

IMPROVING ADHESION TO TPO WITH WATERBORNE ACRYLIC RESINS

Dr. Brent Crenshaw
Sr. R&D Chemist

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Agenda

- Roof Coatings
- Single Ply and TPO
- Adhesion
- EPS® 2252
 - Properties
 - Formulation
- Summary
- Questions

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

Single Ply Membrane Roofing

A roof system in which the principal roof covering is a single layer of flexible membrane

Thermoplastic

- Poly vinyl chloride (PVC)
- Thermoplastic polyolefin (TPO)

Thermoset

- Ethylene propylene diene monomer (EPDM)

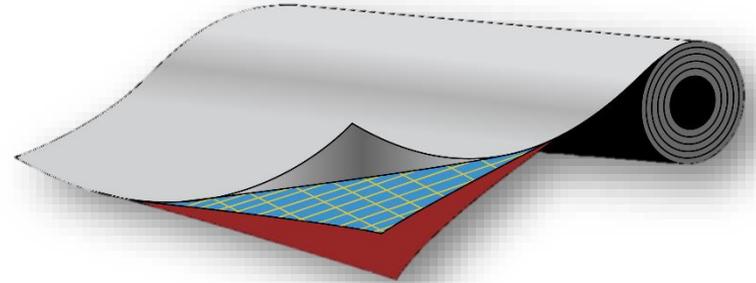
Adhered or mechanically fastened to roof

Seams heat welded or adhered together



TPO Roofing

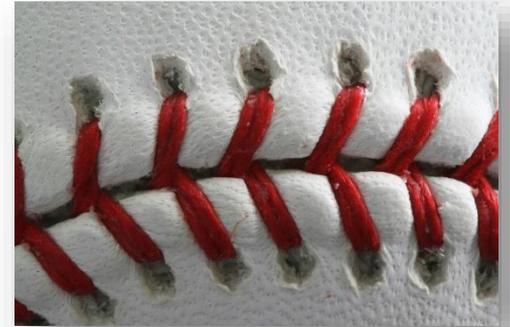
- Thermoplastic – can be melted and reshaped
- Reinforced with polyester or glass fabric
 - 45 mils – 90 mils
 - 5 – 30 year warranties
- ASTM D6878 – Published 2003
- Double digit growth rate
- Aged roofs needing to be replaced or coated
- Adhesion to TPO is challenging!



Adhesion – Mechanical Bonding

Mechanical bonding

- Velcro
- Stitches
- Mechanical fasteners



Adhesion - Chemical Bonding

Chemical bonding

Covalent

Polar

Van der Waals

Bond strength ↑



Welded metal



Magnetized pin



Neodymium Magnets

Photo-oxidative Degradation of Polyolefins

Polyolefin structures

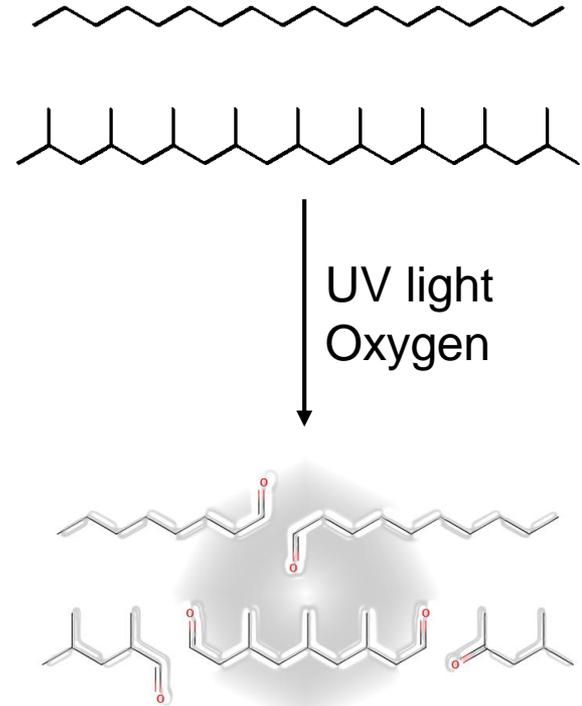
- Only Van der Waals forces

Mechanism of aging

- UV and Oxygen work to sever chains
- Surface degrades and chalks
- Polarity of the surface increases

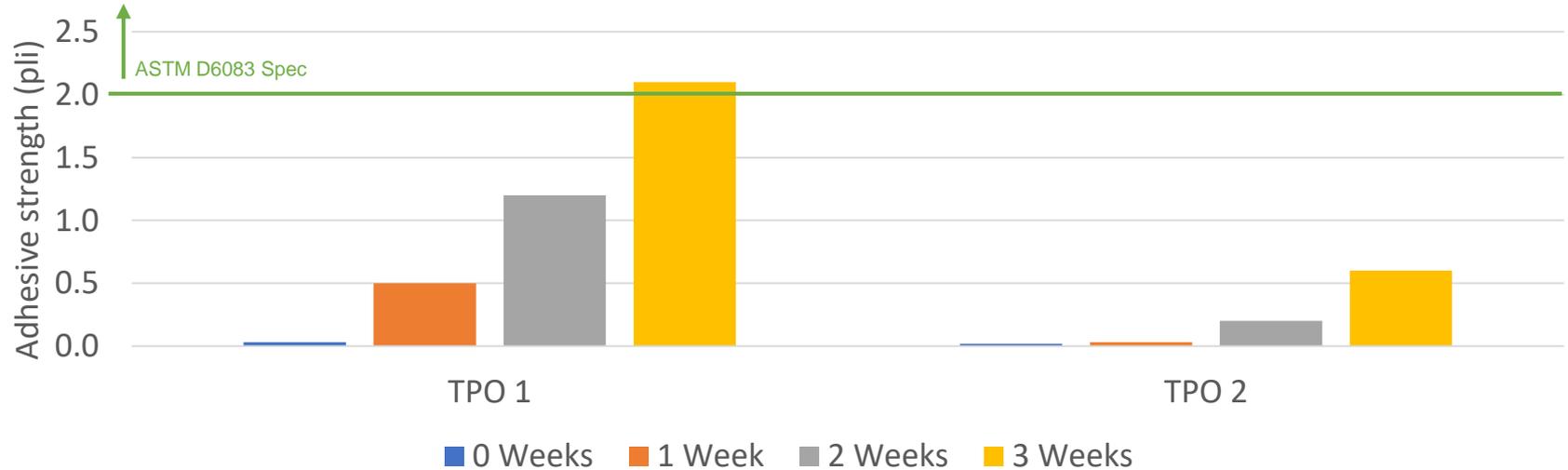
Stabilizers

- Inhibit the degradation process



Adhesion with Aging

180° Wet Peel Adhesion of a Commercial Roof Coating to QUV Aged TPO



Primers on Aged TPO

Aging of TPO is inconsistent

- Dirt and debris
- Water ponding
- Biological growth
- Shadows
- Edge reflection
- Mechanical damage
- And more...



Primers or surface treatment is used to normalize the surface and promote adhesion everywhere.

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Bonding to TPO

Chemically modify the surface

- Aged membranes
- Plasma Treatment
- Flame treatment

Prime the Surface with like material

- Chlorinated Polyolefins
- Solvent based adhesives
- **EPS® 2252 – Waterborne acrylic**

EPS® 2252: Technical Information

Excellent adhesion to TPO, EPDM, metal, asphalt, and other common roofing substrates

<50 g/L VOC capable

Can be used in both primer and basecoat formulations

Formulated without APEOs

Specifications

Weight Solids	60.0 +/- 0.70%
Weight/Gallon	8.55 +/- 0.10
pH	8.0 - 9.0

Typical Properties

Volume Solids	59.0 +/- 0.70%
T _g	-32° C
Volatile(s)	Water Ammonia

Adhesion Properties: Competitive Benchmarking

Sample	Solvent or Water	24hr dwell	Mode of Failure	7 day dwell	Mode of Failure
Commercial 1	Water	4.1	Adhesive	3.8	Adhesive
Commercial 2	Water	6.9	Adhesive	4.5	Adhesive
EPS® 2252	Water	9.5	Cohesive	15.5	Cohesive
Commercial 3	Solvent	2.2	Cohesive	8.5	Cohesive
Commercial 4	Solvent	2.5	Cohesive	8.1	Cohesive
Commercial 5	Solvent	1.9	Cohesive	10.3	Cohesive



Primer / Base Coat

- **Primer/base coat function**
 - Adhesion
 - Corrosion resistance
 - Bleed block
 - Build thickness
- **Primer**
 - Primarily resin / carrier
 - Not for film build – applied at 200-400 sqft/gal
- **Base Coat**
 - Functionality of a binder but also counted in film build
 - Often tinted gray to speed up cure and distinguish from top coat



EPS® 2252 RC1 Base Coat Formula

Pounds	Gallons	Raw Material
155.00	18.61	Water
3.00	0.30	Dispersant
3.00	0.40	Base
1.00	0.12	Defoamer
30.00	0.90	TiO2
430.00	19.05	Calcium Carbonate
450.00	52.63	EPS 2252
3.00	0.33	Biocide
11.00	1.15	Fungicide
11.00	1.27	Glycol
3.00	0.27	HEC Thickener
44.15	5.30	Water

Formulation Parameters	
Weight Solids	64.87%
Volume Solids	51.90%
Pigment Volume Conc.	38.91
Calculated VOC Level	24 g/L
Weight/Gal	11.41 lbs

Typical Properties	
Viscosity	90 - 100 KU
pH	9.0 - 10.0
Color	White

Testing Protocol

Sample Preparation

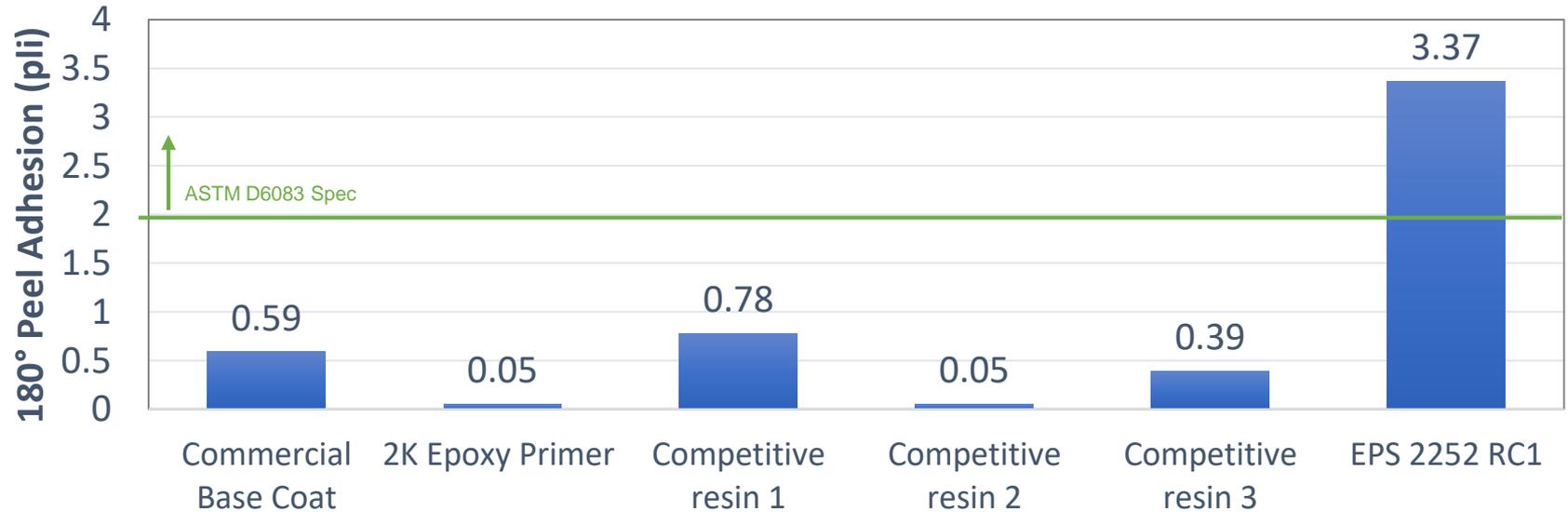
- Base coat formulation was applied to substrate using a 20 mil drawdown bar and allowed to dry overnight
- Primers applied at 4-8 wet mils and allowed to dry overnight.
- Fabric embedded in 20 mils of topcoat – EPS® 2719 SR2
- Cured 2 weeks under ambient conditions (Dry Adhesion) then soaked in water 1 week before testing (Wet Adhesion)

180° Peel Adhesion

- Adhesion was run at 2 inches/min in a tensile testing machine
- Wet adhesion was conducted while the sample was still wet

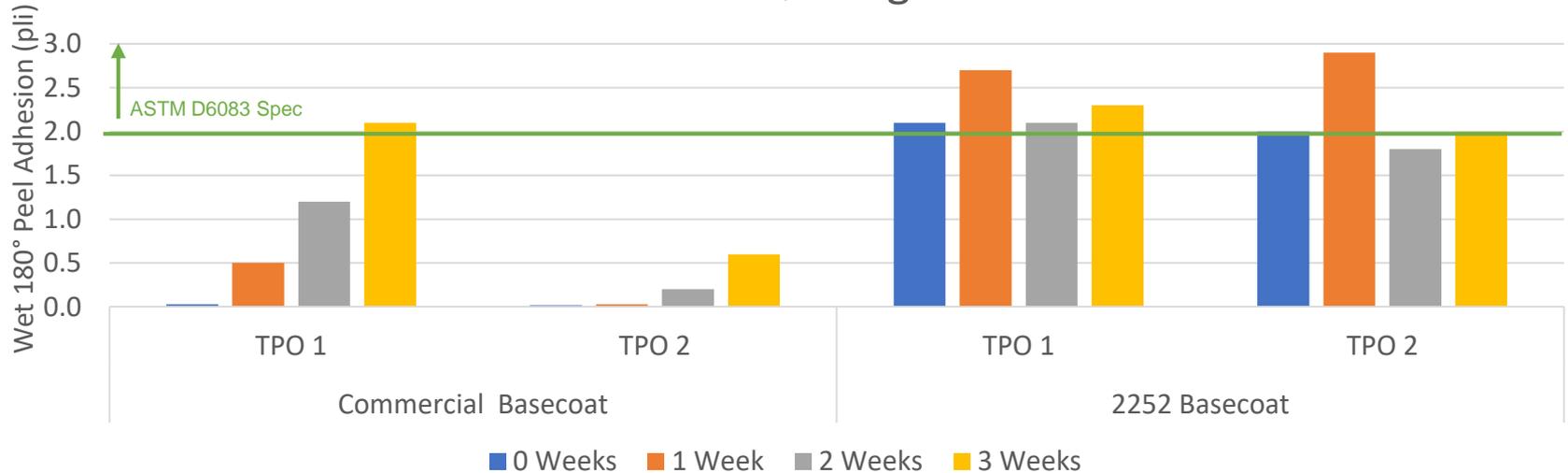
Primer Benchmarking

Wet Adhesion to New TPO



EPS 2252 on New and Aged TPO

Wet Adhesion of a Commercial Roof Coating and EPS 2252 Basecoat to QUV Aged TPO



Multi-Substrate Adhesion

	Steel (CRS)	Oiled CRS	Galvanized (HDG)	Aluminum	PVC (hard)	PVC (membrane)	Oiled Aluminum	High Zinc HDG	APP Mod Bit	SBS Mod Bit	TPO 1	TPO 2	Concrete	PU Foam	EPDM	Silicone	PVDF
2252	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Fail
Resin 1	Pass	Fail	Fail	Fail	Pass	Pass	Fail	Fail	Fail	Pass	Fail	Fail	Pass	Pass	Fail	Fail	Fail

Formulation: Experimental Design

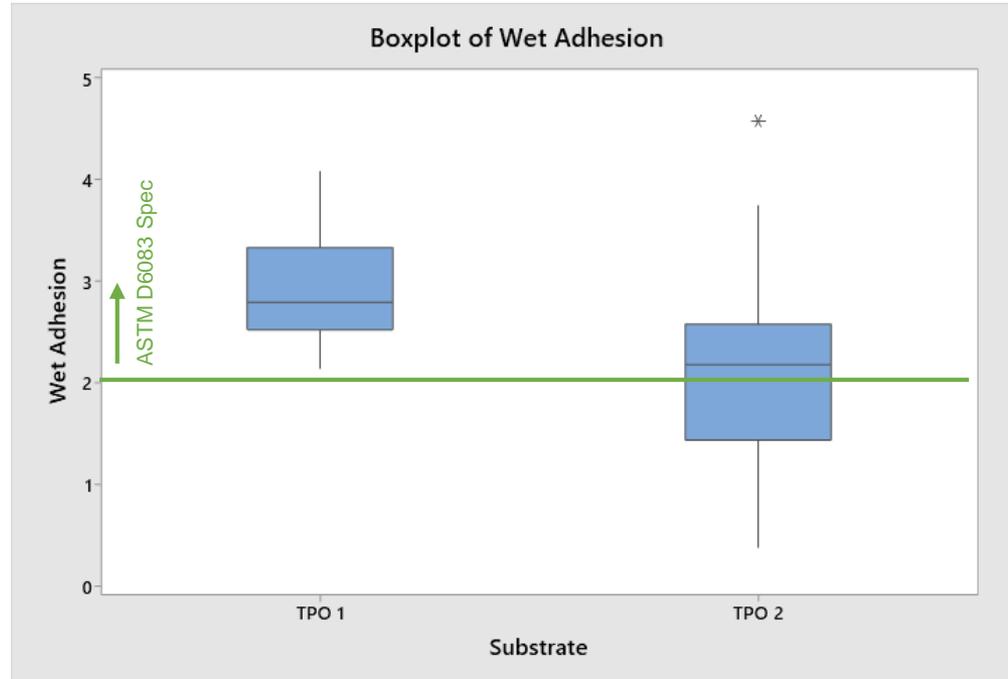
Purpose

- Compare 180° peel adhesion of different formulations of EPS® 2252 on different TPOs

Variables tested

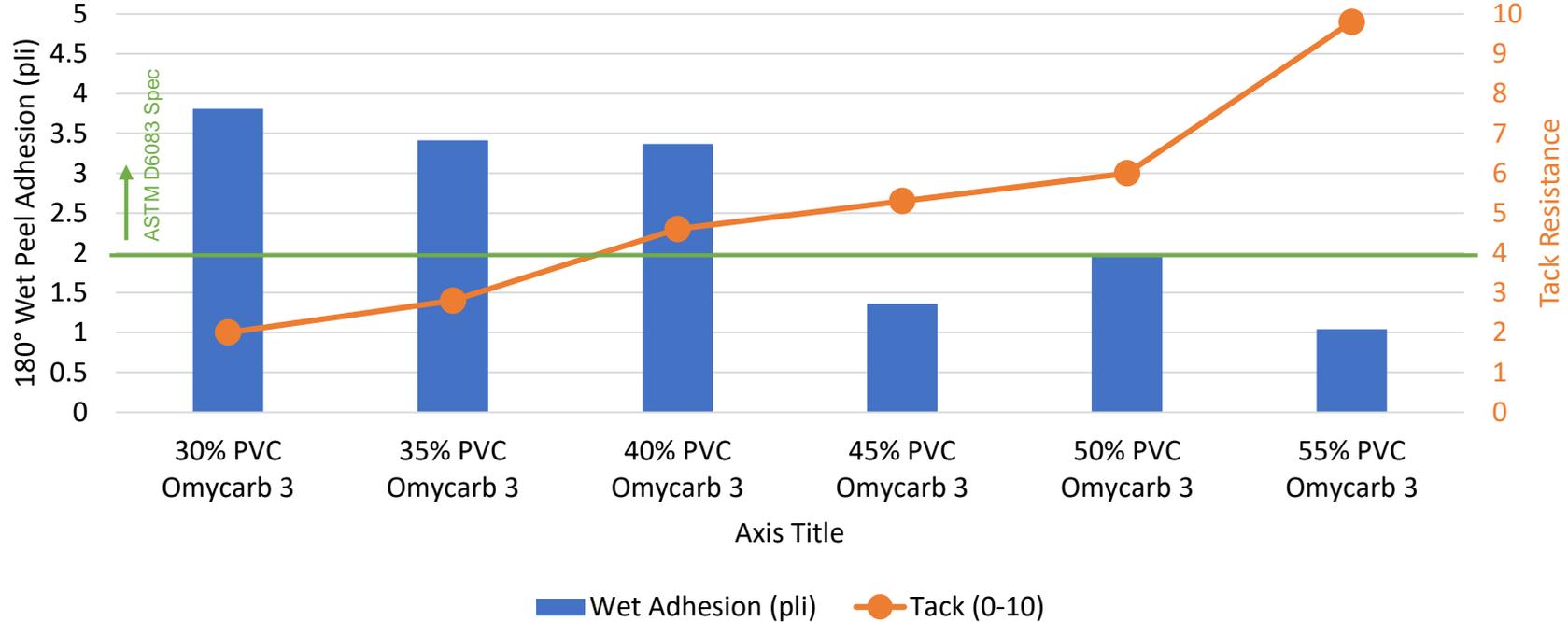
- Pigment Volume Concentration
- Defoamer types
- Dispersant types
- TiO2 types
- Formula viscosity
- Wetting aids

Overall Results Comparison



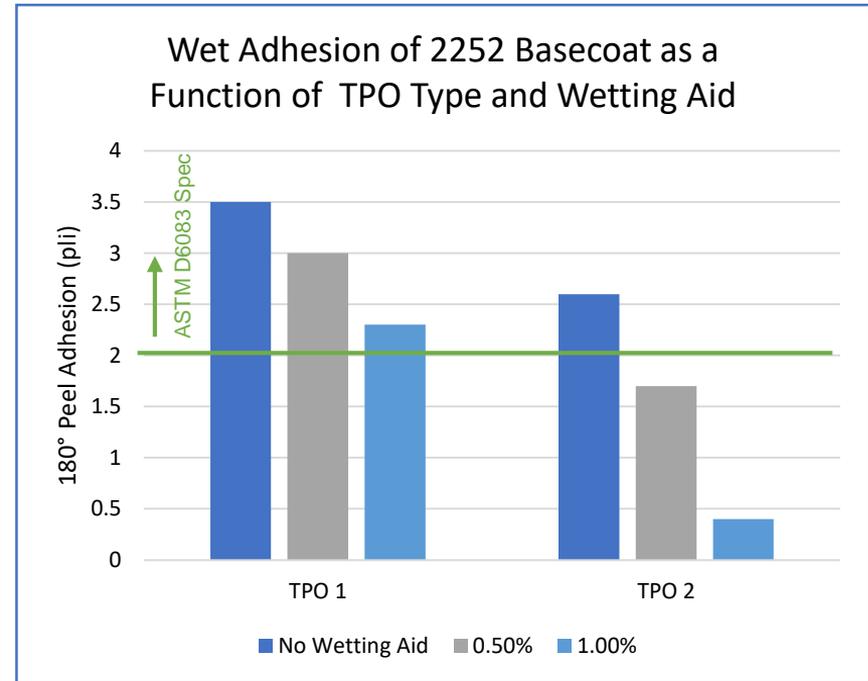
Strength of adhesion to TPO varies by manufacturer

EPS® 2252: Formulation - PVC



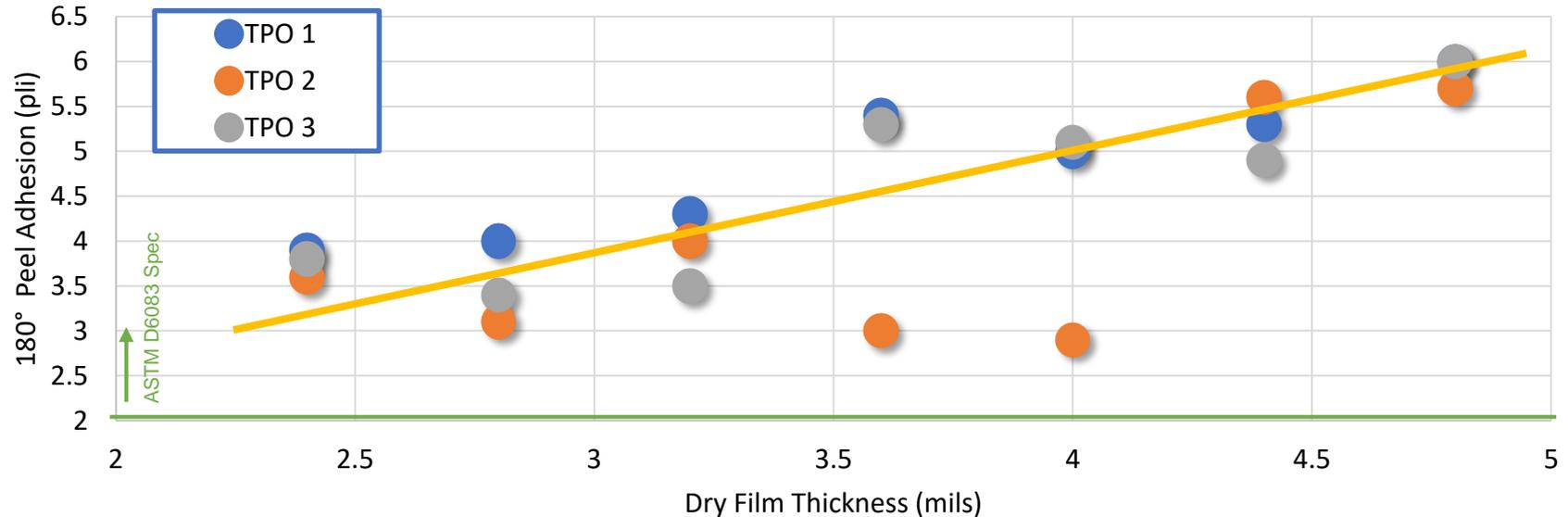
EPS® 2252: Formulation - Dispersants and Surfactants

- The use of and level of dispersants, surfactants and wetting aids may impact the adhesion performance properties of the roof coating.
- A ladder study is recommended to determine the optimum level.



Substrates and Film Thickness

Adhesion of 2252 Primer as a Function of Dry Film Thickness



- Adhesion values tend to increase with increasing film thickness
- For more challenging substrates increased film thickness can increase adhesion.

Summary

Roof coatings are often the most economical and sustainable way to maintain a roof over the long term

Coating TPO is challenging due to the difficulty of adhering to it
EPS[®] 2252 is a novel waterborne option that provides excellent adhesion to both new and aged TPO

- Can be formulated as a primer or basecoat
- Minimal formulation leads to optimal adhesion

Dr. Brent Crenshaw, PhD
bcrenshaw@eps-materials.com

More information available at:
www.epsc.ca.com

