DIRT-PICKUP RESISTANCE IN LOW T_g ELASTOMERIC COATINGS

Robert Sandoval, Ph.D.

EPS – Engineered Polymer Solutions

R&D Technical Director

Western Coatings Symposium Oct. 2021







- **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







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



What's in the Coating Formulation?

Raw Material	Pounds
Water	155
Dispersant	3
Ammonia	3
Defoamer	1
TiO2	90
Calcium Carbonate	370
	0
Defoamer	2
Acrylic Latex	450
(55% solids, 45% water)	400
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





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



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



PVC Ladder



Modification of formula with PVC does not dramatically alter the DPUR

Resin T_g : +9 °C







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



Resin T_g : +9 °C

$\mathbf{T}_{\mathbf{g}}$ Ladder with polymers



- 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?



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)



EPS Dirt Pickup Resistance Technology

Incorporate technology into multiple resins at high and low T_a

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





All samples in same coating formulations



	ΔΕ: 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
Τ _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





All samples in same coating formulations





What about "real world" dirt pickup resistance?



Initial



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



Initial

3 months





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



Initial







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



Initial

3 months





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



Silicone Comparison

EPS Acrylic

Sample	EPS EXP 1
Τ _g	-26°C
DPUR	EPS DPUR









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



Commercial Silicone Coating

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



Silicone Coating



Dirt Particulate ∆E: 45.59



Additives – Dirt Particulate



- Wax additives •
- Fluorosurfactant •
 - Greater improvement in DPUR using dry dirt particulate \rightarrow Longterm regulatory concerns •
- EPS resin technology shows improved DPUR with no formulation modifications and a softer resin ۲



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 scrutinyModest or little to no impact on DPUR
Adjust PVC of formula	No strong improvementsSignificant 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



QUESTIONS?

Technical Contributors

Formulating and Testing: Alejandra Hernandez Synthesis: Jonathan Wang, Ashley Rodgers Exterior Exposure Testing: Pat Lutz



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.

