

# Enabling sustainability and extreme weatherability in protective coatings

Novel TMCD-based resin show extreme weatherability for asset protection

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Eastman*

*Presented by Muhammad Farooq | Eastman*

# Eastman | A materials innovation company

- Celebrating more than **100 years of vital innovations that enhance people's lives every day.**
- A Fortune 500 company with approximately **14,000 employees and approximately ~9.2 billion USD** in revenue
- Operates **four business segments**
- Dedicated to **enhancing the quality of life in a material way**
- Sustainability strategy commitment to **mitigating climate change, mainstreaming circularity** and **caring for people and society**



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# Unique chemistry and unparalleled expertise

*Material advances needed to meet market needs.*

Working with formulators and coatings users in the industry for decades, Eastman has developed, adapted, and perfected unique and specialized chemistries for a wide variety of coatings applications to meet market needs, including:

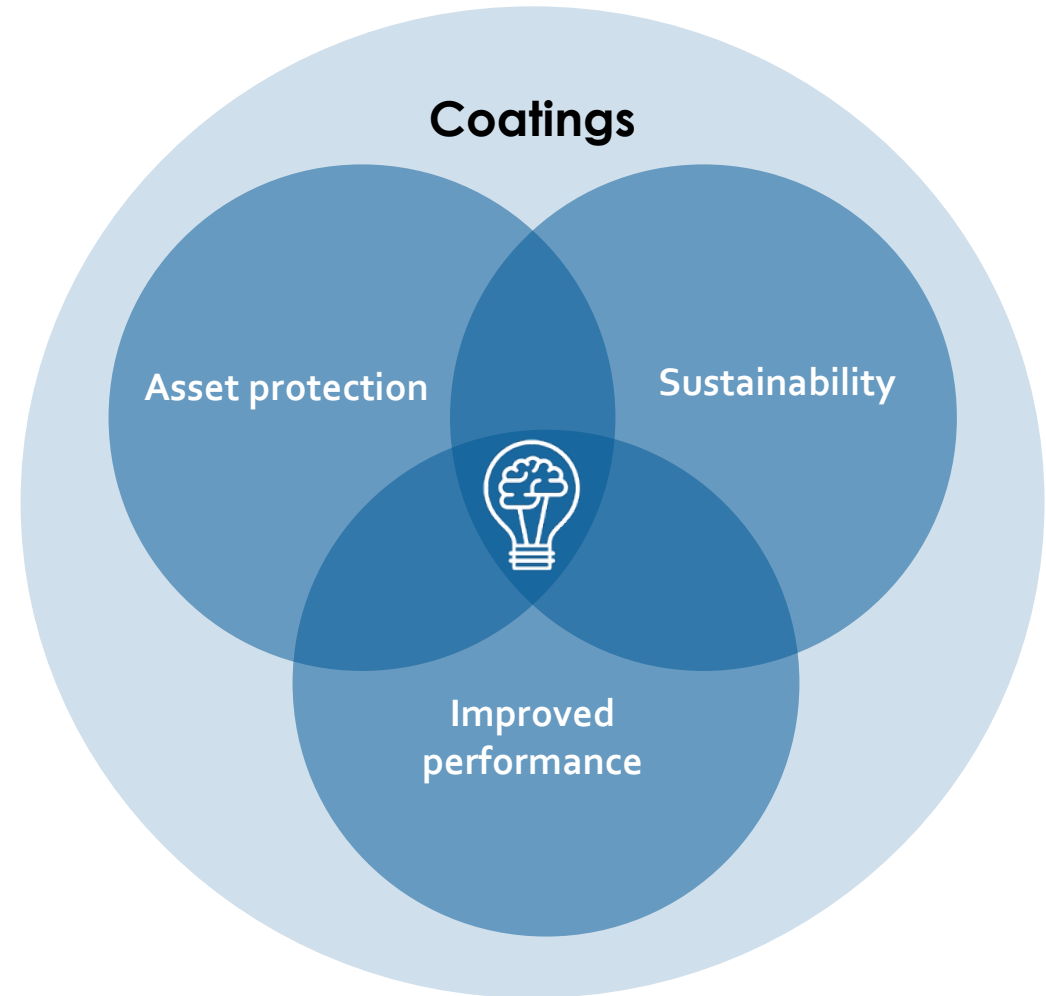
**TMCD-based resins**

**Cellulose esters**

**Solvents**

**Coalescing aids and additives**

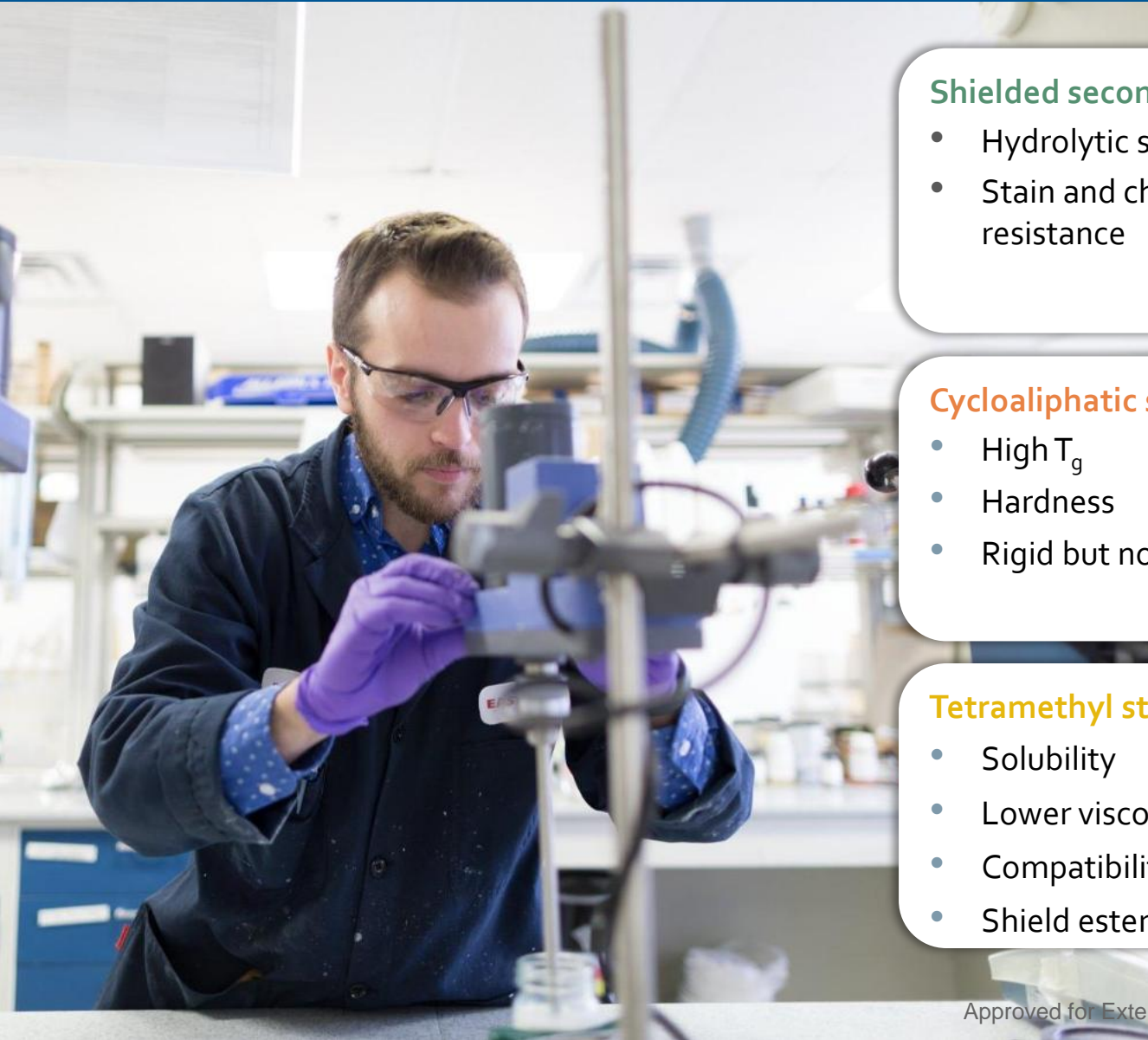
**Specialty and functional amines**



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# Solving industry needs with innovative solutions

TMCD-based hyperdurable resin is the newest technology advancement from Eastman.



## Shielded secondary hydroxyls

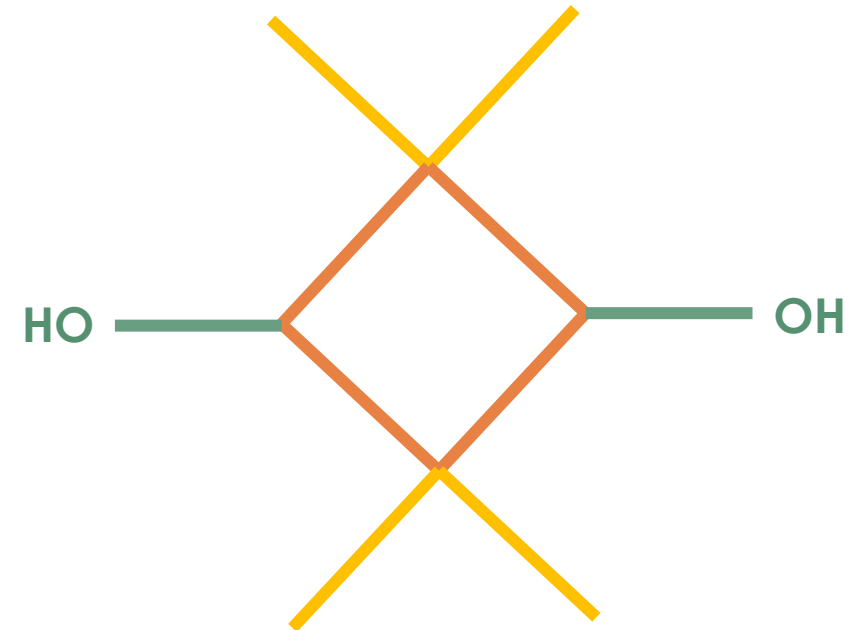
- Hydrolytic stability
- Stain and chemical resistance

## Cycloaliphatic structure

- High  $T_g$
- Hardness
- Rigid but not aromatic

## Tetramethyl structure

- Solubility
- Lower viscosity
- Compatibility
- Shield ester linkages



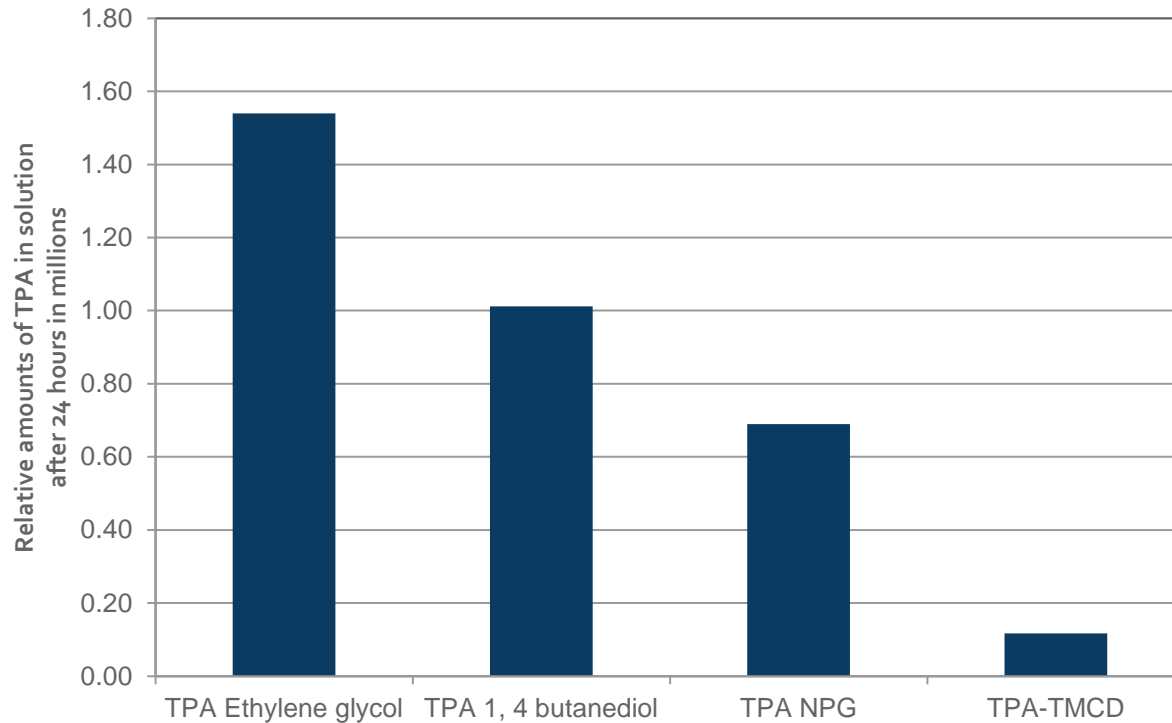
2,2,4,4-tetramethyl-1,3-cyclobutanediol (TMCD)

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# Hydrolysis resistance of TMCD-based resins

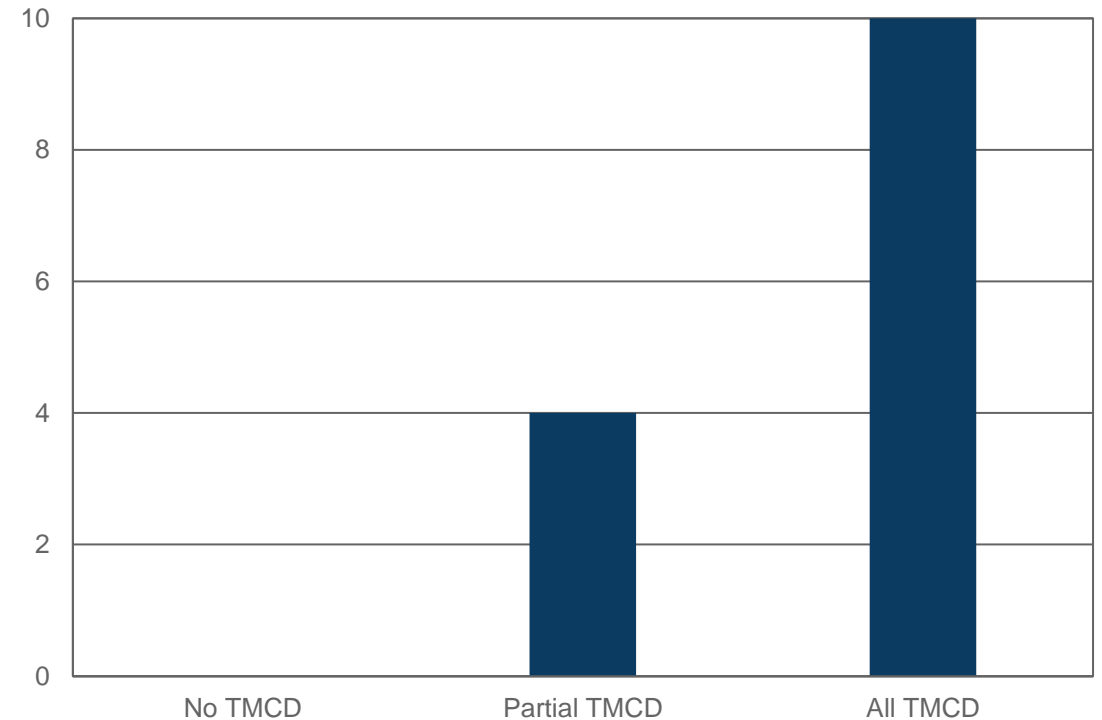
TMCD-based hyperdurable resin showcase exceptional hydrolytic stability in acidic or basic environments.

Degree of hydrolysis TMCD



Terephthalic acid/glycol resin  
0.03 M NaOH (aq.) for 24 hours at 95°C;  
liquid chromatography-mass spectrometry for TPA content

Acid etch



36-day 50% H<sub>2</sub>SO<sub>4</sub> exposure;  
10 = no damage, 0 = completely destroyed

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# Tetrashield solution

*A versatile, super durable resin for use in protective and industrial coatings*

Typical resin physical properties	PC4000
Solvents	<i>n</i> -Butyl acetate
Non-volatiles	75%
Brookfield viscosity	65 poise
Color	<75 APHA
Hydroxyl number	145-155 mg KOH/g
Acid number	<10 mg KOH/g
Glass transition temperature (T <sub>g</sub> )	38°C

## Available on request:

- Case studies
- Samples
- Starting point formulations
- Technical tips
- Technical data sheets
- Safety data sheets
- Laboratory and testing capabilities
- Technical know-how/collaboration partner

PC4000 is **versatile** and can be used at a **100% dosage or blended** with other major resins to achieve certain performance targets, improve performance and/or lower formulation costs.

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A photograph of several large, white, spherical industrial storage tanks in an industrial facility. The tanks are supported by concrete pillars and are surrounded by a network of pipes and scaffolding. The scene is set against a sunset sky with warm orange and pink hues. A white rounded rectangle is overlaid on the left side of the image, containing the text 'Weathering performance'.

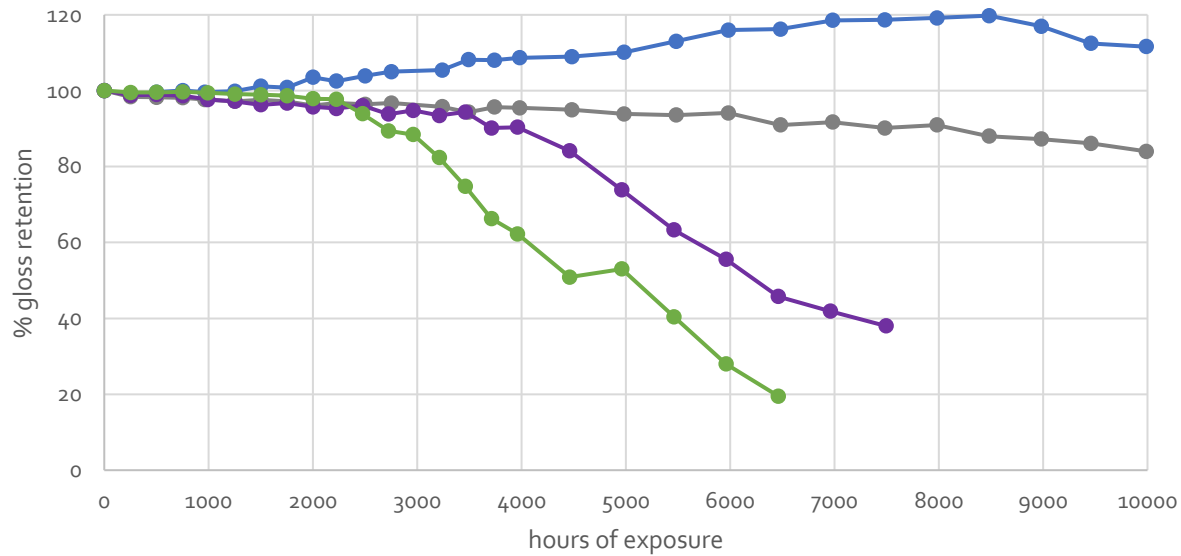
# Weathering performance

*this tank protected by*  
**Eastman TETRASHIELD**  
*protective resin systems*

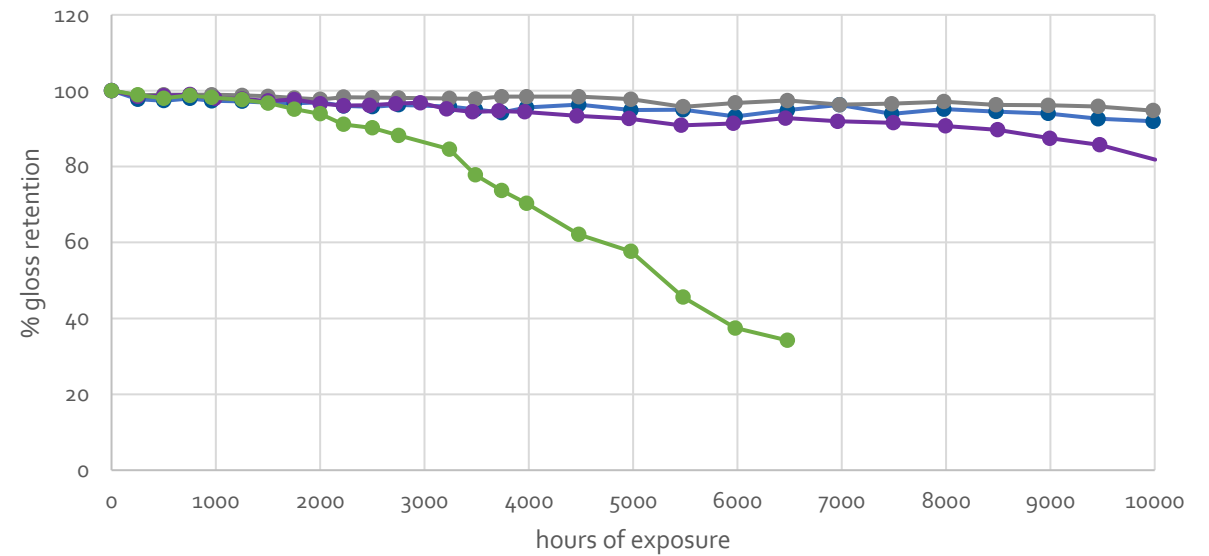
# PC4000 resin compared to other chemistries

QUVA | 60-degree gloss retention | HALS and UVA included

## White formulation



## Black formulation



FEVE    PC4000    Acrylic    Polyester

Notes:  
UVA-340, G154 Cycle 1

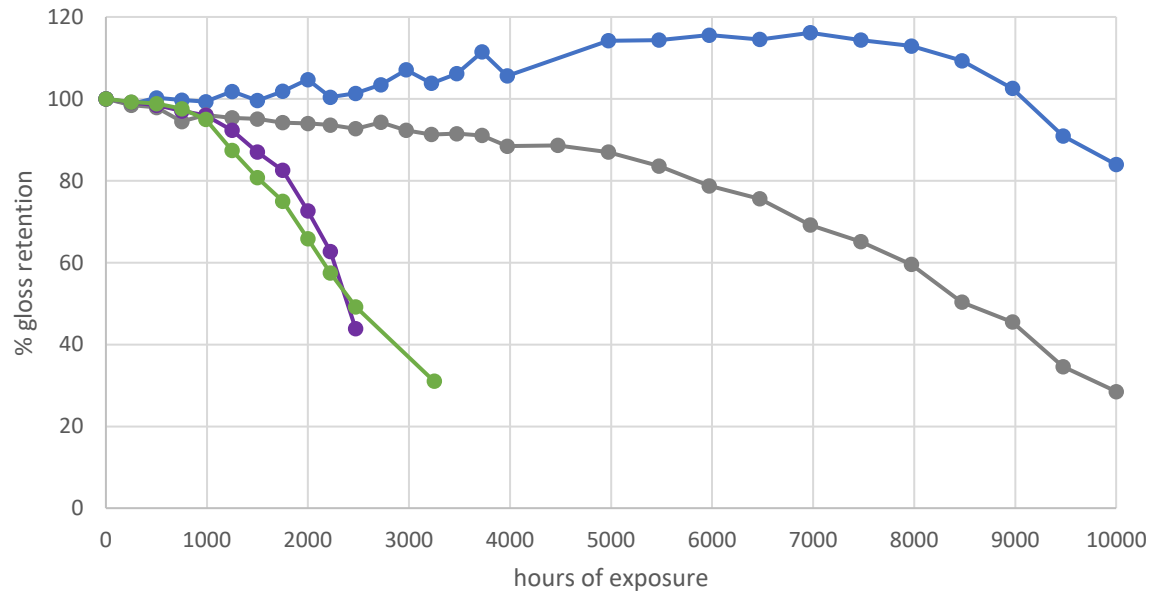
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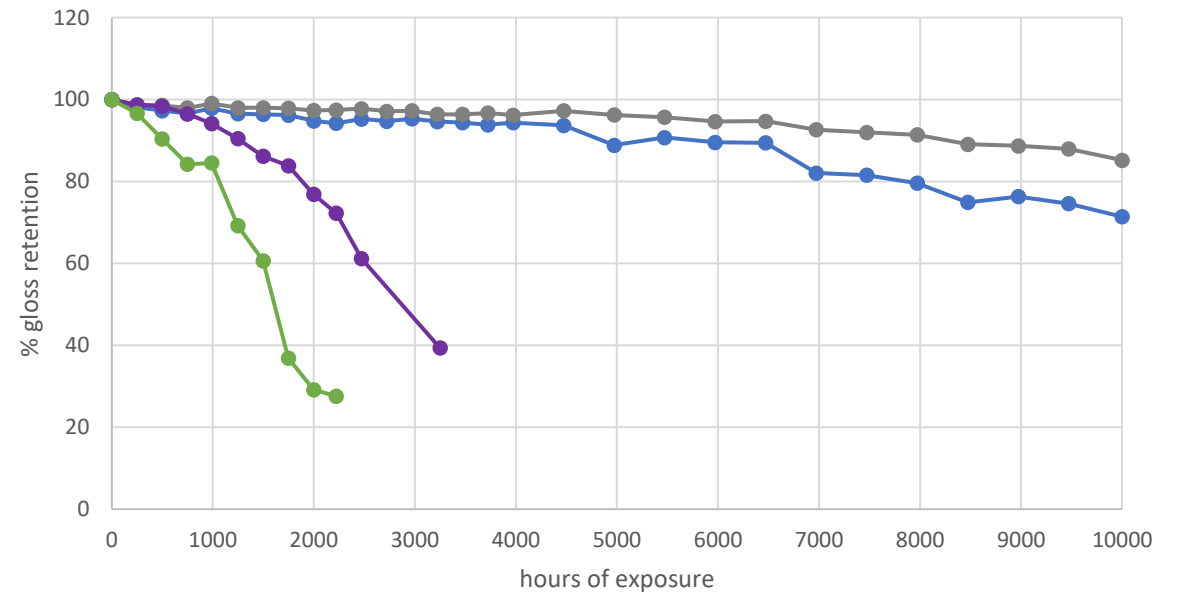
# PC4000 resin compared to other chemistries

QUVB | 60-degree gloss retention | HALS and UVA included

## White formulation



## Black formulation



FEVE    PC4000    Acrylic    Polyester

Notes:  
UVB-313, G154 Cycle 2

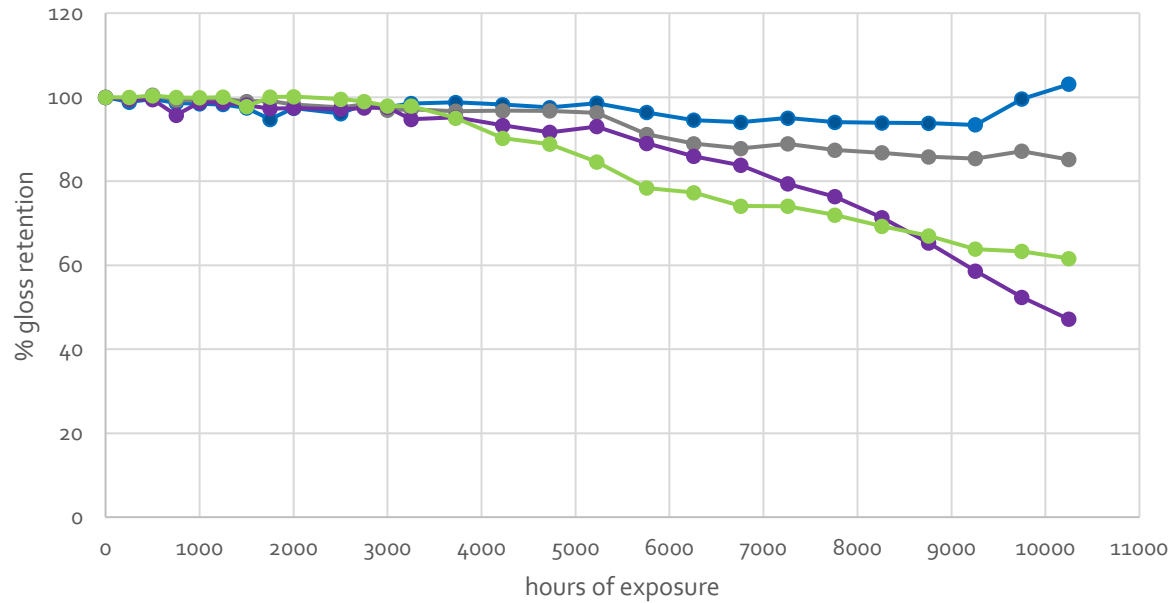
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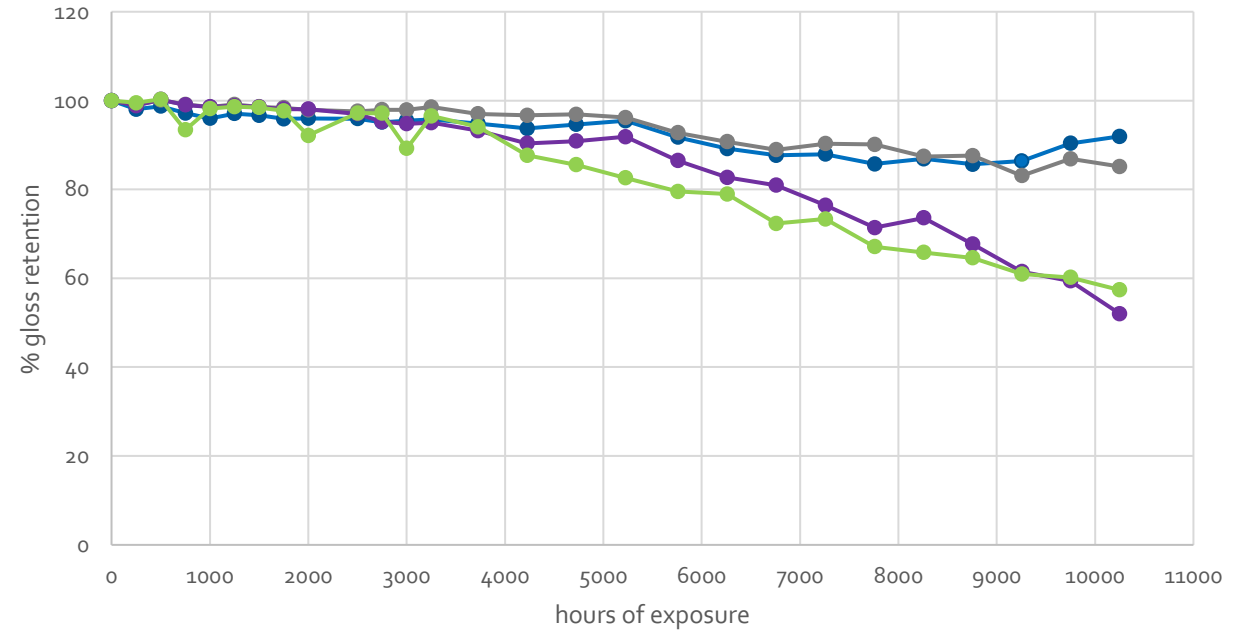
# PC4000 resin compared to other chemistries

Xenon | 60-degree gloss retention | HALS and UVA included

## White formulation



## Black formulation



FEVE PC4000 Acrylic Polyester

Notes:  
ISO 16474-2 C1

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# The weathering difference

*Continuing to invest in weathering studies.*

The background of the slide features a grid of several line graphs, each representing a different weathering test. The graphs show various data points over time, with some lines showing a downward trend and others showing a slight increase or stability. The graphs are arranged in a 2x3 grid, with the central one partially obscured by the text box.

PC4000 has gone through multiple accelerated weathering tests, and we are continuing to collect real world weathering data

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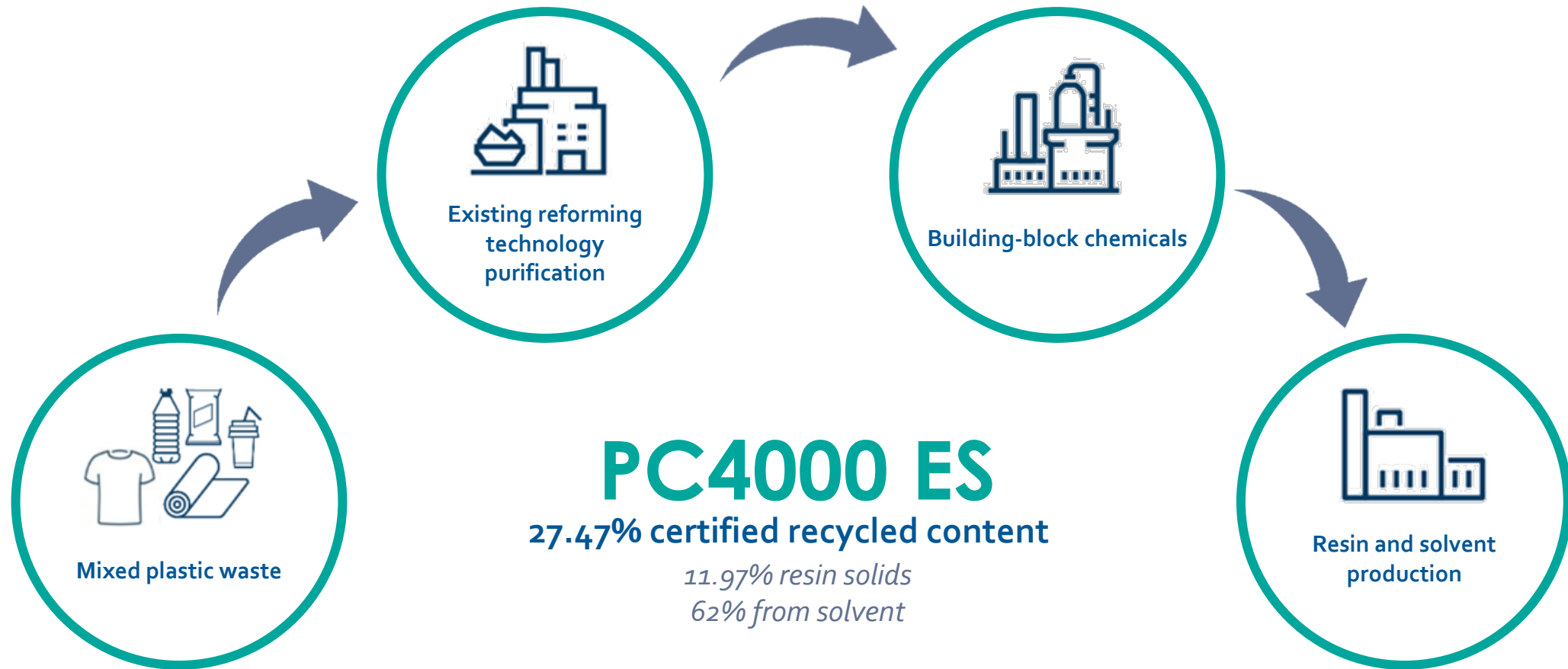
# Creating coatings that protect

*Outdoor application usages and case studies.*



# Making your paint greener

PC4000 can be produced with certified recycled content.



No performance tradeoffs from PC4000

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# Conclusion

- The coatings industry is continuously investing in R&D for technical advancements – seeking ways to provide more innovative, durable solutions while developing value-added sustainable solutions.
- While fluoropolymers are considered the gold standard in protective and industrial markets for long-term weathering performance, there are trade-offs associated with these materials — halogen-containing material and regulatory pressure.
- Accelerating weathering data shows that PC<sub>4000</sub> perform comparably to FEVE, and Eastman is continuing with ongoing studies until failure, including collecting real world weathering data.
- Eastman has taken our best-in-class hyperdurable weathering PC<sub>4000</sub> resin and is now offering a sustainable version that includes certified recycled content called PC<sub>4000</sub> ES.
- The PC<sub>4000</sub> and PC<sub>4000</sub> ES resins are chemically equivalent and perform exceptionally well against exposure to UV and photo-oxidation.

# Backup

# Tetrashield solution

*A versatile, super durable resin for use in protective and industrial coatings*

Typical resin physical properties	PC4000	PC4050
Solvents	<i>n</i> -Butyl acetate	<i>n</i> -Butyl acetate
Non-volatiles	75%	70%
Brookfield viscosity	65 poise	25 poise
Color	<75 APHA	<75 APHA
Hydroxyl number	145-155 mg KOH/g	290-320 mg KOH/g
Acid number	<10 mg KOH/g	<5 mg KOH/g
Glass transition temperature (T <sub>g</sub> )	38°C	17°C

*PC4000 is **versatile** and can be used at a **100% dosage or blended** with other major resins to achieve certain performance targets, improve performance and/or lower formulation costs.*

*PC4050 can be **blended with PC4000** to reduce drying time and accelerate hardness development.*

## Available on request:

- Case studies
- Samples
- Starting point formulations
- Technical tips
- Technical data sheets
- Safety data sheets
- Laboratory and testing capabilities
- Technical know-how/collaboration partner

\*PC4050 is not TSCA registered but approved for EU, China, and India. We are currently evaluating obtaining TSCA approvals.

Approved for External Use

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# Hydraulic fluid resistance, 7 day exposure

## 2K Tetrashield

Brake Fluid



2K Tetrashield



Commercial polyester



Commercial acrylic

Skydrol



**Exceptional  
chemical  
resistance**

**and**

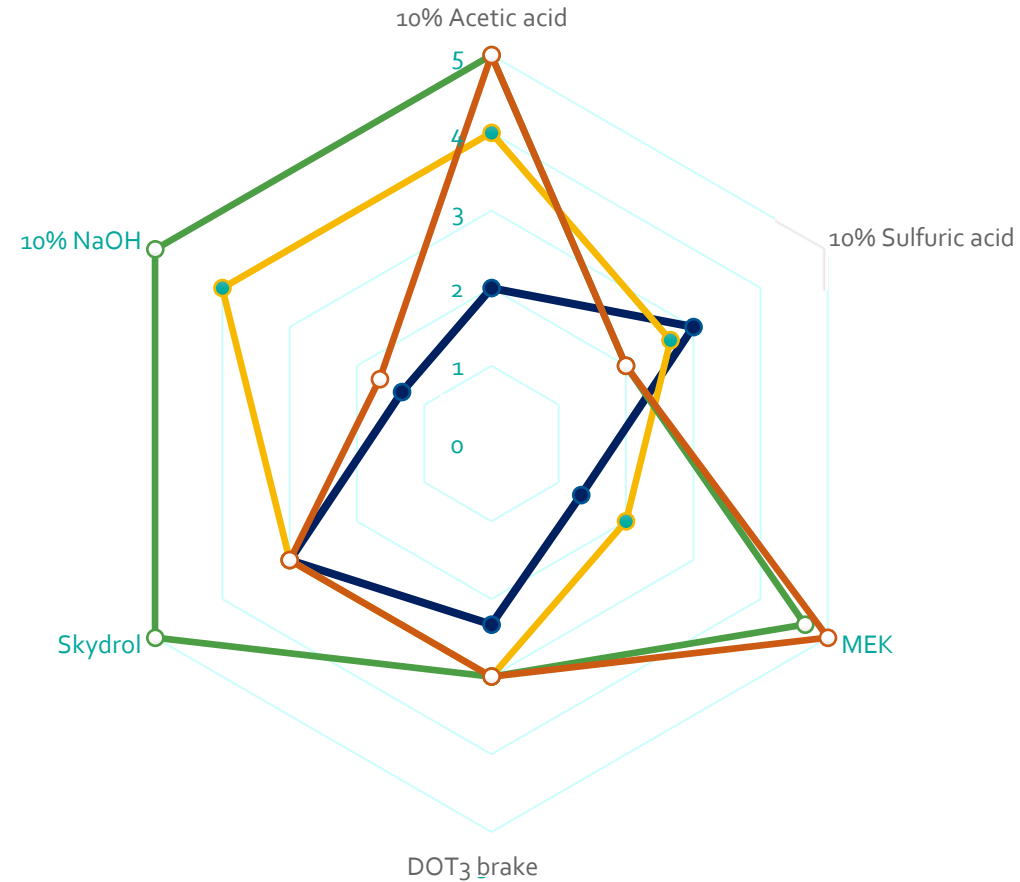
**Exceptional  
corrosion  
resistance**

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# Chemical resistance

7-day exposure data

- ↑ Better**
- Damage rating**
1. No change
  2. Ring or slight loss of gloss
  3. Film softening or swelling
  4. Film lifting from substrate
  5. Complete failure



- Tetrashield
- Benchmark 1
- Benchmark 2
- Benchmark 3

# Corrosion resistance over primer

*ASTM B117 over shot-blasted steel*

