT:1,2 benzisothiazolin-3-one

20% BIT

CMIT/MIT: 5-chloro-2-methyl-4-isothiazolin-3-one & 2-methyl-4-isothiazolin-3-one
1.15% CMIT, 0.35% MIT

- **Microorganisms:**

- Wild Strains

Neutralizing Agents

Neutralizing Agents

- **Organic**
  - •2-Amino-2-Methyl-1-Propanol (AMP-95)
  - •2-Amino-2-Ethyl-1,3-Propane-Diol (AEPD VOX 1000)
- **Inorganic**
  - •Ammonia
  - •Sodium Hydroxide (NaOH)
  - •Potassium Hydroxide (KOH)
  - •Sodium Carbonate (Na_2CO_3)
  - •Potassium Carbonate (K_2CO_3)

Bacterial In-Can Preservative

BIT Evaluation using Wild Strains in a Low VOC Semi-Gloss Formulation

AMP-95

BIT ppm	Challenge 1 (5×10^6 CFU/ml)	Cycle I		Challenge 2 (5×10^6 CFU/ml)	Cycle II		Challenge 3 (5×10^6 CFU/ml)	Cycle III		Challenge 4 (5×10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
500		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
450		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
400		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
350		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
300		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
250		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
200		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
100		0.0	0.0		0.0	0.0		0.0	0.0		5.0	4.0
0		0.0	0.0		4.8	**0.0**		4.8	6.1		6.6	3.9

AEPD VOX 1000

BIT ppm	Challenge 1 (5×10^6 CFU/ml)	Cycle I		Challenge 2 (5×10^6 CFU/ml)	Cycle II		Challenge 3 (5×10^6 CFU/ml)	Cycle III		Challenge 4 (5×10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
500		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
450		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
400		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
350		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
300		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
250		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
200		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
100		0.0	0.0		0.0	0.0		0.0	0.0		2.5	0.0
0		0.0	0.0		4.4	0.0		3.3	0.4		5.4	3.6

SODIUM HYDROXIDE

BIT ppm	Challenge 1 (5×10^6 CFU/ml)	Cycle I		Challenge 2 (5×10^6 CFU/ml)	Cycle II		Challenge 3 (5×10^6 CFU/ml)	Cycle III		Challenge 4 (5×10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
500		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
450		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
400		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
350		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
300		0.0	0.0		0.5	0.0		0.0	0.0		0.0	0.0
250		0.0	0.0		1.5	0.0		1.5	0.0		5.0	5.0
200		0.0	0.0		2.5	0.0		1.0	0.0		6.0	5.0
100		0.0	0.0		5.0	0.0		6.0	6.5		7.5	5.5
0		0.0	0.0		6.5	7.3		6.1	6.1		7.0	3.4

*BIT dosages are based on actives of Rocima™ BT 2S

Bacterial In-Can Preservative

CMIT/MIT Evaluation using Wild Strains in a Low VOC Semi-Gloss Formulation

AMP-95

CMI/MI ppm	Challenge 1 (5 x 10^6 CFU/ml)	Cycle I		Challenge 2 (5 x 10^6 CFU/ml)	Cycle II		Challenge 3 (5 x 10^6 CFU/ml)	Cycle III		Challenge 4 (5 x 10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
25		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
22		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
19		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
16		0.0	0.0		0.0	0.0		0.0	0.0		1.5	0.0
13		0.0	0.0		0.0	0.0		0.0	0.0		3.0	4.0
10		0.0	0.0		0.0	0.0		0.0	0.0		5.5	4.0
7		0.0	0.0		0.0	0.0		0.0	0.0		7.0	4.0
6		0.0	0.0		0.0	0.0		0.0	0.0		7.0	5.0
0		0.0	0.0		4.8	0.0		4.8	6.1		6.6	3.9

AEPD VOX 1000

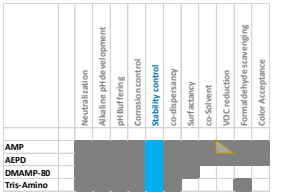
CMI/MI ppm	Challenge 1 (5 x 10^6 CFU/ml)	Cycle I		Challenge 2 (5 x 10^6 CFU/ml)	Cycle II		Challenge 3 (5 x 10^6 CFU/ml)	Cycle III		Challenge 4 (5 x 10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
25		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
22		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
19		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0
16		0.0	0.0		0.0	0.0		0.0	0.0		3.0	0.0
13		0.0	0.0		0.0	0.0		0.0	0.0		4.5	0.0
10		0.0	0.0		0.0	0.0		0.0	0.0		5.5	5.5
7		0.0	0.0		0.0	0.0		0.0	0.0		6.0	6.0
6		0.0	0.0		0.0	0.0		0.0	0.0		6.0	5.0
0		0.0	0.0		4.4	0.0		3.3	0.4		5.4	3.6

POTASSIUM CARBONATE

CMI/MI ppm	Challenge 1 (5 x 10^6 CFU/ml)	Cycle I		Challenge 2 (5 x 10^6 CFU/ml)	Cycle II		Challenge 3 (5 x 10^6 CFU/ml)	Cycle III		Challenge 4 (5 x 10^6 CFU/ml)	Cycle IV	
		Day 1	Day 7		Day 8	Day 14		Day 15	Day 21		Day 22	Day 28
25		0.0	0.0		0.0	0.0		0.0	0.0		5.5	5.0
22		0.0	0.0		0.0	0.0		0.0	0.0		6.0	5.0
19		0.0	0.0		0.0	0.0		0.0	0.0		6.0	2.5
16		0.0	0.0		0.0	0.0		0.0	0.0		5.5	2.5
13		0.0	0.0		0.0	0.0		0.0	0.0		6.5	5.0
10		0.0	0.0		0.0	0.0		0.0	0.0		6.0	4.0
7		0.0	0.0		0.0	0.0		4.0	6.5		6.5	4.0
6		0.0	0.0		0.0	0.0		4.0	7.0		6.5	5.0
0		0.0	0.0		7.1	6.0		5.1	6.6		6.5	4.5

* CMIT/MIT dosages are based on actives of Kathon™ LX 1.5%

Summary



➢ ANGUS Alkanolamines, AMP-95 and AEPD VOX 1000 with CMIT/MIT biocides enhance the preservation of paints from in-can microbial contamination. This effect was most significant with AEPD VOX 1000.

➢ AEPD VOX 1000 showed the most effect on synergy with BIT biocide. To achieve the optimum preservation, the Sodium Hydroxide system required more than a threefold BIT biocide dosage versus the AEPD VOX 1000 system.

➢ It is recommended that formulators maintain current biocide dose level and enhance the robustness of protection through addition of AEPD VOX 1000.

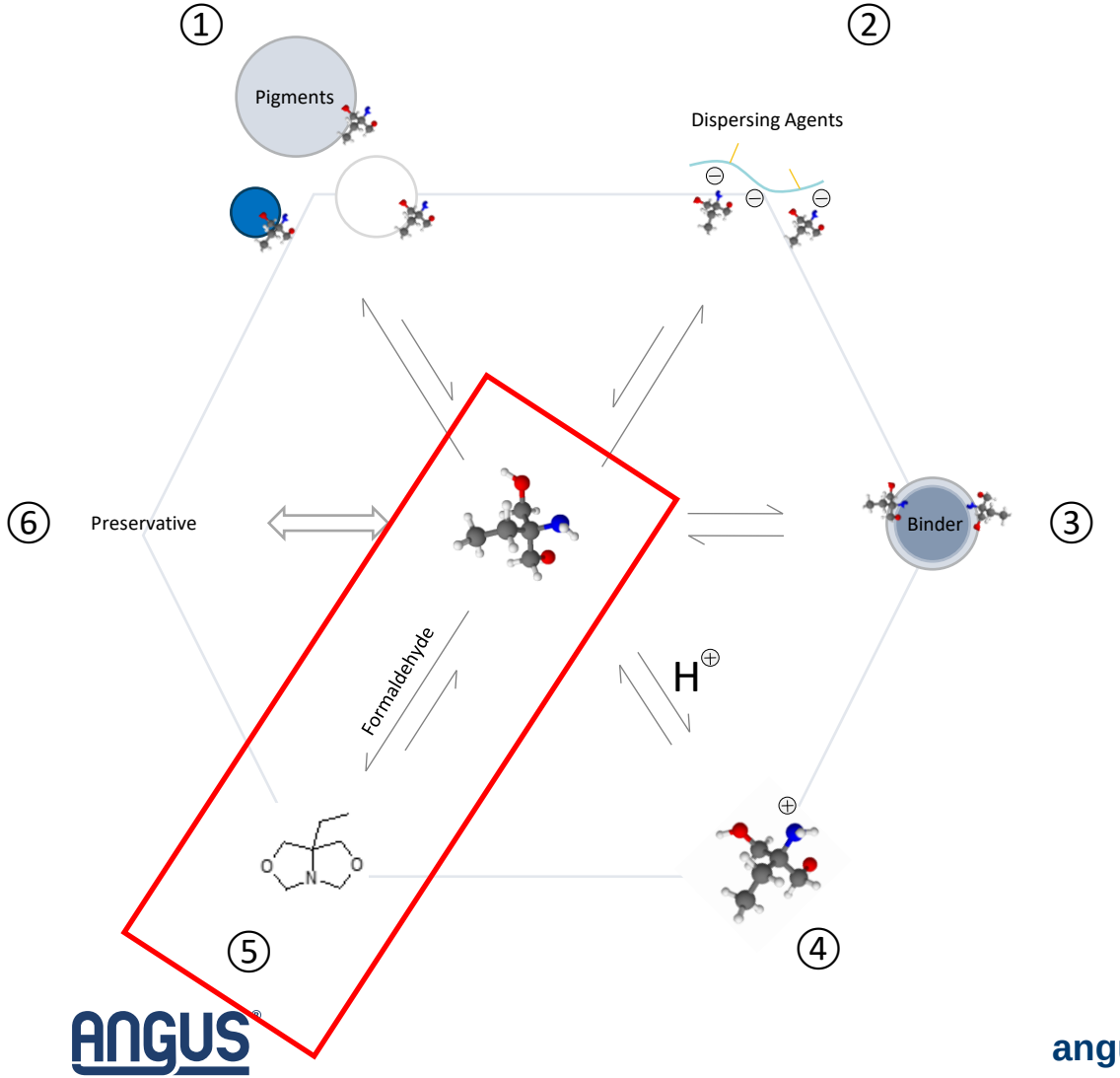
Get More Information

ANGUS®
CHEMICAL COMPANY

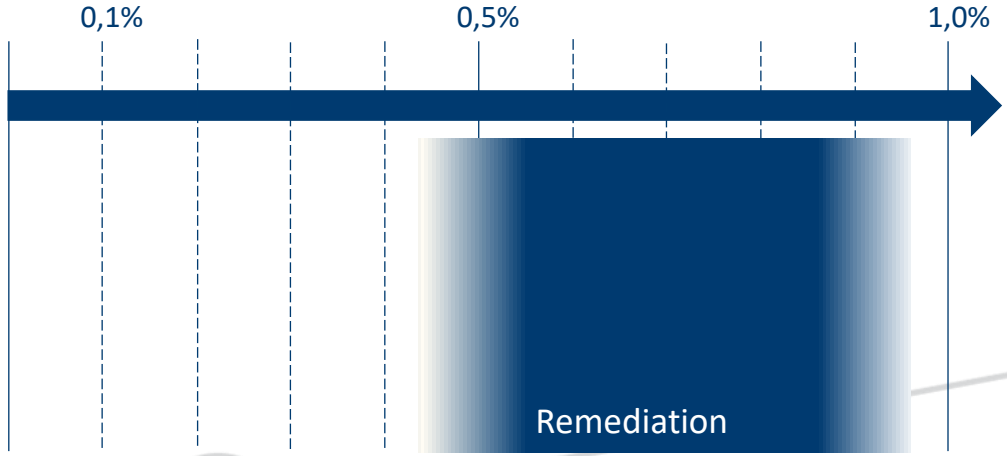
Formaldehyde remediation

DISCOVER A **BETTER** WAY™

Formaldehyde Remediation/Scavenging



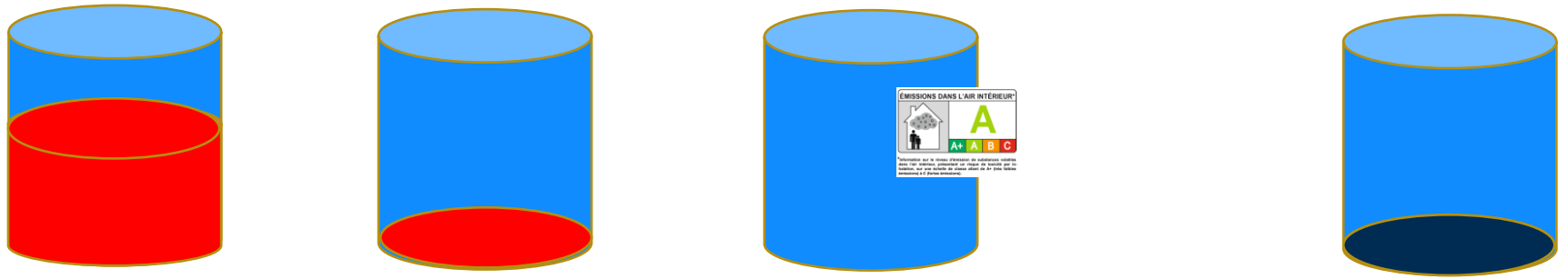
Effect	Cause	Dispersion	Let Down
Dispersion	①②	X	
Stability	①②③④	X	X
Buffer	④		X
Remediation	⑤		X
Biostability	⑥	X	X



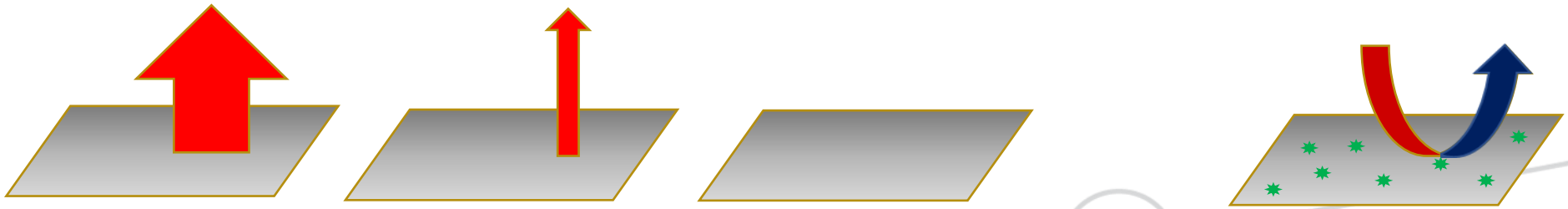
Evolution of Paints

Solvent based	Water borne	Zero VOC	Surface remediation
	ISO 16000-6		ISO 16000-23
	AEPD VOX 1000		Tris Amino Crystal

Emission during the application



Emission during the paint life



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ISO 16000-6
No VOC contribution

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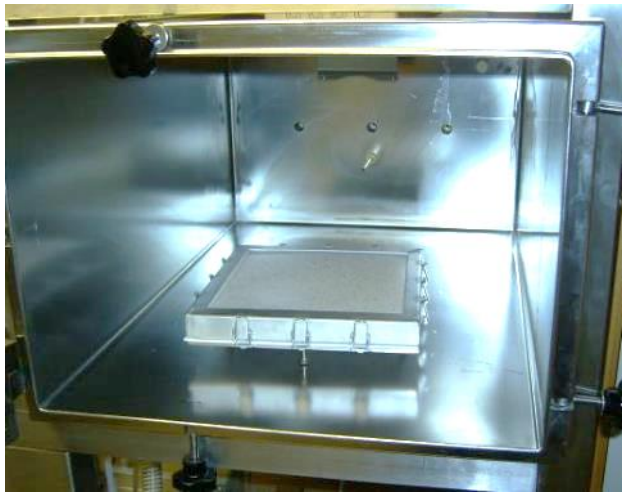
ISO Standards Description

Analytical Measurement ISO 16000-6 /-23

- Stainless steel, volume: 119 L, 23°C, 50% relative humidity, air exchange rate: ½ per hour
- Loading: 1 m^2 test specimen per m^3 air volume
- Sample application: one layer of 100 g/m^2, immediately transferred into the test chamber
- Sampling: after 28 days, drawing air samples from the chamber outlet through Tenax TA tubes
- Analyses: Thermal desorption and GC / MS



Examples with AMP™ and AEPD™ VOX 1000

Formulation: Styrene Acrylic latex, Interior Satin Wall Paint, PVC 40%

		FUNCTION	% WEIGHT	
GRIND	WATER	Solvent	26.25	26.25
	HYDROXYETHYL CELLULOSE (CELLOSIZE QP3000H) *	Thickener	0.50	0.50
	AEPD VOX 1000 *	**Multifunctional Amine**	**0.30**	-
	AMP 90 *	**Multifunctional Amine**	**-**	**0.30**
	POLYCARBOXYLATE (OROTAN N4045) *	Acrylic dispersant	0.45	0.45
	2-BUTOXYETHANOL	Defoamer	0.20	0.20
	PROPYLENE GLYCOL	Antifreezing agent	3.03	3.03
	TITANIUM DIOXIDE	Pigment	16.16	16.16
	TALC	Filler	4.04	4.04
	GROUNDED CALCIUM CARBONATE	Filler	8.08	8.08
	PRECIPITATED CALCIUM CARBONATE	Filler	4.04	4.04
LET DOWN	GLYCOLETHER (DOWANOL 4PNB) *	Coalescing agent	1.01	1.01
	STYROL ACRYLATE POLYMER (UCAR LATEX DL420G) *	Binder	30.60	30.60
	2-BUTOXYETHANOL	Defoamer	0.20	0.20
	BIT and MIT (ROCIMA MBX) *	Biocide	0.20	0.20
	ACRYLIC POLYMER (ACRYSOL RM-55) *	Thickener	0.50	0.50
	WATER	Solvent	4.65	4.65

- pH after 24h: 8.8 – 9.0
- Viscosity after 24h:
  11500 - 11800 mPa.s
  (Brookfield, Spindle 5, 20 rpm)

**raw material used as received*

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AEPD™ VOX 1000 Multifunctional Additive

Emission Test Results

Concentration after 28 days (µg/m³)	
Formaldehyde	Below detection limit
Acetaldehyde	Below detection limit
Toluene	Below detection limit
Tetrachloroethylene	Below detection limit
Xylene	Below detection limit
1,2,4-Trimethylbenzene	Below detection limit
1,4-Dichlorobenzene	Below detection limit
Ethylbenzene	Below detection limit
2-Butoxyethanol	Below detection limit
Styrene	Below detection limit
TVOC	300

- **AMP-90™: traces are visible on the emission test after 28 days (10µg/m3)**

  Despite AMP-90™ has to be considered as VOC, it is not a major contributor to the TVOC in this test.

- **AEPD VOX 1000: below detection limit in the emission test after 28 days**

  AEPD VOX 1000 neutralizing amine is not contributing to the TVOC.

- **TVOC < 1000 µg/m3**

  Main contributor to this TVOC value is another additive of the formulation.

- **The emission of the tested paint formulation corresponds to the emission class A+**

*: Indoor air emissions

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ISO 16000-23 Examples

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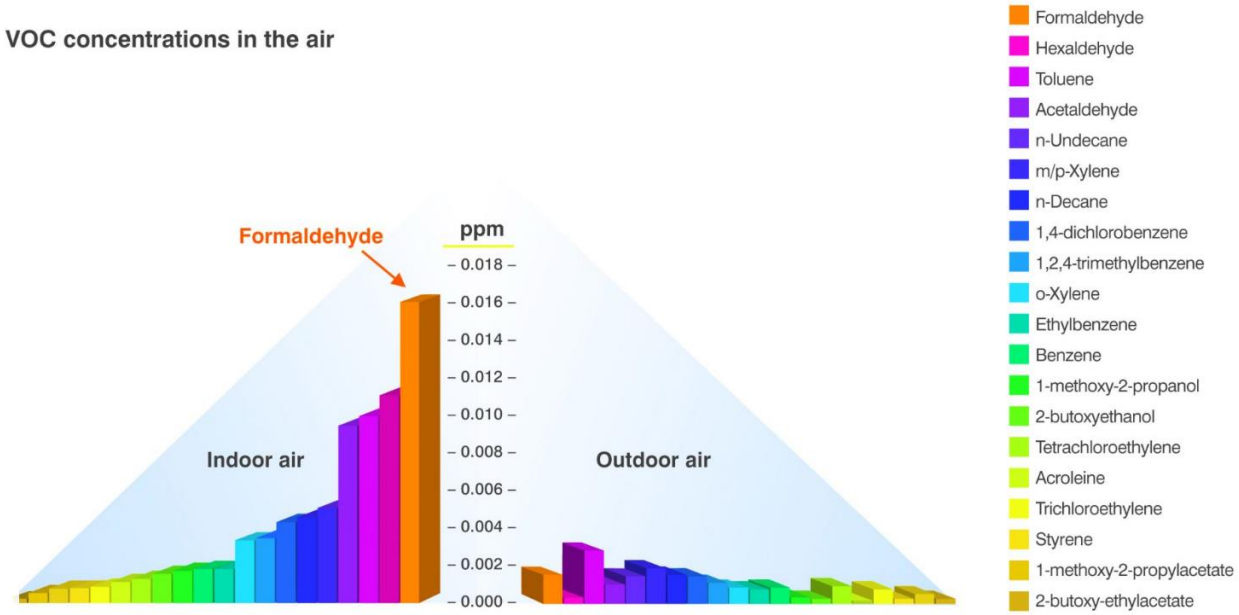
Formaldehyde Scavenging



Analysis of chemical concentration in residences, daycare centers and school buildings

- VOCs are the most prevalent pollutants
- Significantly higher levels in indoor air than in the outdoor atmosphere
- 3 of the 4 most prevalent VOCs in the air are aldehydes

Validation Using ISO 16000-23

3.1 Chamber Test Parameters

Parameter	Value	Parameter	Value
Chamber volume, V[L]	119	Preconditioning period	-
Air Change rate, n[h^{-1}]	0.5	Test period	10/02/2020 - 16/03/2020
Relative humidity of supply air, RH [%]	50 ± 3	Area specific ventilation rate, q [m/h or $m^3/m^2/h$]	0.36
Temperature of supply air, T [°C]	23 ± 1	Loading factor [m^2/m^3]	1.4

3.2 Preparation of the Test Specimen

The sample was homogenised and applied onto a glass plate.

Number of Layers	Application amount per layer, g/m^2	Drying time, h
2	140	8

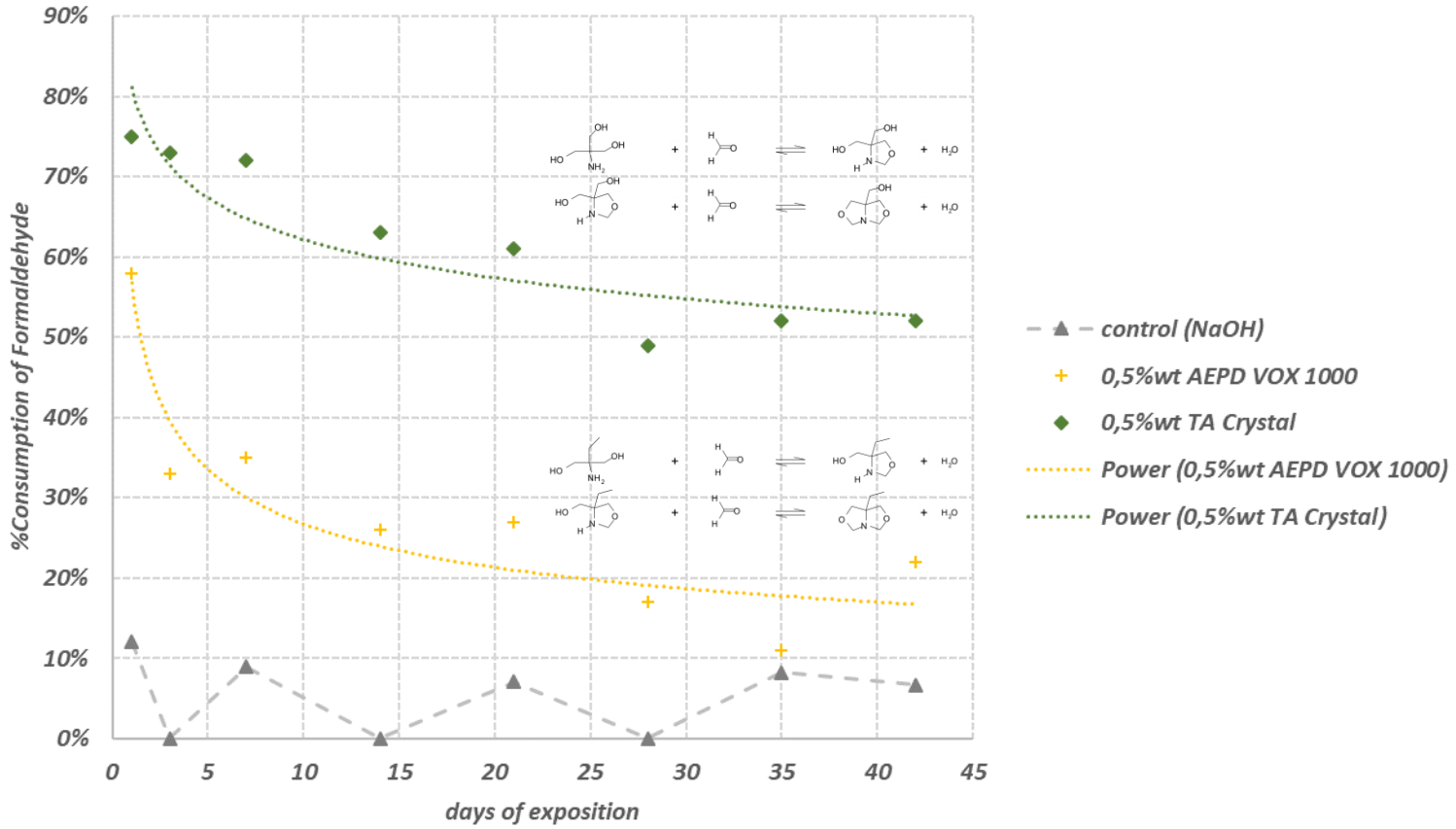
Test performed according to ISO 16000-23 at the European Eurofins laboratory. Regular testing conditions implemented as detailed in the table

Validation Using ISO 16000-23

Water	17,18
DOWSIL 108F	0,14
Natrosol 250 MHBR	0,36
10 min à 800 tr/min	
descendre à 500 tr/min	
Orotan 731	0,10
Proxel BZ plus	0,10
AMP 95	
5 min à 500 tr/min puis on monte a 1000	
Kronos 2190	17,00
Durcal 5	8,50
Finntalc M15	1,00
Disperstion time	20 min
Dispersion speed	1800 tr/min
Descendre à 800 tr/min	
Primal SF-016	44,00
Agitation 5 min - 800 tr/min	
DOWSIL 108F	0,06
Aquaflow NHS 300	0,70
Aquafflow NLS 220E	2,75
Water	8,10
Agitation 5 min - 800 tr/min	
Total	**100,00**

Evaluation of Scavenging Performance

TRIS AMINO™ and AEPD™ VOX 1000



- With only 0.5% wt of the total paint formulation, both products can improve formaldehyde scavenging
- TRIS AMINO Crystals demonstrate the highest efficiency

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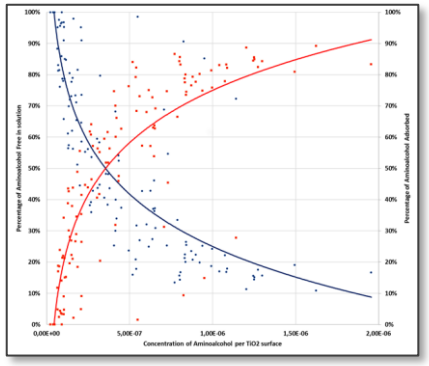
Conclusions

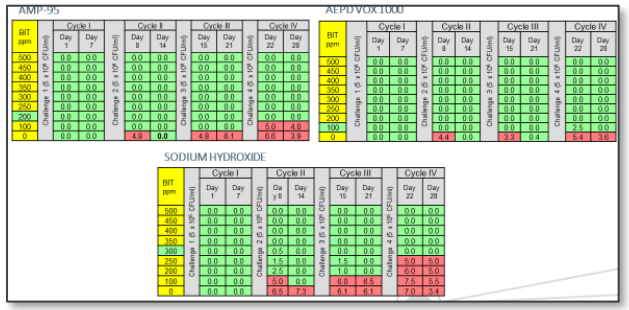
DISCOVER A **BETTER** WAY™

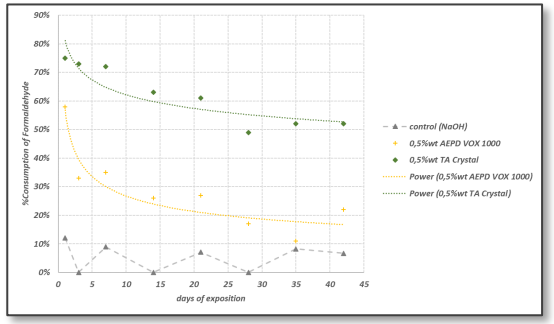
Conclusions

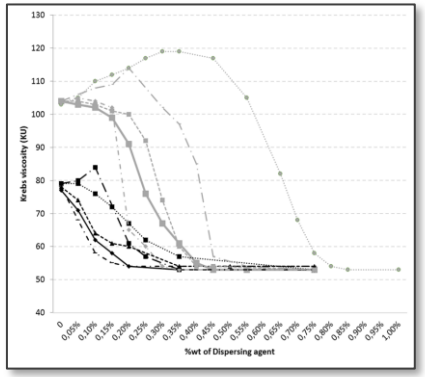
Multifunctional booster

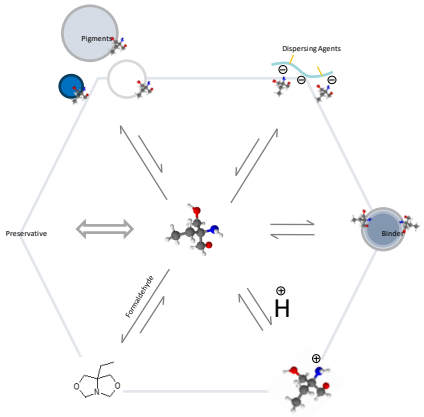
- Multiple interactions with several raw materials
- Support quality improvement and optimizations
- Versatile effects











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