DIRT-PICKUP RESISTANCE IN LOW T_g ELASTOMERIC COATINGS

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Western Coatings Symposium
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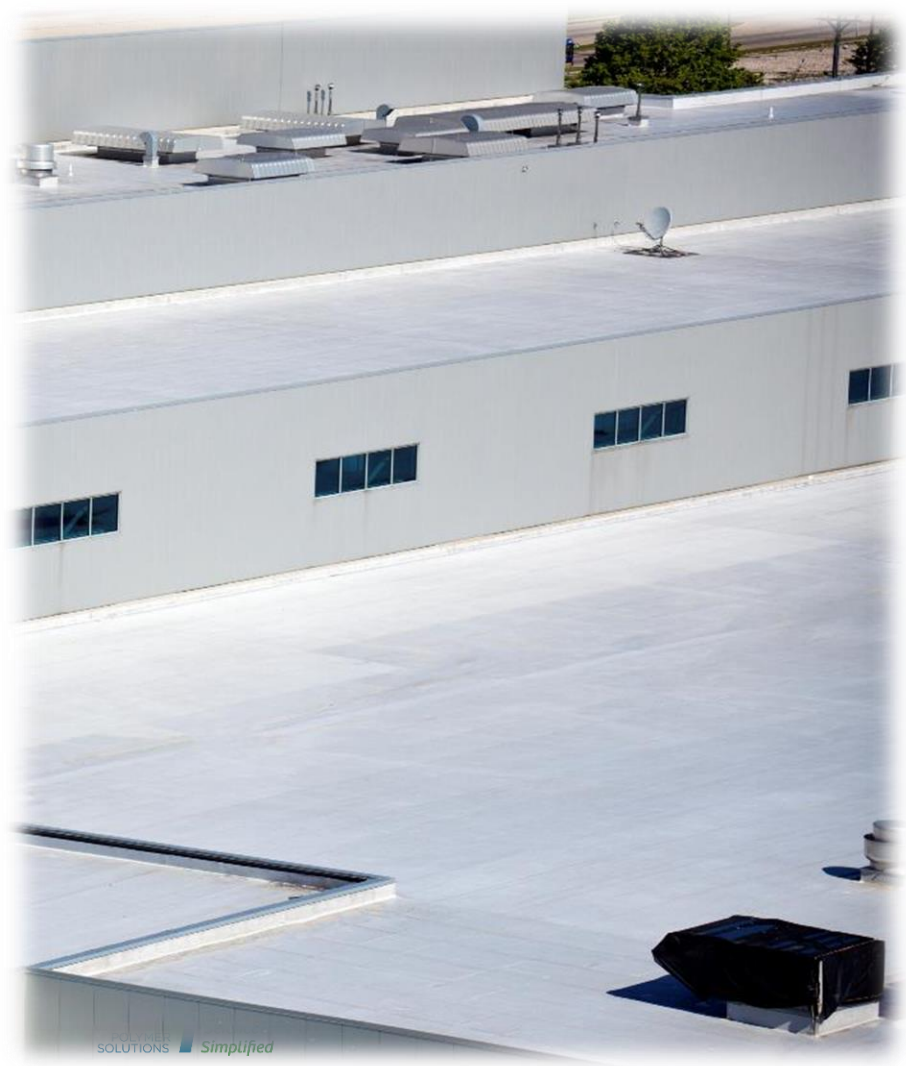

- **Dirt-pickup resistance** (DPUR) is a key requirement for exterior coatings.
- DPUR can impact aesthetics, but more importantly, it can significantly impact **building energy costs** in roof coating applications
- Agenda
  - DPUR in soft elastomeric roof coatings
  - Traditional means to improve DPUR
  - New resin technology in soft elastomeric coatings

What is a Roof Coating?

RCMA (Roof Coatings Manufacturers Association)

- Roof Coating: A fluid-applied adhered coating used for roof maintenance, roof repair, or as a component of a roof covering system or roof assembly

Cool Roof Coatings

- A roof coating that has been designed to reflect more sunlight and absorb less heat than a standard roof – www.energy.gov

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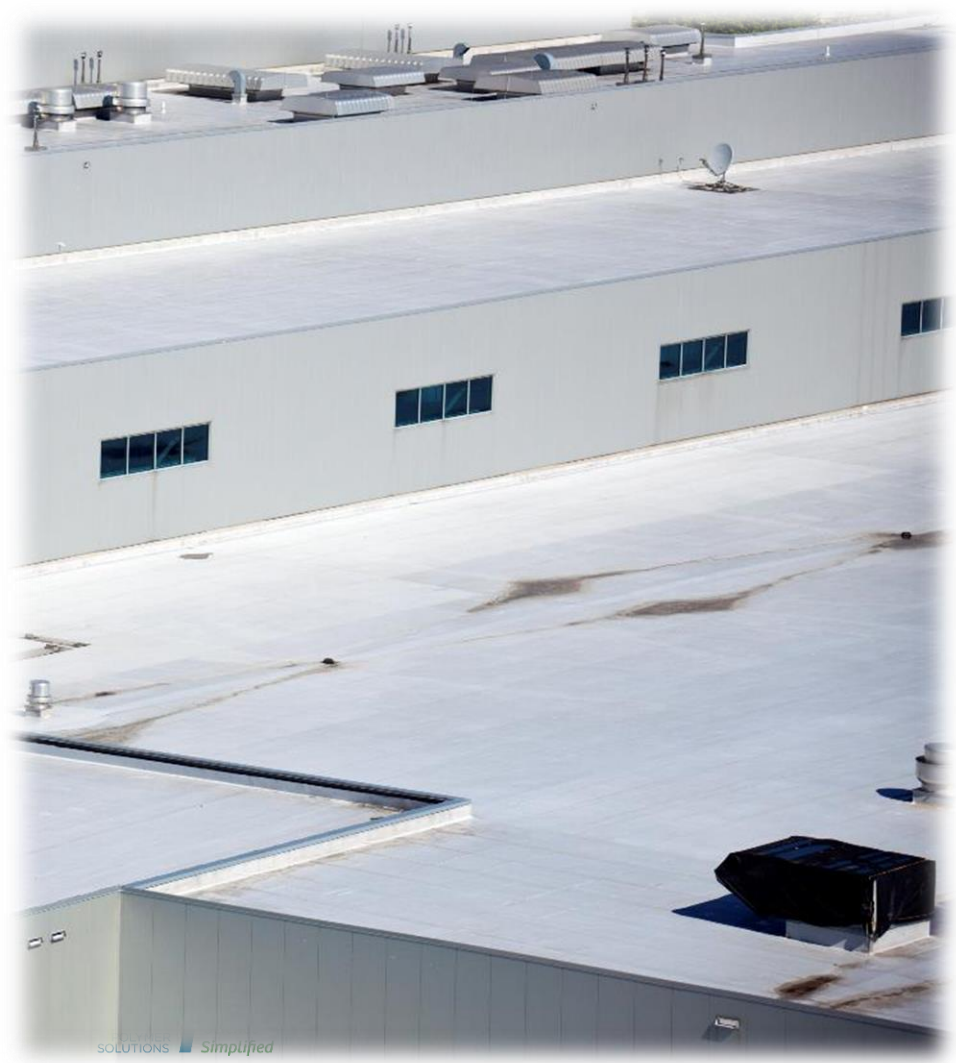

Typical Benefits of Cool Roof Coatings

Economic

- Repair and /or coat vs tear off and replace
- Federal and local **tax deductions**
- **Less energy** required for cooling
- Peak Energy Use Reduction

Sustainable

- Protect the roof surface by providing a **low-cost**, sacrificial layer that absorbs the punishment of the elements
- **Extends the life of the roof** indefinitely – Can recoat to refresh the surface
- Reflective roof coatings **reduce surface temperatures**
- Avoids building or occupant disruption and roof replacement

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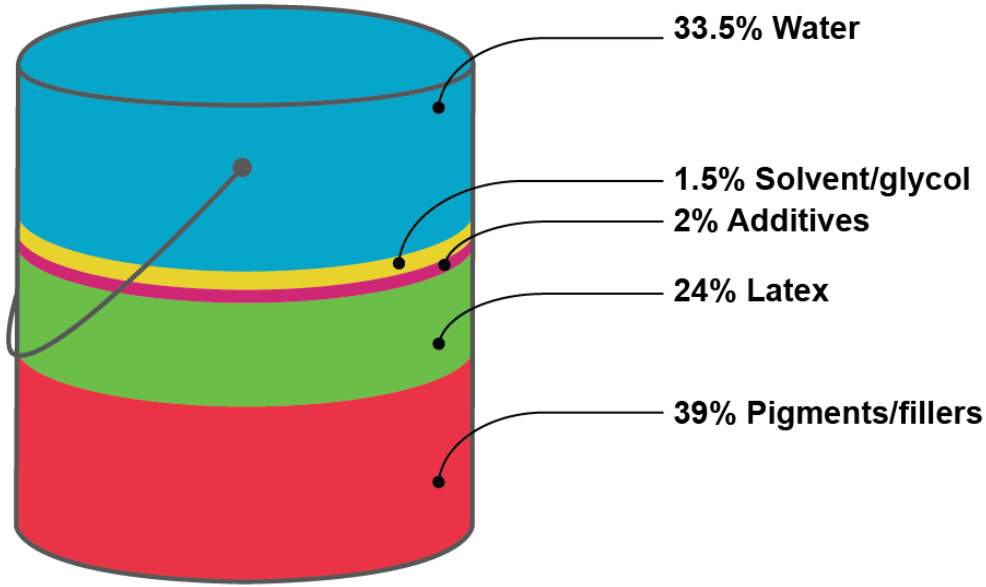
What's in the Coating Formulation?

Raw Material	Pounds
Water	155
Dispersant	3
Ammonia	3
Defoamer	1
TiO2	90
Calcium Carbonate	370
Defoamer	2
Acrylic Latex (55% solids, 45% water)	450
Coalescent	7
Biocide/Fungicide	11
Glycol	11
Cellulose Thickener	3
Total	**1162**

Parameter	Value
Wt% solids	65
Vol% solids	51
PVC	40
VOC, g /liter	41
wpg	11.6



Three varieties of acrylic roof coatings

- ASTM D6083 Type I (-26 °C low temp. flex)
- ASTM D6083 Type II (-10 °C low temp. flex
- General Purpose (no specification)

Low temperature flexibility mainly driven by resin choice

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Study Overview

- **Formulation Modifications**
  - PVC
  - Additives
    - Fluorosurfactant
    - Wax
- **Resin Modifications**
  - Glass Transition Temperature (T_g)
  - Incumbent resin technology
  - New resin technology
- **Silicone roof coatings**
- **“Real world” DPUR results**

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Red Iron Oxide Slurry Testing

- Standard accelerated testing for Dirt Pickup resistance
- Cure samples
  - Room temperature curing (3 days)
  - QUV for 7 days
- Apply a red iron oxide slurry
- Allow to dry
- Lightly rinse with water and wipe with cheesecloth

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PVC Ladder

ΔE: 44.59

ΔE: 47.71

ΔE: 51.52

Modification of formula with PVC does not dramatically alter the DPUR

Resin T_g: +9 °C

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Additives

Control
ΔE: 47.99

Wax
ΔE: 47.53

Fluorosurfactant
ΔE: 44.84

- Wax additives
- Fluorosurfactant
  - Fluorinated materials are under increasing scrutiny
- Minimal to no impact of additives on DPUR

Resin T_g: +9 °C

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T_g Ladder with polymers

T_g: -32°C

ΔE: 52.37

T_g: +9°C

ΔE: 25.14

T_g: +56°C

ΔE: 9.98

- Higher Tg polymers tend to perform better for dirt pickup resistance
  - What happens if you need a low Tg polymer?
    - ASTM D-6083 Type I (-26 °C low temperature flexibility)
    - ASTM D-6083 Type II (-10° C low temperature flexibility)
  - What if you need low VOC?

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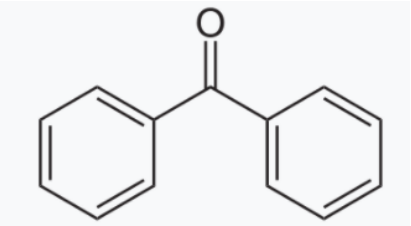
Benzophenone

- Known in the art to add to resins and coating formulations to improve dirt pickup resistance
- Benzophenone is activated by UV light and abstracts a hydrogen from the acrylic resin
- Crosslinking occurs between radicals at surface of coating
- Benzophenone may trigger Prop 65 labeling requirements
- Benzophenone is a VOC according to ASTM D-6886 (methyl palmitate GC method)
- Benzophenone is disclosed on an SDS
- Solid at room temperature , not trivial to add to a coating formulation



Benzophenone
(Diphenyl ketone)

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EPS Dirt Pickup Resistance Technology

Incorporate technology into multiple resins at high and low T_g

Resin ID	Measured T_g (°C)	Dirt pickup resistance technology
Comparative C	-32	None
EPS EXP 1	**-26**	**EPS DPUR**
Comparative E	-26	None
Comparative A	-26	Benzophenone
EPS EXP 2	**-10**	**EPS DPUR**
Comparative D	-10	None
Comparative B	-10	Benzophenone

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EPS Technology vs. no DPUR or BP

ΔE: 44.59

ΔE: 3.90

ΔE: 37.33

ΔE: 24.79

ΔE: 4.40

ΔE: 61.37

Panel Section	**1**	2	**3**	**4**	5	**6**
Sample	Comparative A	EPS EXP 1	Comparative E	Comparative B	EPS EXP 2	Comparative C
T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

All samples in same coating formulations

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T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

What about “real world” dirt pickup resistance?

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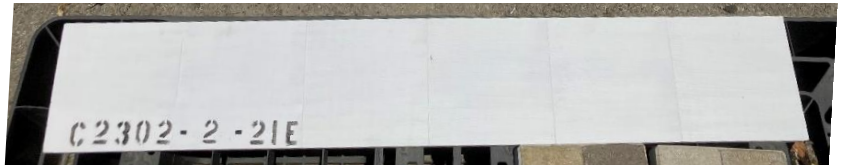
Los Angeles Exterior Exposure

Initial



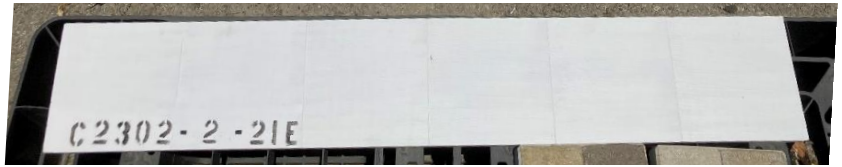
1 2 3 4 5 6

Panel Section	1	2	3	4	5	6
Sample	Comparative A	EPS EXP 1	Comparative E	Comparative B	EPS EXP 2	Comparative C
T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

Horizontal Exposure

Los Angeles Exterior Exposure

Initial



1 2 3 4 5 6

3 months

1 2 3 4 5 6

Panel Section	1	2	3	4	5	6
Sample	Comparative A	EPS EXP 1	Comparative E	Comparative B	EPS EXP 2	Comparative C
T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

Horizontal Exposure

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Los Angeles Exterior Exposure

Initial

1 2 3 4 5 6

3 months

1 2 3 4 5 6

Panel Section	1	2	3	4	5	6
Sample	Comparative A	EPS EXP 1	Comparative E	Comparative B	EPS EXP 2	Comparative C
T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

Horizontal Exposure

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Los Angeles Exterior Exposure

Initial

1 2 3 4 5 6

3 months

1 2 3 4 5 6

Panel Section	1	2	3	4	5	6
Sample	Comparative A	EPS EXP 1	Comparative E	Comparative B	EPS EXP 2	Comparative C
T_g	-26°C	-26°C	-26°C	-10	-10	-32°C
DPUR	None	EPS DPUR	Benzophenone	Benzophenone	EPS DPUR	None

Horizontal Exposure

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Silicone Comparison

Sample	EPS EXP 1
T_g	-26°C
DPUR	EPS DPUR

EPS Acrylic

ΔE: 3.90

Commercial Silicone Coating

ΔE: 3.34

- Silicone coating shows low ΔE
- Silicone roof coatings typically show poor DPUR performance in the field
- Red iron oxide slurry has water carrier → *silicone coating is very water resistant*

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Silicone Comparison – Dirt particulate

- Lab DPUR evaluated using a dry dirt particulate
- Sample with dirt cured in oven and light even pressure applied
- Sample tapped to remove excess dirt
- Silicone coating using a dry dirt particulate elicits very poor DPUR in the lab

EPS DPUR Acrylic
T_g -26°C

ROX

ΔE: 3.90

Dirt Particulate

ΔE: 6.75

Silicone Coating

ROX

ΔE: 3.34

Dirt Particulate

ΔE: 45.59

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Additives – Dirt Particulate

Control

ΔE: 27.81

Wax

ΔE: 29.39

Fluorosurfactant

ΔE: 13.46

EPS EXP 2

ΔE: 6.74

- Wax additives
- Fluorosurfactant
  - Greater improvement in DPUR using dry dirt particulate → Longterm regulatory concerns
- EPS resin technology shows improved DPUR with no formulation modifications and a softer resin

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Summary of Results

Concept	Comments
Use of higher T_g resins	• Higher VOC • Certain roof coating requirements require Low Temperature Flexibility (-10°C or -26°C)
Incorporation of Unique Additives	• Increased regulatory scrutiny • Modest or little to no impact on DPUR
Adjust PVC of formula	• No strong improvements • Significant formulation changes
Utilize resins containing benzophenone	• Small to moderate impact on DPUR • Prop 65 →Potential regulatory scrutiny
Use of alternate chemistries such as silicone coatings	• Water resistant • Poor DPUR using non-aqueous dirt particulate • Cost
EPS Dirt Pickup Technology	• Large impact on DPUR, even at very low T_g • No formulation modification needed → Technology built into resin

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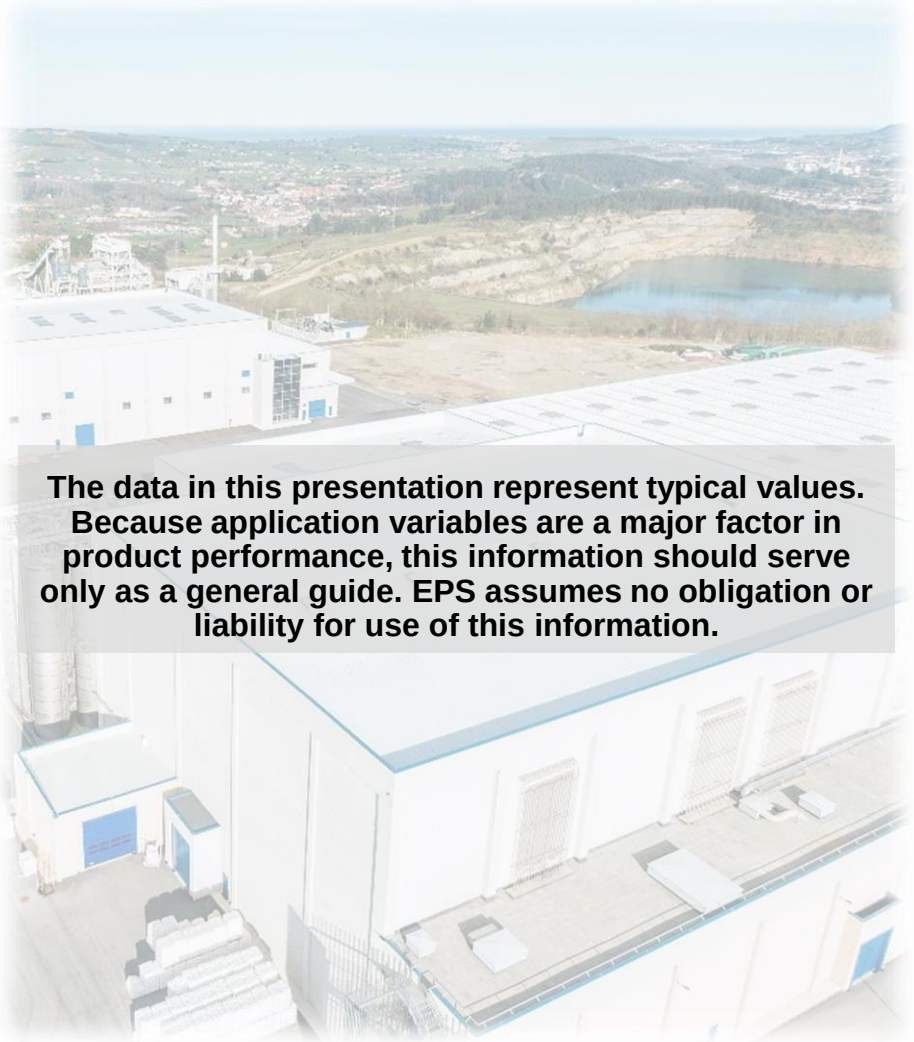
QUESTIONS?



The data in this presentation represent typical values. Because application variables are a major factor in product performance, this information should serve only as a general guide. EPS assumes no obligation or liability for use of this information.

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Exterior Exposure Testing: Pat Lutz

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