Influence of polymer emulsions on durability of liquid acrylic elastomeric roof membranes

Artur Palasz, Ph.D.
Technical Center of Raw Materials
for Architectural Paints, Spektrochem, Poland

CTT Summit (Coatings Trends & Technologies Summit)
Lombard, IL, USA, September 7th, 2023

Coatings Trends & Technologies SUMMIT

Spektrochem

Your speaker

Artur Palasz, Ph.D.
Formulation scientist
Technical director

Professional baclbsround

- Polymer latex chemist
- Expert in formulating and testing of raw materials for waterborne paints
- Specialist in the ASTM testing

Spektrochem

Technical Center of Raw Materials for Architectural Paints

I am responsbile for

- Projects for US and European clients (raw materials producers)
- New business development
- Supervision of ASTM tests

Author of technical articles published by global coating journals

PCI Paint & Coatings Industry
European Coatings journal
Coatings World
Journal of Surface Coatings Australia
Pitture e Vernici european coatings formulation
PPCJ Polymers Paint Colour Journal
COATINGSTECH
American Coatings Association

Speaker at international conferences

The University of Southern Mississippi
Waterborne Symposium
European Coatings Show 2023
TT Coatings Trends & Technologies
ASTM International

Spektrochem

About us

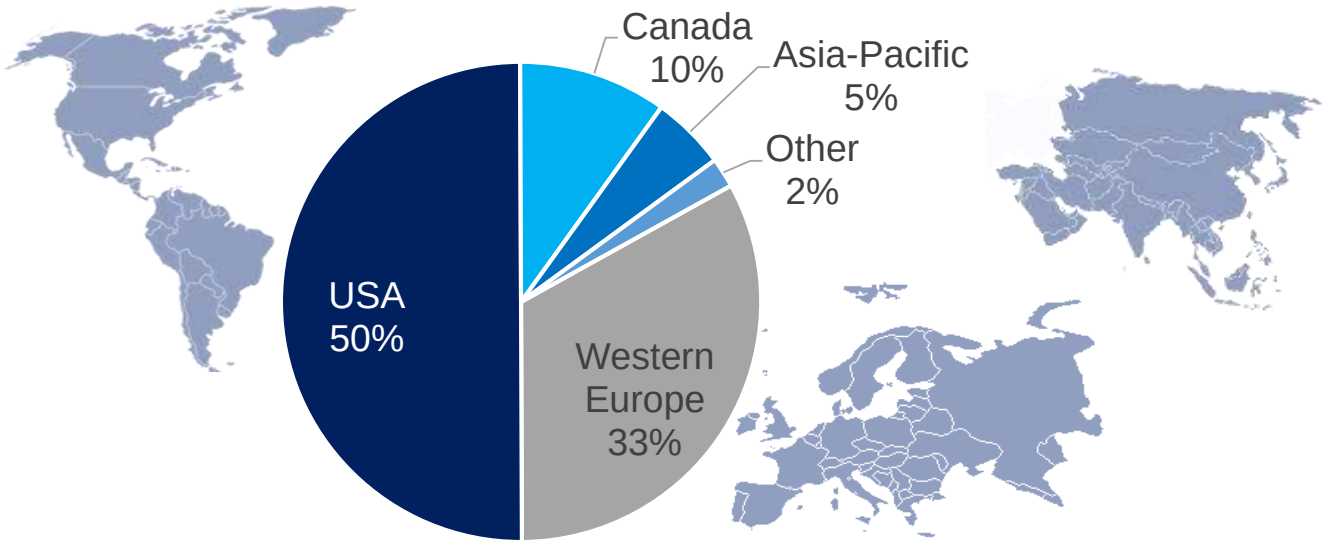
Who we are? Where we are?

We are a formulating and testing laboratory

We are located in Poland

We are a provider of knowledge about the efficiency of raw materials in formulations

We are an organizational member of ASTM



What we do?

We cooperate with raw material producers in the field of:

- Studies of raw materials in the formulations
- Start point formulations
- Comparison of raw materials performance
- Investigation of dosage efficiency
- Laboratory tests of paint and coatings

Case studies | Guideline formulations | Raw materials comparison | ISO and ASTM testing

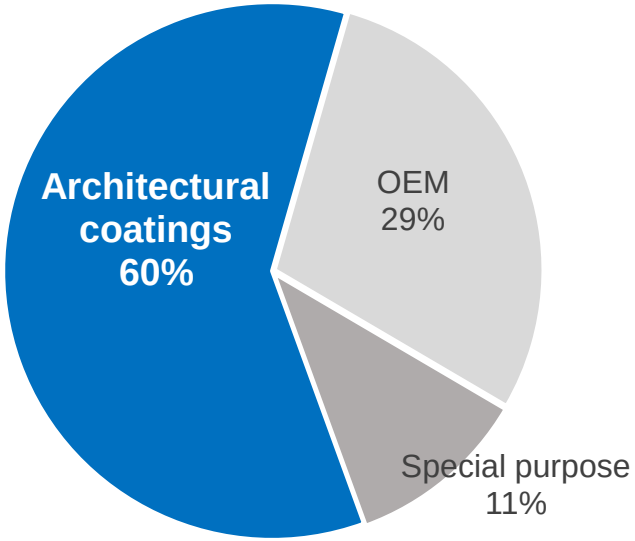
R&D → Technical marketing → Product support → Technical sale

Raw materials producer — raw material introduction → Paint producer

Spektrochem

Experts in evaluation of raw materials performance in WB paint formulations

US paint market * by volume



* source: American Coatings Association, 2017

Water-borne coatings

- Architectural latex paints
  - Interior wall and ceilings
  - Exterior facade
  - Easy-to-clean
  - Primers and undercoaters
  - Elastomeric roof membranes
- Wood coatings
  - Clear floor varnishes
  - Trim paints and enamels
  - Joinery and general purpose
- DTM coatings (direct-to-metal)
  - DIY and industrial

- Renewable and BIO-resources
- Sustainability
- Circular economy and upcycling

Raw materials

- Binders
  - Acrylic copolymer emulsions
  - Alkyd emulsions
  - 1K and 2K PU dispersions
  - 2K epoxy dispersions
- Additives
  - Rheology modifiers
  - Wetting and dispersing
  - Defoamers
  - Flow and leveling agents
  - Freeze-thaw additives
  - Open-time extenders
  - Waxes and other…
- Standard and functional fillers, e.g.
  - Nepheline syenite, kaolin, talc
- Pigments
  - TiO_2, pigments for tinting

Spektrochem

Introduction

Why paying attention to the proper performance of raw materials in liquid elastomeric roof membranes formulations is so important:

- Roofs are most exposed to weather conditions
- The application requires a weather window
- Renovation, disassembly of roof elements are expensive

Factors Impacting Critical Performance Features

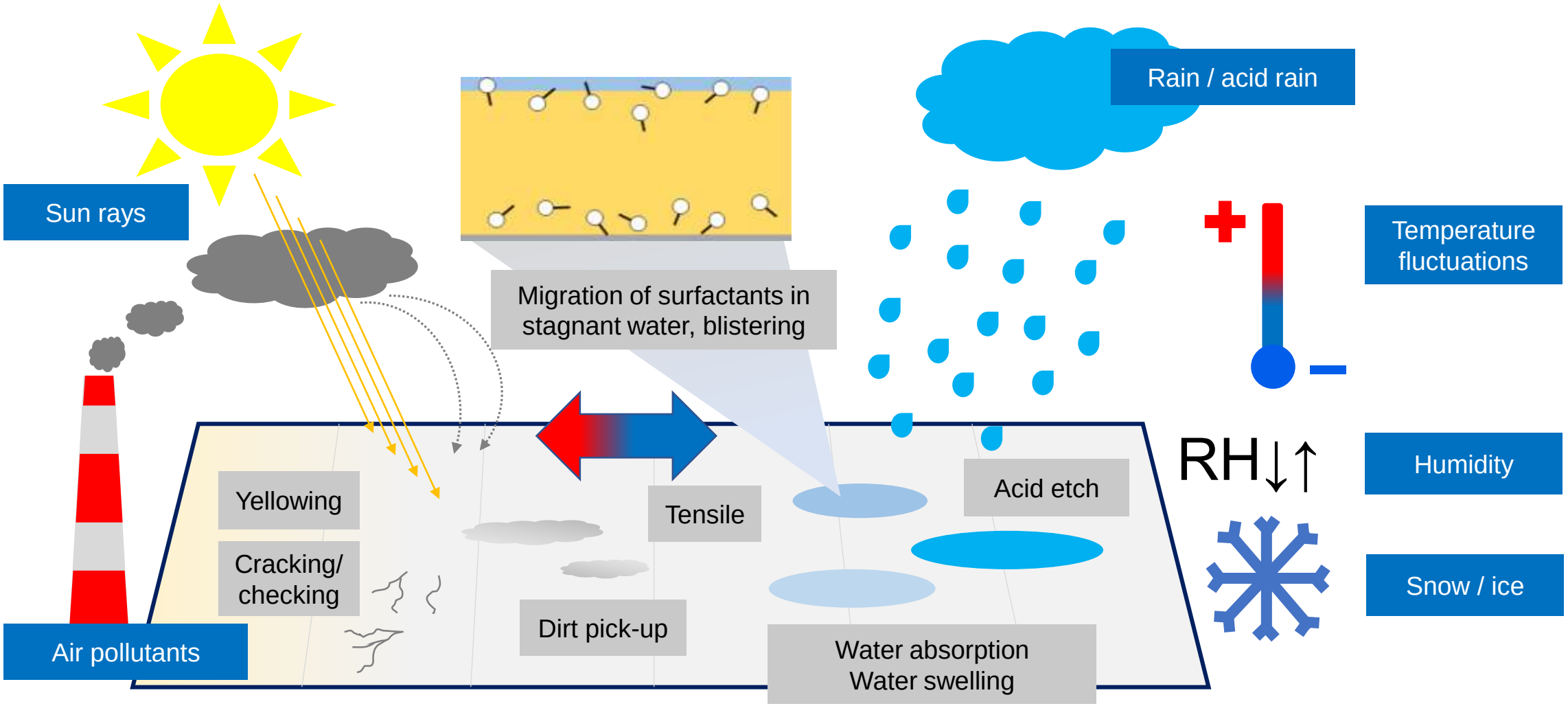
To ensure long-lasting performance, it is necessary to test raw materials in the formulation for:

- Changes in properties under the influence of weathering conditions (loss of flexibility, chalking, etc.)
- Effect on water absorption
- Dirt pick-up

…and providing this knowledge to formulators

Spektrochem

Factors causing weathering on roofings



Spektrochem

Polymer emulsions for studies

The project uses 9 polymer dispersions dedicated to elastomeric roof membranes

Polymer dispersion	Type	Surfactants	Solid content	pH	Brookfield viscosity	MFFT	Tg
A	Styrene-acrylic	Anionic/non-ionic	50%	8.3	4,500 mPa · s	0 °C	0 °C
B	Hydrophobic acrylic	No data	55%	8.0 – 8.5	100 – 1,000 mPa · s	10 °C	No data
C	Styrene-acrylic	Anionic (biodegradable)	50%	7.0 – 8.0	< 450 mPa · s	< 1 °C	– 5 °C
D	Styrene-acrylic	Anionic (biodegradable)	50%	7.0 – 8.0	1,500 – 6,000 mPa · s	< 1 °C	– 5 °C
E	Acrylic	Anionic	55%	9.3	< 200 mPa · s	0 °C	– 39 °C
F	Acrylic	Anionic	55%	9.5	500 mPa · s	0 °C	– 35 °C
G	Acrylic	No data	60%	5.0 – 7.0	1,300 mPa · s	0 °C	– 35 °C
H	Styrene-acrylic	No data	52.5%	6.0 – 7.0	< 600 mPa · s	0 °C	– 35 °C
I	Styrene-acrylic	No data	50%	7.0 – 8.0	2,000 – 6,000 mPa · s	0 °C	2 °C

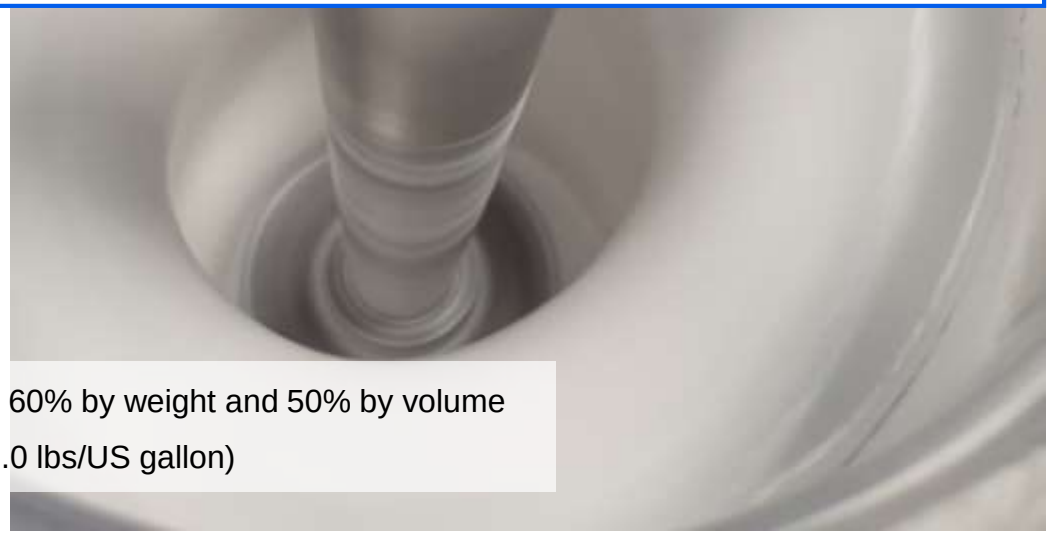
Spektrochem

Elastomeric acrylic roof membrane formulation

Formulation PVC 44% type I* ASTM D6083

Formulation	Pounds
Demineralized water	100.0 lbs
Propylene glycol	18.0 lbs
Dispersing additive	4.0 lbs
In-can preservative	3.0 lbs
Defoamer	2.0 lbs
Titanium dioxide	80.0 lbs
Ground calcium carbonate	354.0 lbs
Polymer emulsion (50% solids)	**420.0 lbs**
HEC thickener	3.0 lbs
Defoamer	1.0 lbs
Coalescing agent	5.0 lbs
Film preservative	10.0 lbs
Total	1,000 lbs

Adjustment of the amount of water and binder to maintain the same amount of solid binder and PVC depending on the solid content in the polymer dispersion (50%, 52.5%, 55%, 60%)



*type I: solids minimum 60% by weight and 50% by volume

Density: 1.44 g/cm^3 (12.0 lbs/US gallon)

Spektrochem

Testing program

Selected to demonstrate the effect of acrylic polymer dispersions on Factors Impacting Critical Performance Features

QUV exposure

Instrument:
QUV/spray chamber with UVB-313EL lamps

- ASTM G154 cycle 5
- 1,000 hrs exposure
- 0.62 W/m^2 @310 nm
- 20 h UV @80 °C
- 4 h condensation @50 °C

Coatings on A-36 Q-Panels
- 14 days donditioning

Evaluation after exposure

Instruments:
Bend tester (cylindrical)
Spectrophotometer
Reflectometer 45/0

- ASTM E313 WI & YI
- ASTM D522 bend test
- ASTM D4213 chalking

Tests immediately after exposure in the chamber

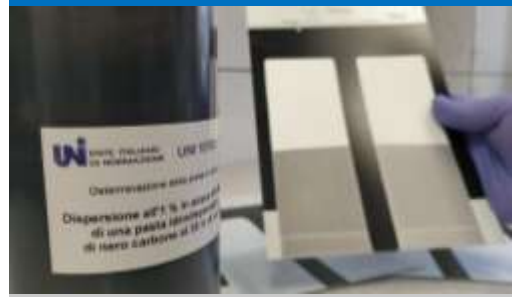
Water absorption

Instrument:
Analytical scale and water bath

- 7 days immersion
- DI water < 5 µS/cm
- Test at 73.5 °F / 23 °C

Tests on free-coatings:
- Application on release paper
- 14 days conditioning

Dirt pick-up resistance



Instrument:
Spherical spectrophotometer di:8°

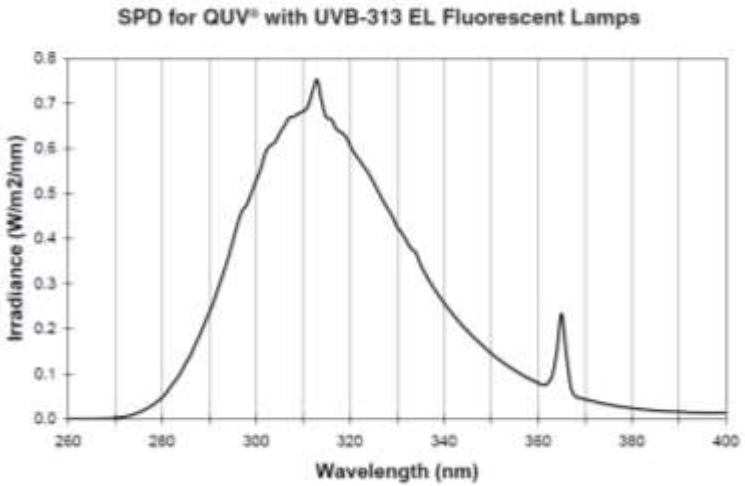
UNI 10792 Italian Standard:
- 30 sec immersion in 2% solution of carbon black pigment concentrate
- 10 sec rinsing under running water
- Results as ΔL (D65/10°)

Spektrochem

UVB-313 exposure test

Why did we choose ASTM G154 cycle 5 for testing?

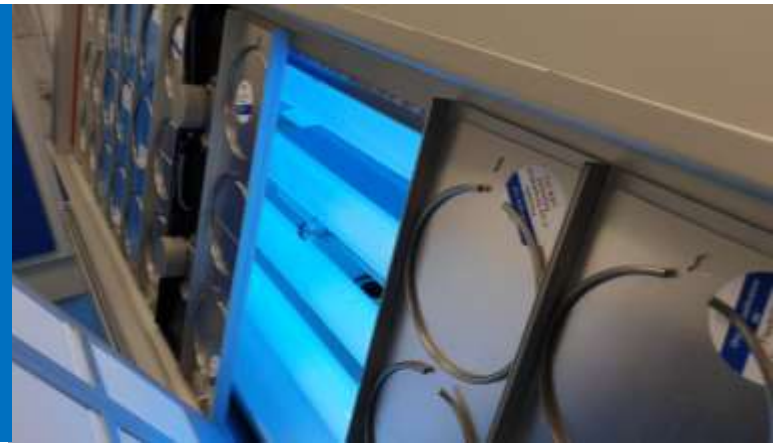
- We want to simulate the harshest weathering acceleration
- We simulate the test in a very short UV wave responsible for extreme damage to the coatings
- Temperature during UV cycle is 20 °C higher than ASTM G154 cycle 1
- The use of condensation instead of water-spray allows to observe chalking (water-spray washes away chalking traces)



Source: Q-Lab Technical Bulletin LU-8051 Spectral Power Distribution for QUV with UVB-313 EL Fluorescent Lamps

Comparison of the exposure cycle used with the most common one

ASTM G154 cycle 1	ASTM G154 cycle 5
Lamps: UVA-340*	**Lamps: UVB-313EL***
8 h UV at 60 °C 0.89 W/m² @340 nm	20 h UV at 80 °C 0.62 W/m² @310 nm
4 h condensation at 50 °C	4 h condensation at 50 °C
*UV spectrum especially from 295 to 370 nm	*Lamps include significant unnatural radiation below the solar cut-off of 295 nm



Spektrochem

Flexibility at low temperature (bend test)

ASTM D522 flexibility on Ø 0.5 in. (13 mm) cylindrical mandrel

Properties		Polymer emulsion in the formulation								
		A	B	C	D	E	F	G	H	I
Before exposure	Bend test at 14 °F / –10 °C	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
	Bend test at –15 °F / –26 °C	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Pass
After exposure UVB-313 1,000 hrs	Bend test at 14 °F / –10 °C	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Fail
	Bend test at –15 °F / –26 °C	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass	Fail
MFFT		0 °C	10 °C	< 1 °C	< 1 °C	0 °C	0 °C	0 °C	0 °C	0 °C
Tg		0 °C	No data	–5 °C	–5 °C	–39 °C	–35 °C	–35 °C	–35 °C	2 °C
Copolymer*		SA	A	SA	SA	A	A	A	SA	SA

**Copolymer: SA – styrene/acrylic, A – pure acrylic*

Spektrochem

In-depth analysis of flexibility loss (fails)

Initial flexibility

14 °F
(–10 °C)

–15 °F
(–26 °C)

A	B	C	D	I
Pass	Pass	Pass	*	Pass
Pass		*		Pass

After 1,000 h
UVB-313

14 °F
(–10 °C)

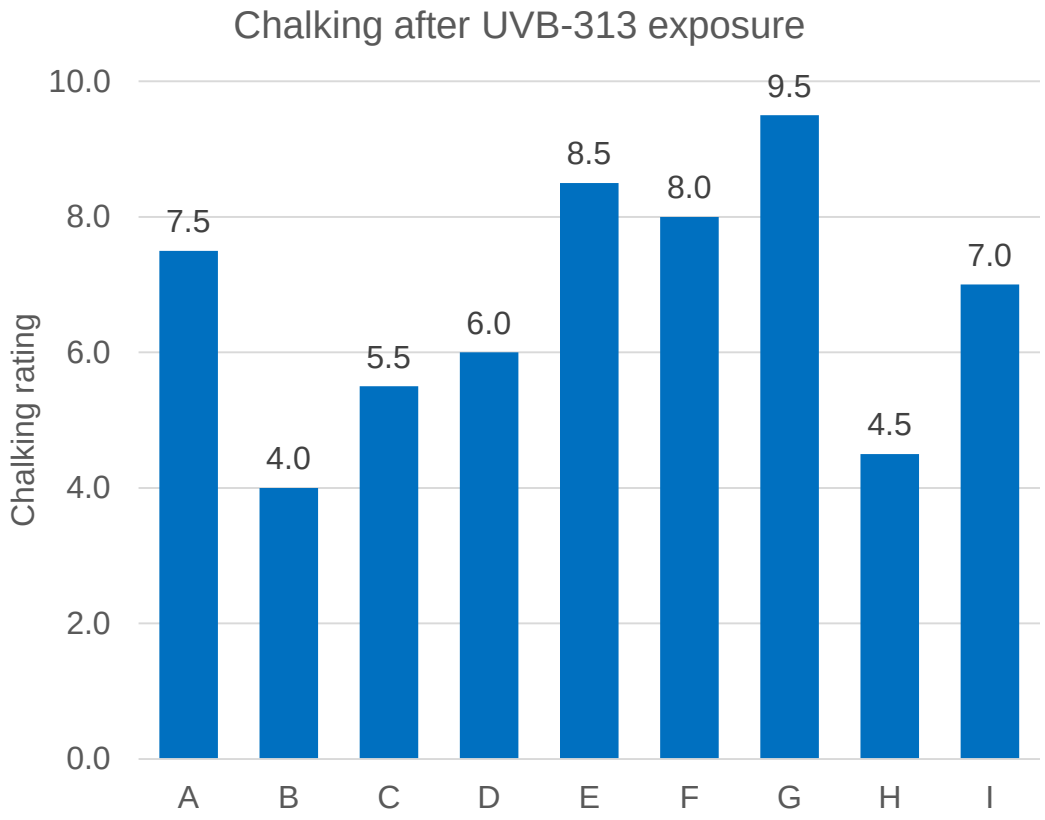
–15 °F
(–26 °C)

A	B	C	D	I
Pass		*	*	
*			*	*

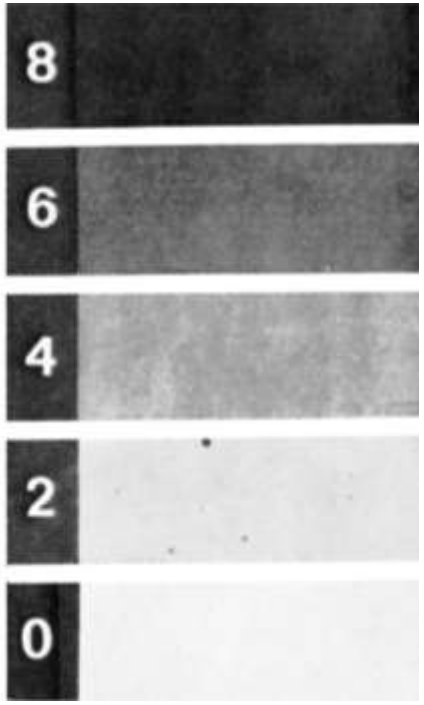
*10x magnification

Spektrochem

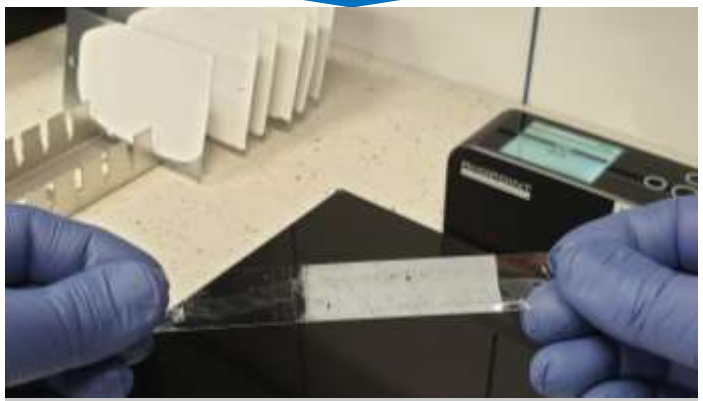
Chalking



ASTM D4213 rating



Tape method



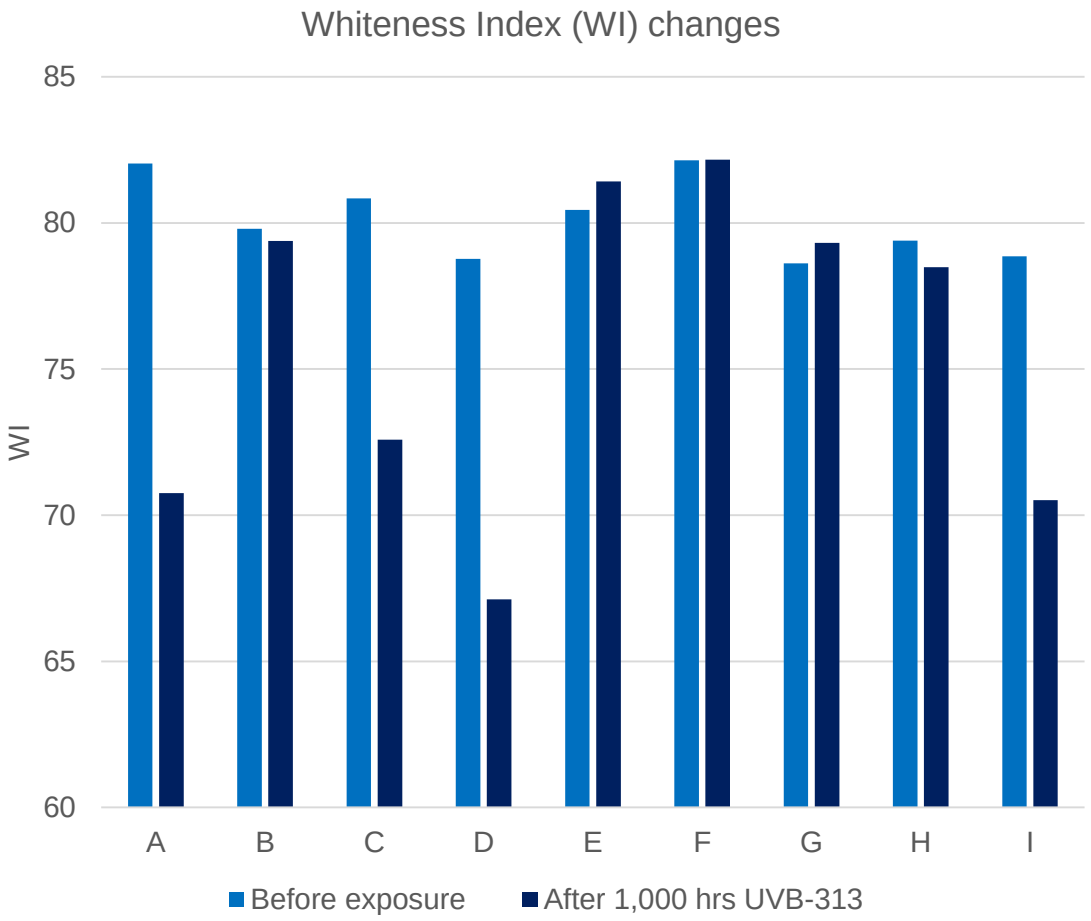
Instrument:
Reflectometer, tape and black glass

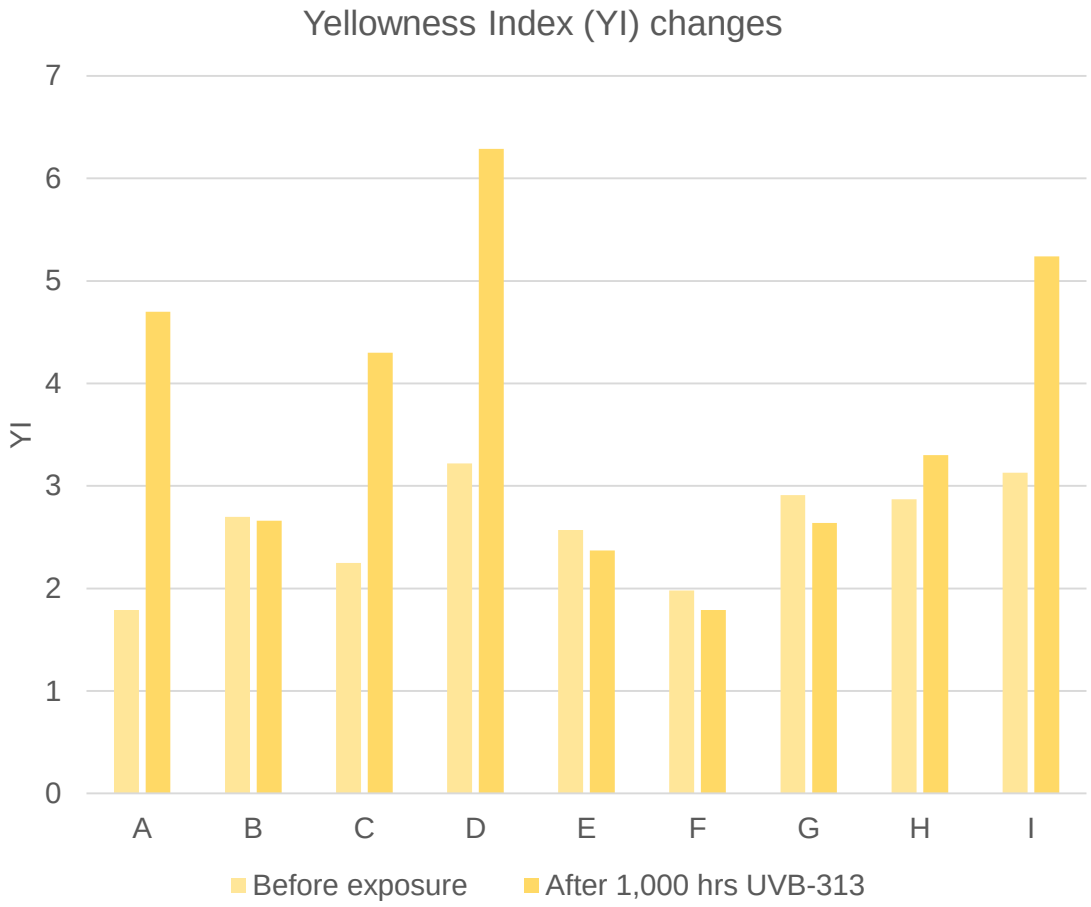
- ASTM D4213 method C
- Evaluation with ASTM rating
- Tests after 1,000 hrs in QUV (ASTM G154 cycle 5)

Spektrochem

Whiteness and yellowness

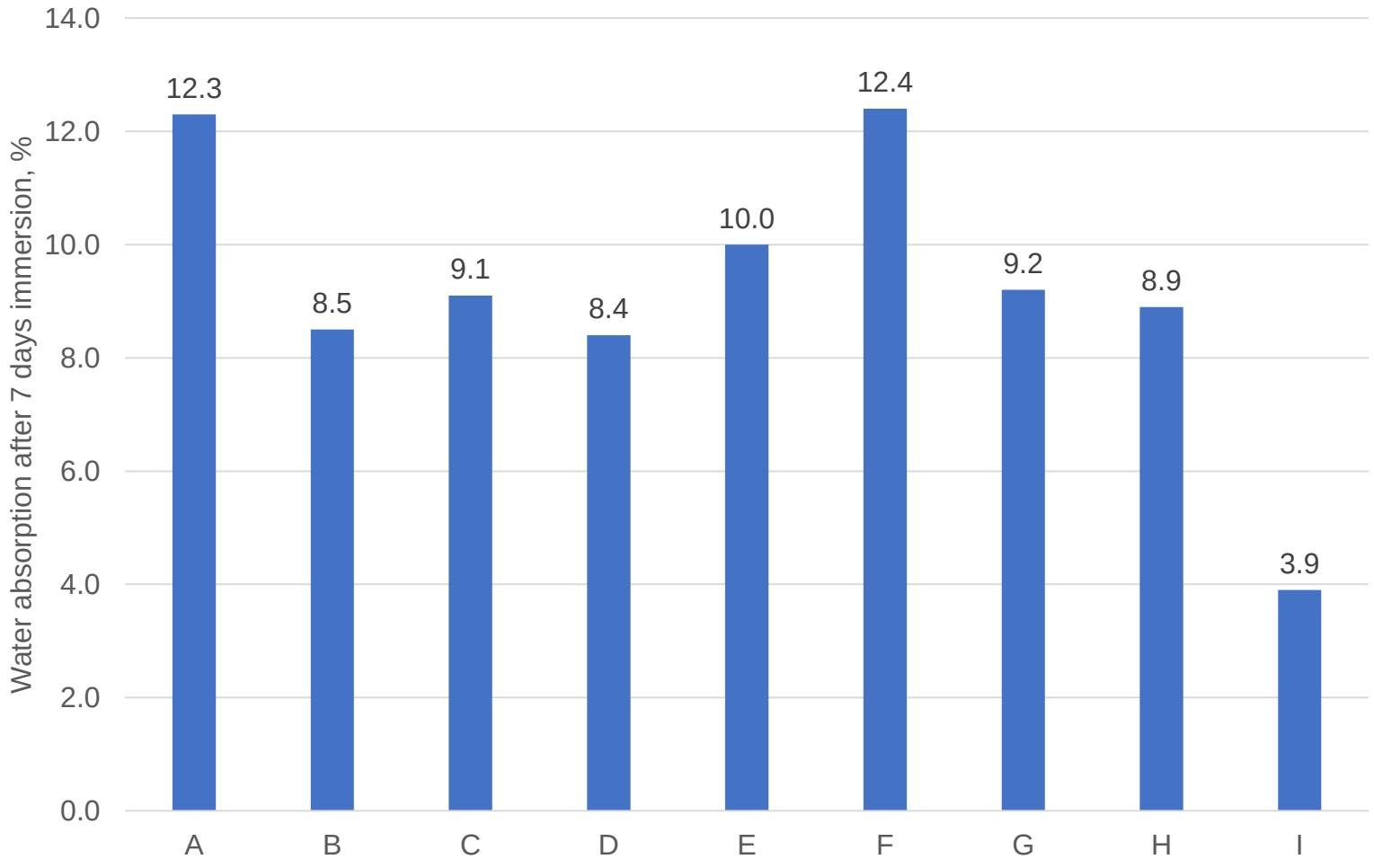
ASTM E313 measurement before and after exposure





Spektrochem

Water absorption



Water absorption test

Instrument:
Beaker with DI water and lab scale

- 7 days immersion @73.5 °F/23 °C
- DI water < 5 µS/cm @77 °F/25 °C
- Free-coating without substrate
- Dry film thickness 0.5 mm/20 mils
- 7 days conditioning
- Requirement max. 20%

Spektrochem

Dirt pick-up

Properties	Polymer emulsion in the formulation								
	A	B	C	D	E	F	G	H	I
Dirt pick-up, *ΔL*	0.00	0.00	0.07	0.06	0.00	0.02	0.00	0.00	0.03

Dirt pick-up rating (UNI 10792):

Very low	*ΔL* ≤ 3
Low	> 3 *ΔL* ≤ 9
Medium	> 9 *ΔL* ≤ 15
High	*ΔL* > 15

Final recommendation

Based on the case studies conducted, the results can be summarized as

Polymer dispersion	Initial flexibility		Flexibility after UVB-313 exposure		Yellowing	Chalking	Water absorption	Dirt pick-up resistance
	14 °F (–10 °C)	–15 °F (–26 °C)	14 °F (–10 °C)	–15 °F (–26 °C)				
A	★★★	★★★	★★★	★	★	★★★	☆☆	★★★
B	★★★	★	★	★	☆☆	★	☆☆	★★★
C	★★★	★	★	★	★	☆☆	☆☆	★★★
D	★	★	★	★	★	☆☆	☆☆	★★★
E	★★★	★★★	★★★	★★★	☆☆	★★★	☆☆	★★★
F	★★★	★★★	★★★	★★★	★★★	★★★	☆☆	★★★
G	★★★	★★★	★★★	★★★	☆☆	★★★	☆☆	★★★
H	★★★	★★★	★★★	★★★	☆☆	★	☆☆	★★★
I	★★★	★★★	★	★	★	★★★	★★★	★★★

★ Low efficiency ☆☆ Moderate efficiency ★★★ The best efficiency

Spektrochem

Summary

For the formulator of liquid roofing membranes :

- Using such data as shown makes it easier to choose the direction in which the binder is selected
- The presented case studies show how parameters change after weathering tests
- The use of recommendation tables facilitates the quick selection of the binder for the project and research in the R&D department

For manufacturer of polymer dispersions:

- Providing the manufacturer of elastomeric liquid membranes with such recommendations allows you to be more competitive
- Carrying out such screening tests allows to determine the application to membranes intended for various operating temperatures
- It's easier to talk to the R&D department about the advantage

Experts in evaluating raw material efficiency in architectural paint formulations

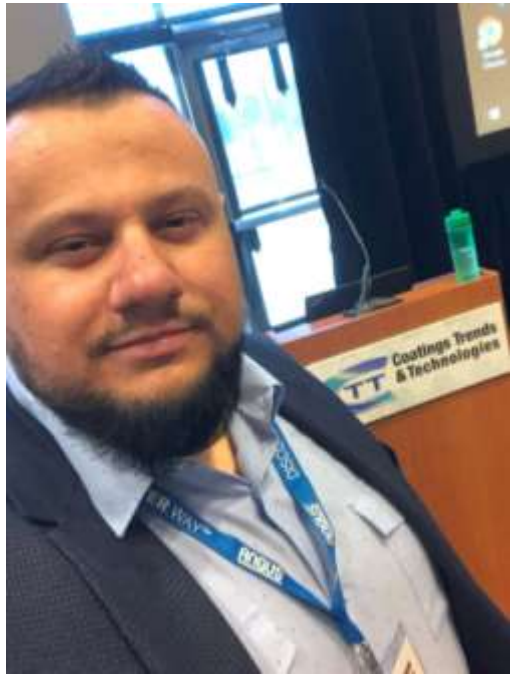
Stop at our stand

Table #52

Spektrochem

Coatings Trends & Technologies SUMMIT

Thank you for your attention



More to discuss?

E-mail: artur.palasz@spektrochem.pl

/arturpalasz

Let's Connect

Spektrochem