



Development of an Innovative Exterior Paint for Compelling Conditions as Low Temperature and High Relative Humidity

**Barış Bakar, Yelda Yorulmaz, Sinem Tümer, Dr.
Funda İnceođlu, Gülden Tombaş, Ece Ünlü Pınar**

**Kalekim Construction Chemicals Co. Inc.
R&D Department
barisbakar@kale.com.tr**

06.12.2023

Overview

- Purpose
- Project Requirements
- Experimental Studies
- Performance Tests
- Conclusion

Purpose

- Climate Change
 - Merging Seasons
 - Warmer and Dry Winters
- Rapid Urban Transformation
 - Non-stop Construction Sites
 - Short Deadlines



Performance Goals

MFFT	: 1°C (80-85% RH)
Crack Bridging	: A1 (> 100 µm)
Freeze Thaw Stability	: 5 Cycles (-18°C - 23°C, ASTM D2243)
Early Rain Resistance (E.R.R.)	: <12 hours (heavy rain)
Additional	: W3, V1, efflorescence resistance

Potential Pathways

- Quick-Set Acrylic Polymers
- Low MFFT Acrylic Polymers
- Early Rain Resistance / Film Forming Additives

Test Methods

Efflorescence Resistance

- Test blocks: cement-mineral filler mixture (low porosity)
- Solution: 3% Potassium nitrate in DI water
- Duration: 14+ days



Test Methods

Early Rain Resistance

- Durability
- Drying Angle
- Showthrough



Wash-off

Blistering

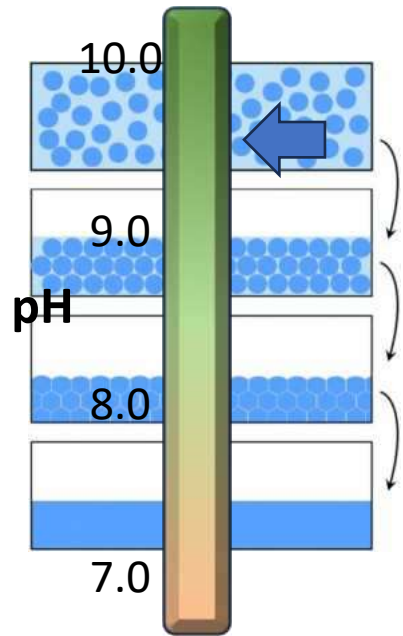
Wrinkling

PEI as E.R.R. Agent

- Adhesion Promoter – Printing Inks, Laminated Films
- Highly branched polymer structure
- Cationic polymer - high affinity for surfaces and anionic substrates
- MW: 2000-25000 g/mol

	pH Level	Effect
• In-can	: > 9.5 is advised	Stable wet state
• Drying	: < 9.0 to trigger reaction	PEI reacts with carboxylic groups

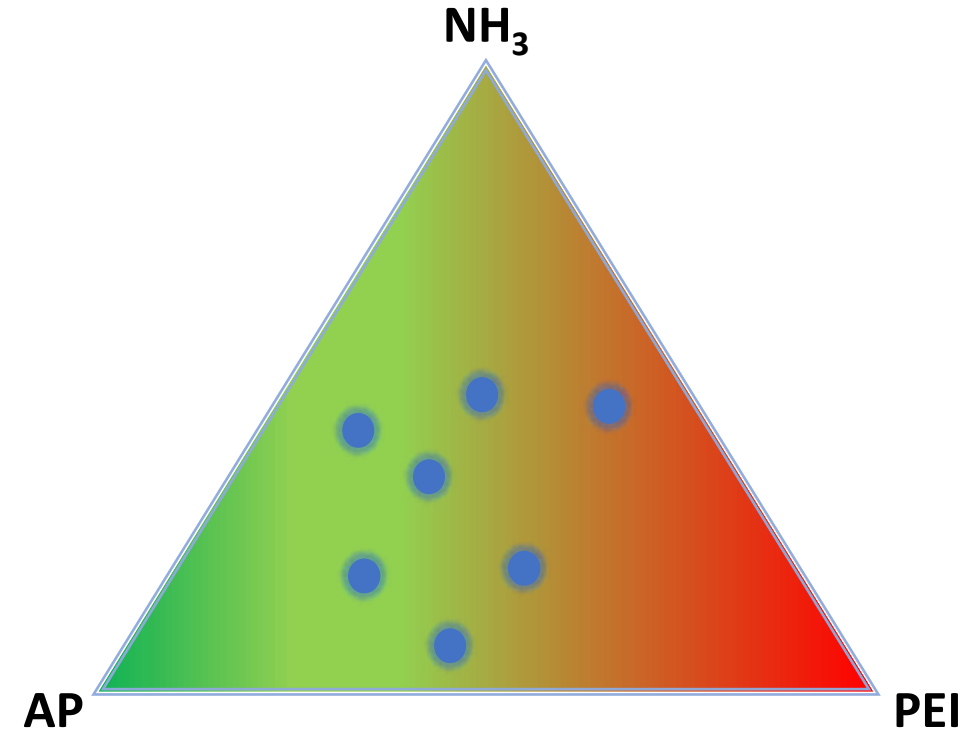
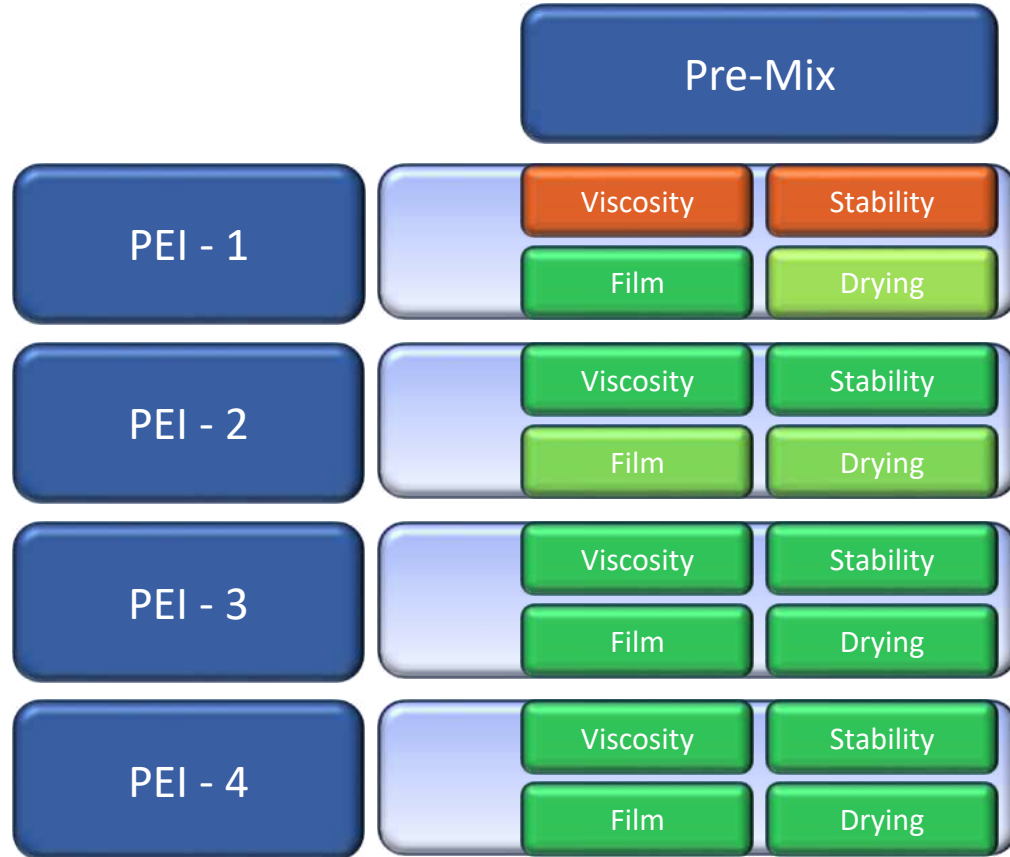
PEI as E.R.R. Agent



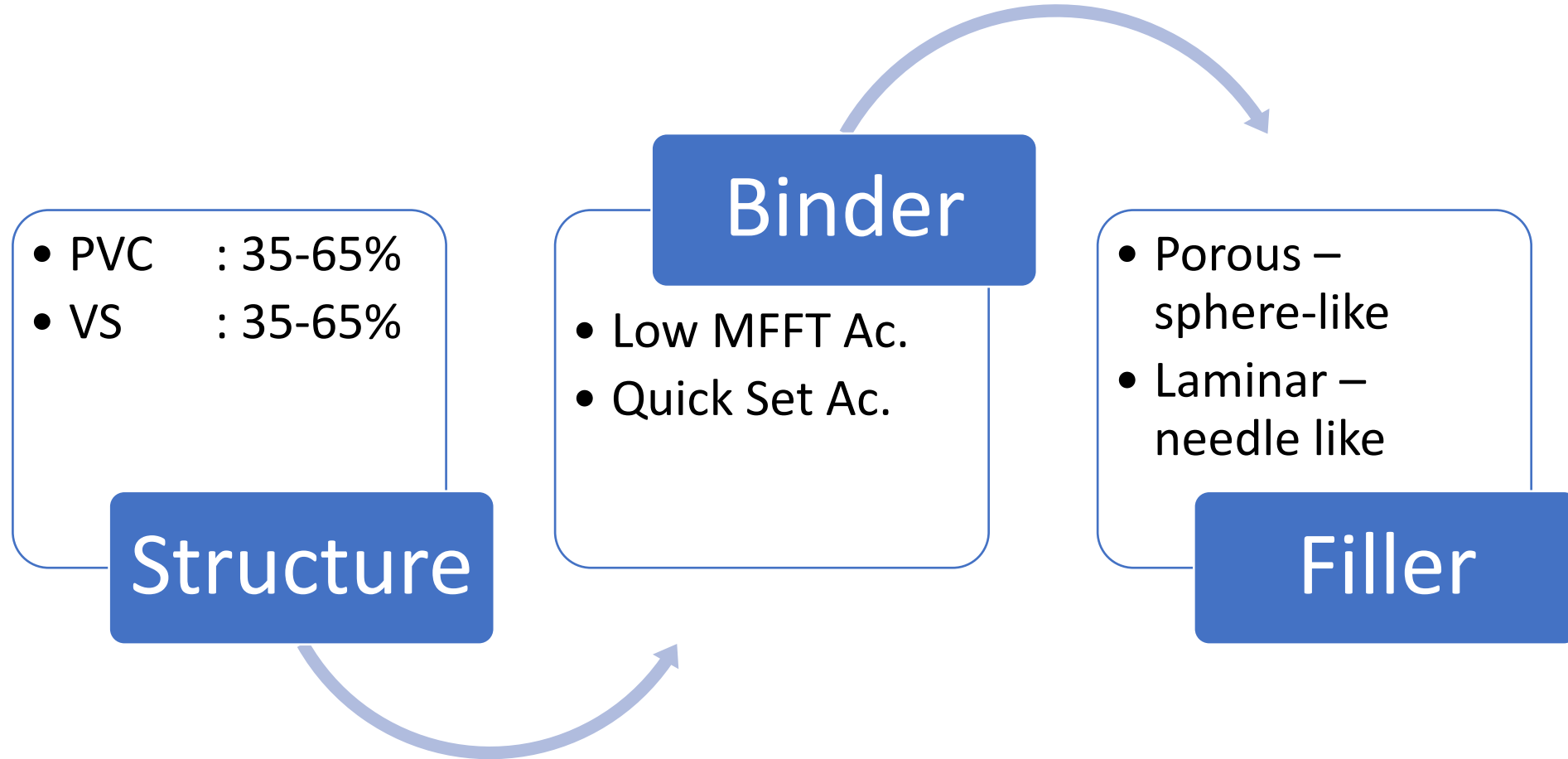
drying e
dry
film



Early Formulation Trials



Formulation Trials



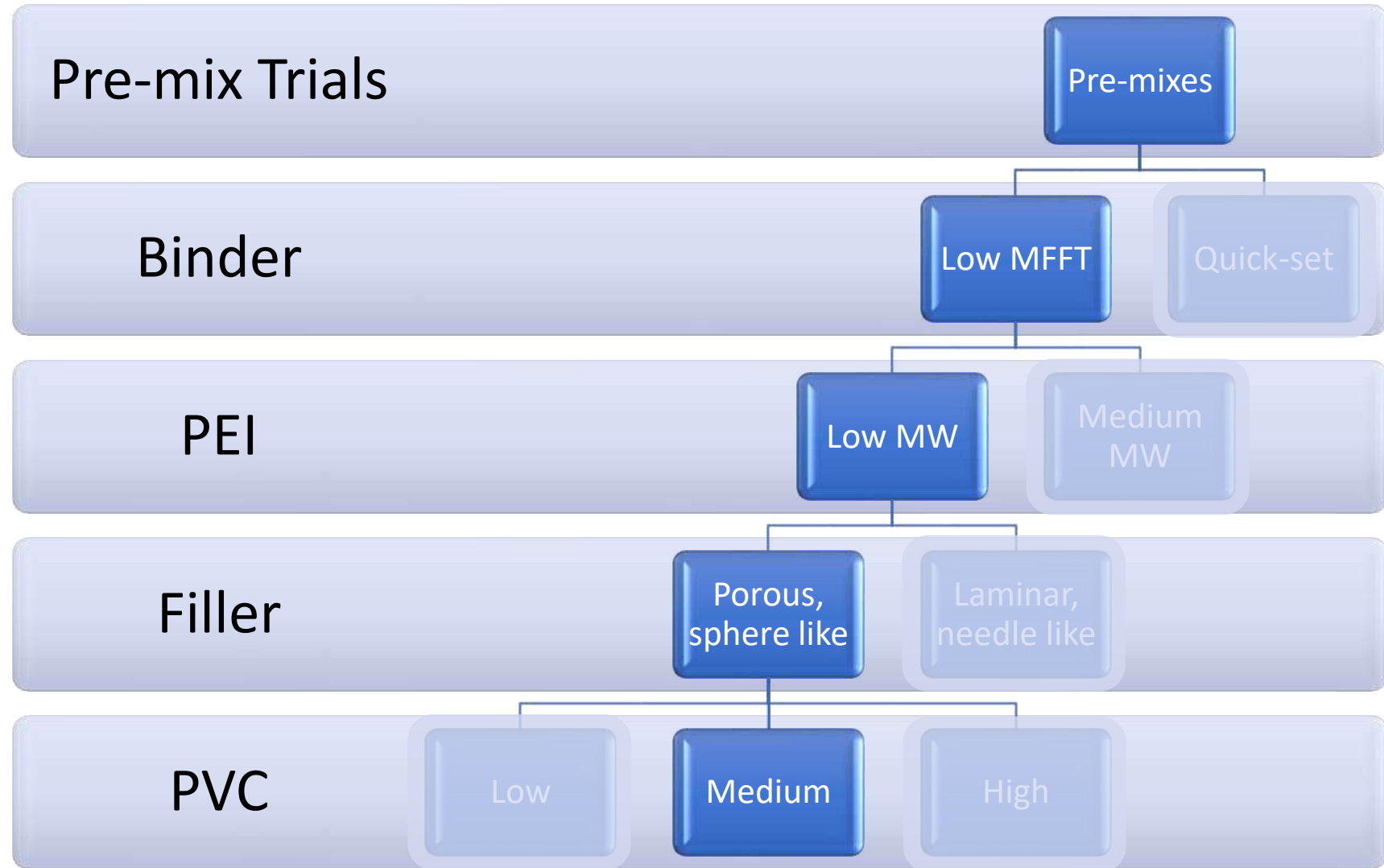
Formulation Trials

Quick-set acrylics: not suitable for application over 10-15 °C

PEI: Low MW PEI's, stable and proper film forming. Optimum ratio: 2.2 % w/w

Filler: Porous fillers are better for drying, no major influence on film forming

PVC: ~55%, optimum for drying, film forming and other properties.

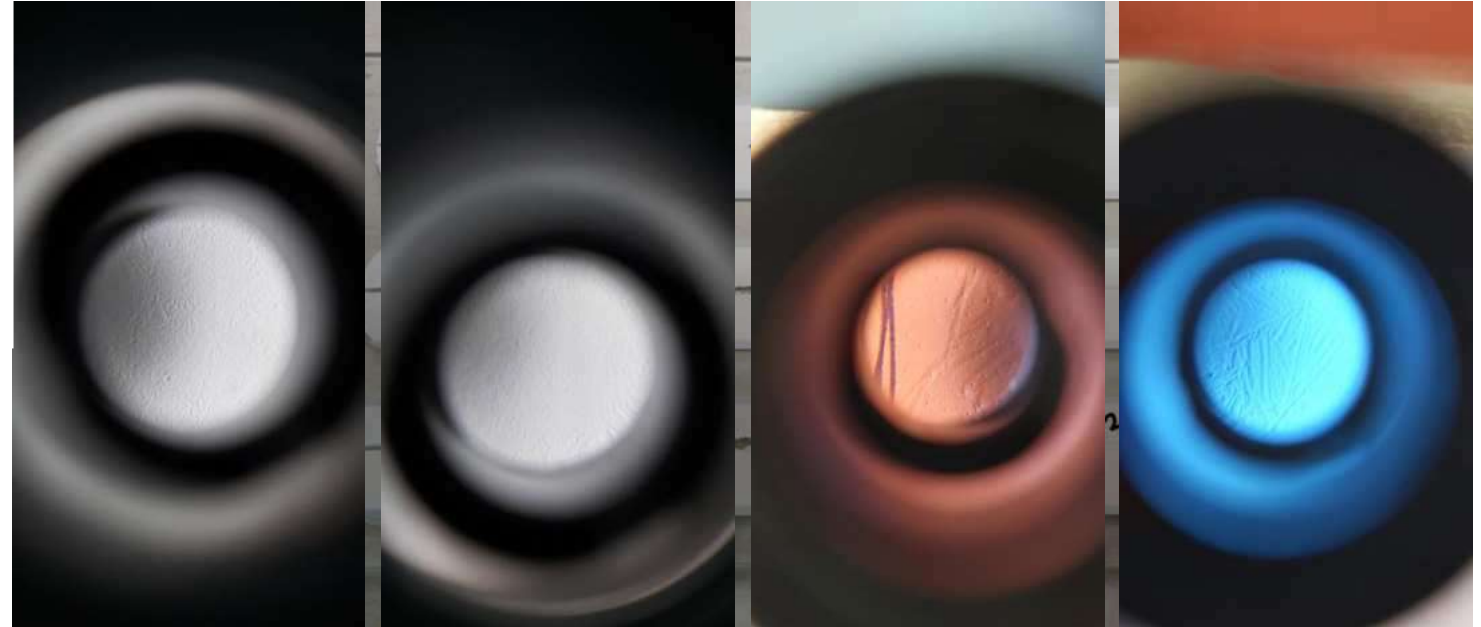


Performance Tests

Drying Time (1 °C, 85 % RH)



MFFT (0 °C)



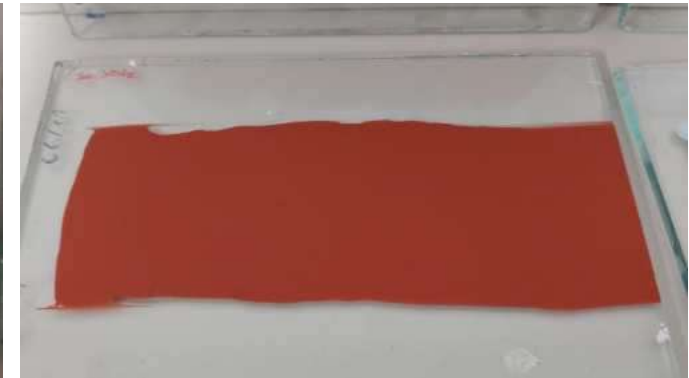
Main body drying is slightly affected
Surface texture drying is slightly affected

Performance Tests

Early Rain Resistance (1 °C, 85 % RH)

Showering Rain
(5 L/min)

Early rain resistance is
achived between
5 h 30 min – 6 h 30 min
for all bases



Performance Tests

Efflorescence Resistance

Observed for 14 Days

Performance via
comparison

Clear for first 7 days
Visually better than
reference

No major «blooming»



Performance Tests

Crack Bridging (Con: 23 °C, 50% RH)

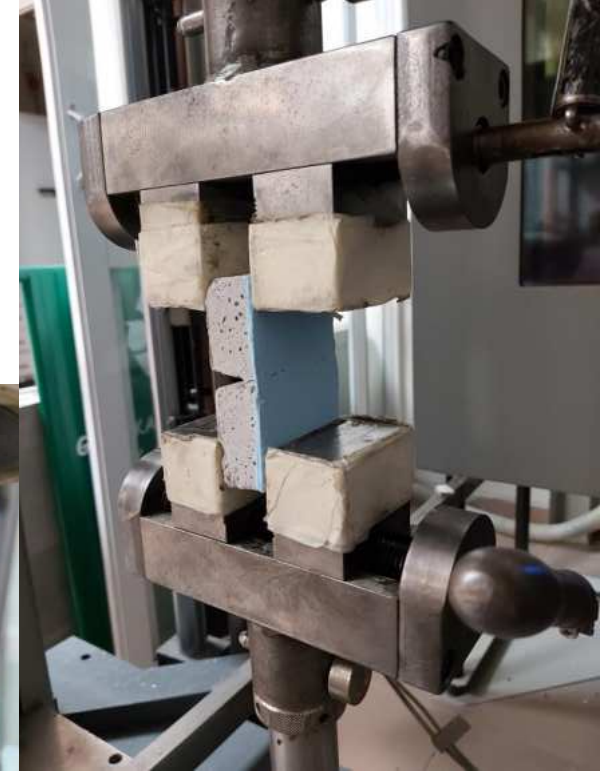
TS EN 1062-7

Speed : 0.05 mm/min

Aim : A1 (100-250 µm)

Measurement : 150-200 µm

Consumption : 0.12-0.13 L/m² (2x)



Conditioned Room Applications

1°C, ~%85 RH

- Leveling, Sagging
- Drying Time – Open Time
- Ease of Application
- Yellowing (White Base)
- Surface Defects



Outdoor Applications

~27°C, Windy, Direct Sun

- Leveling, Sagging
- Drying Time – Open Time
- Ease of Application
- Yellowing (White Base)
- Surface Defects



Natural & Accelerated Weathering

- Color Measurements
- Gloss
- (USA B10 fluorescent lamp)
- Dirt Pick-up



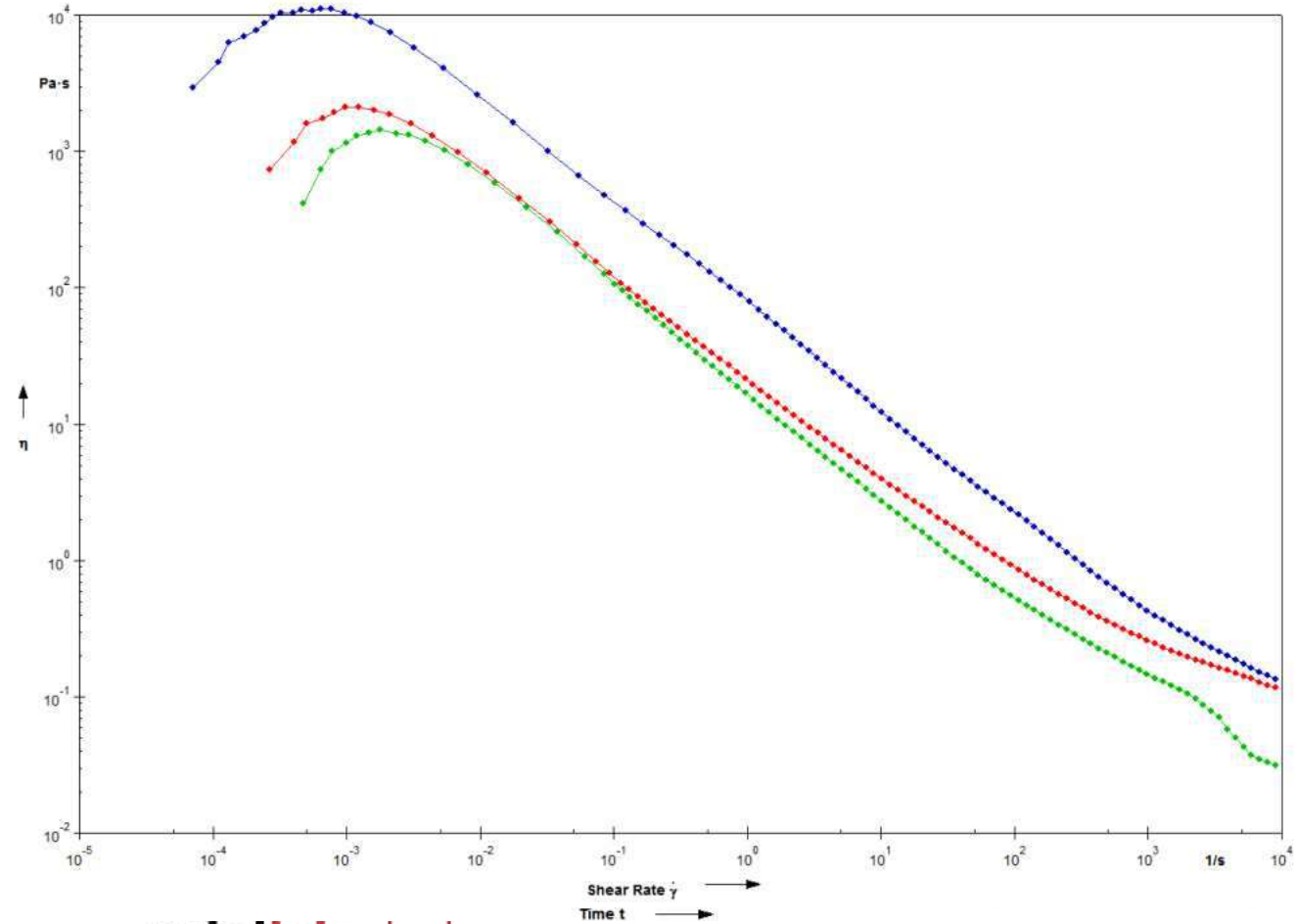
th

		Reference											
Initial		L	a	b									
1. M	B1D1	95,07	-0,79	2,66	-1,15	0,04							
	B1D2	95,71	-0,76	2,47	-0,51	0,07	0,97	1,1	-0,51	0,07	0,97	1,1	
		L	a	b	ΔL	Δa	Δb	ΔE	$\Sigma \Delta L$	$\Sigma \Delta a$	$\Sigma \Delta b$	$\Sigma \Delta E$	
3. M	B1D1	92,44	-0,65	4,08	-2,63	0,14	1,42	2,99	-3,78	0,18	2,58	4,58	
	B1D2	93,1	-0,67	3,78	-2,61	0,09	1,31	2,92	-3,12	0,16	2,28	3,87	
		L	a	b	ΔL	Δa	Δb	ΔE	$\Sigma \Delta L$	$\Sigma \Delta a$	$\Sigma \Delta b$	$\Sigma \Delta E$	
6. M	B1D1	89,62	-0,45	5,26	-2,82	0,2	1,18	3,06	-6,6	0,38	3,76	7,61	
	B1D2	90,29	-0,45	4,77	-2,81	0,22	0,99	2,99	-5,93	0,38	3,27	6,78	

Rheological Analyzes

Flow Curve: Application Properties
Thixotropy: Sagging - Leveling

Reference Ext. Paint 1
Reference Ext. Paint 2
New Formulation



Pilot Production

1000 kg for white base

	Target	R&D	QC
Brookfield Vis. ($\times 10^3$ cPs) (sp 6-10/100 rpm)	16.5 \pm 3.0 / 3.50 \pm 1.0	19.1 / 3.48	16.4 / 3.10
d (g/mL)	1.50 \pm 0.02	1.49	1.49
ICI (Ps)	1.2 \pm 0.4	1.4	1.16
Gloss (60° / 85°)	2.5 \pm 1.0 / 5.5 \pm 1.5	2.7 / 4.6	2.7 / 4.4
Hiding Power (200 μ m)	> 98.00	98.68	98.37
Storage Stability ($\times 10^3$ cPs) (sp 6-10 rpm) (80°C, 7 d)	< 40.00	30.6	32.7
pH	> 9.5	9.85	10.25
MFFT	\leq 1.0	\leq 1.0	-
E.R.R. (1°C, ~%85 RH)	12 h	~ 6.5 h	-
Crack Bridging (Class)	A1	A1 (~170)	-
Water Permeability (Class)	W3	W3	W3
Water Vapor Permeability (Class)	V1	V1	V1
Freeze Thaw Stability (-18 °C 16 h, 23 °C 8 h)	Positive	Positive	Positive
Film Structure (foam, blistering, cracking, etc.)	Positive	Positive	Positive

Results and Discussion

- Quick-set acrylics provide solutions for narrow applications
- Although proven to be successful, PEI is hard to handle in a formulation and requires sensitive adjustments
- PEI molecular weight plays a significant role for performance
- Structure of the fillers provided enhancements for drying times but had little to no effect for E.R.R.

THANK YOU FOR YOUR ATTENTION

QUESTIONS?

barisbakar@kale.com.tr

