

Formulating with Commercially Available Soy-based vs. Petro-based Materials

SSOY



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Coatings Trends and Technologies Summit

September 8, 2023



OMNI TECH
STRATEGIC SUSTAINABLE SOLUTIONS



Experienced renewable chemistry consultants with expertise:

- Market research and analysis
- IP landscape
- Competitive analysis
- Product commercialization
- Technology assessment
- Strategic planning
- Life-Cycle analysis
- Technoeconomic analysis
- Regulatory compliance

Builds demand to ensure strong, profitable future for U.S. Soybean farmers

- Represents over 500,000 U.S. soybean producers in 31 states
- Promotes sustainability of U.S. Soy farming
- Focuses on research and market development
- Checkoff contributions of 0.5 % of the net market price per bushel sold
- The USB approved a program budget of \$163.7 M for FY23

**U.S. SOY SUSTAINABILITY
Scorecard Results
1980-2020**

ENERGY

46%

LESS

PER BUSHEL



CO₂ EMISSIONS

43%

LESS

PER BUSHEL

WATER USE
Irrigation water
use efficiency
improvement



60%
LESS
PER BUSHEL

**LAND USE
EFFICIENCY**

48%
LESS
PER BUSHEL



**SOIL
CONSERVATION
IMPROVEMENT**

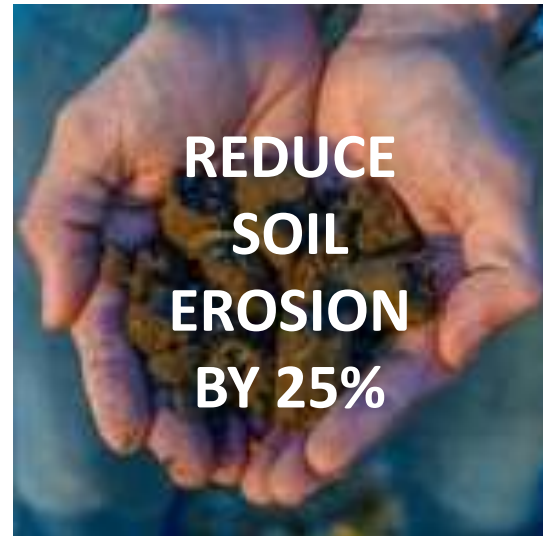
34%
LESS
PER ACRE

2025 SUSTAINABILITY GOALS

BY 2025, U.S. SOY FARMERS AIM TO:



measured as acres per
bushel



measured as tons per
bushel



measured as BTUs per
bushel

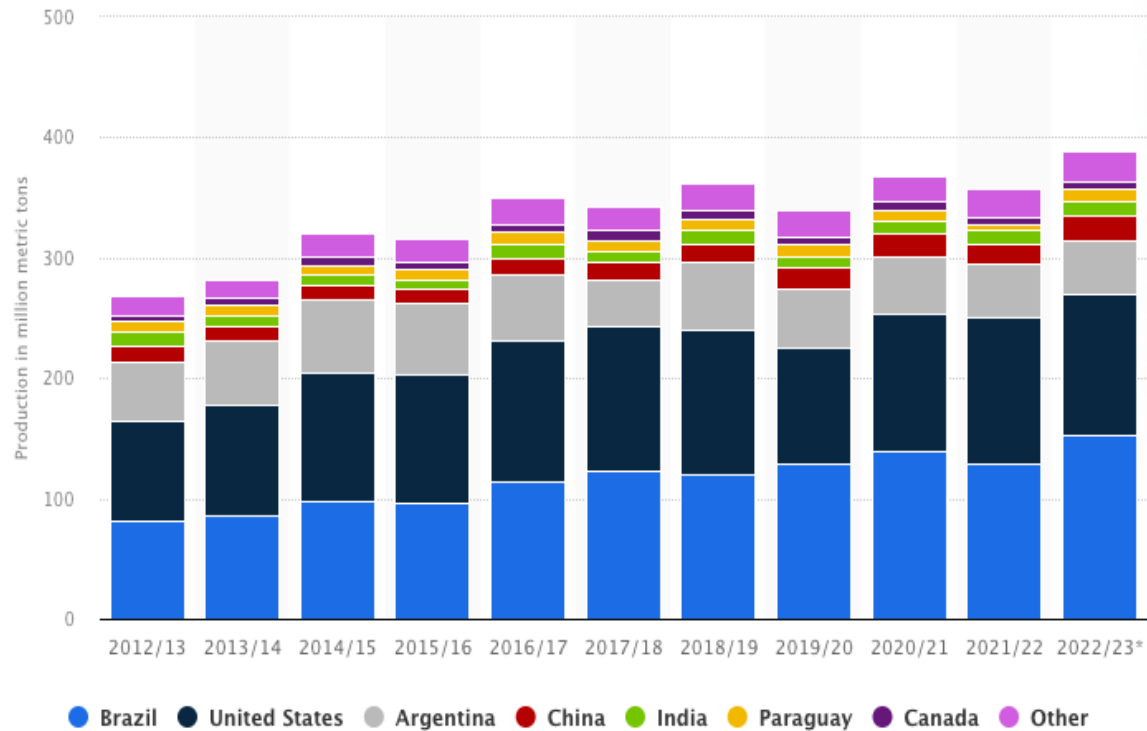


measured as pounds CO2-
equivalent gasses emitted
per year

Source: US Soy Sustainability Overview Year 2021

SOY IS A GLOBAL PRODUCT

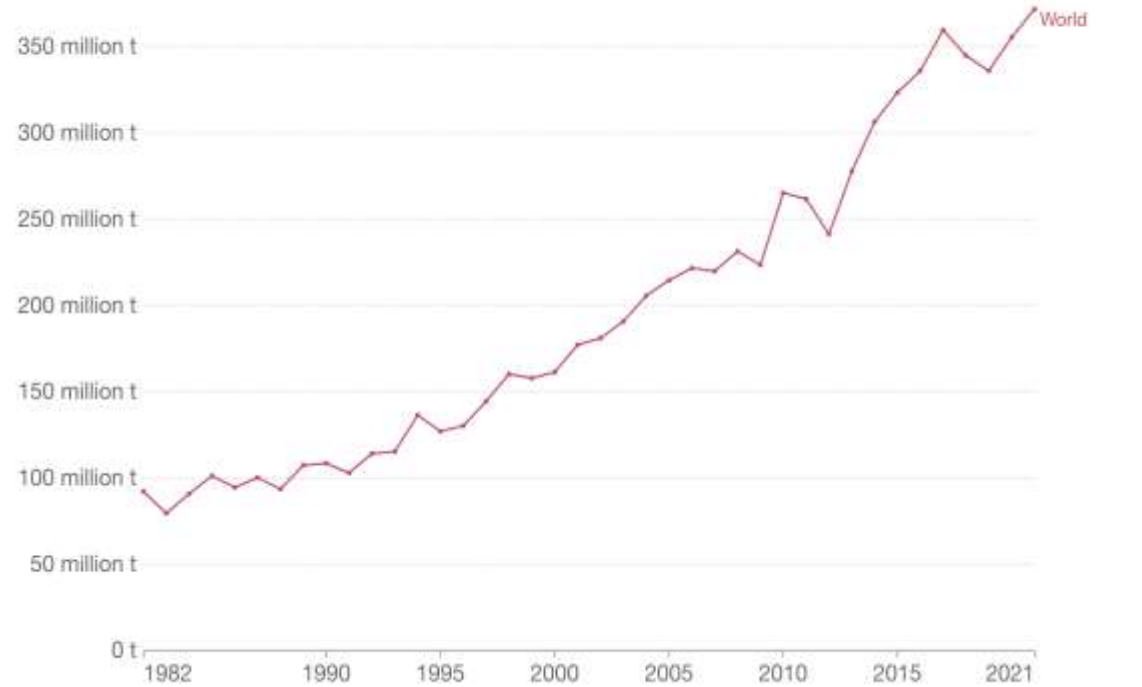
Global Soybean Production (Million MT)



Global Data

Soybean production

Soybean production is measured in tonnes.



Source: Food and Agriculture Organization of the United Nations

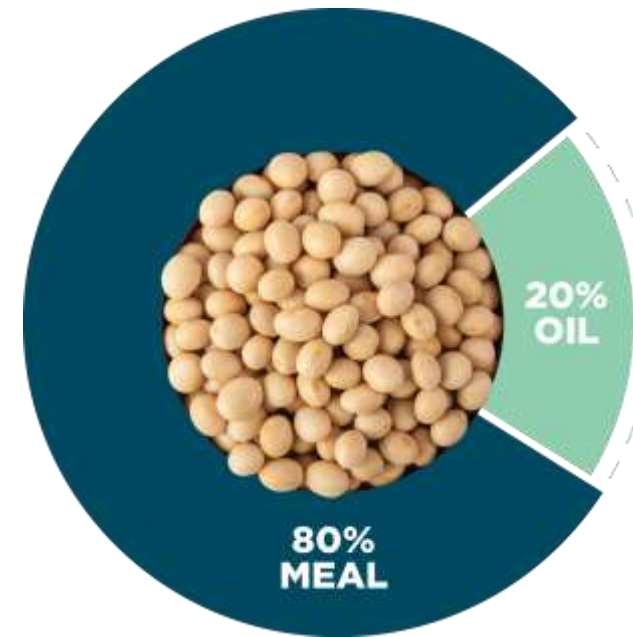
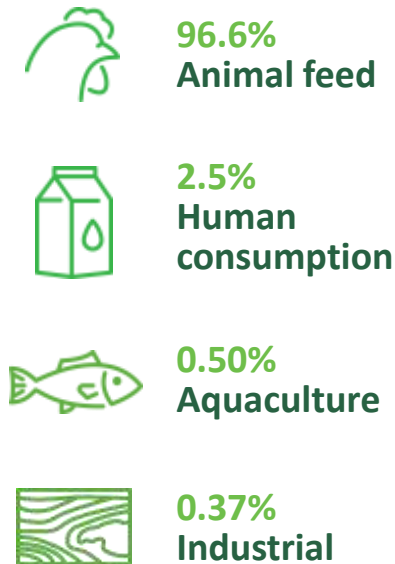
OurWorldInData.org/agricultural-production - CC BY

Sources: Statistica and Our World Data

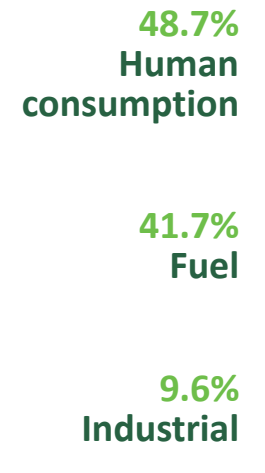
FOOD + FUEL AND CHEMICALS

WITH U.S. SOY
YOU GET BOTH
FOOD AND
FEEDSTOCKS

MEAL



OIL



Source: Market View Database 2021

“Soybean meal is the main source of feed protein worldwide”

Dr. Rouf M. Mian, acting research leader of the Soybean Research Unit, USDA – ARS and research geneticist at North Carolina State University



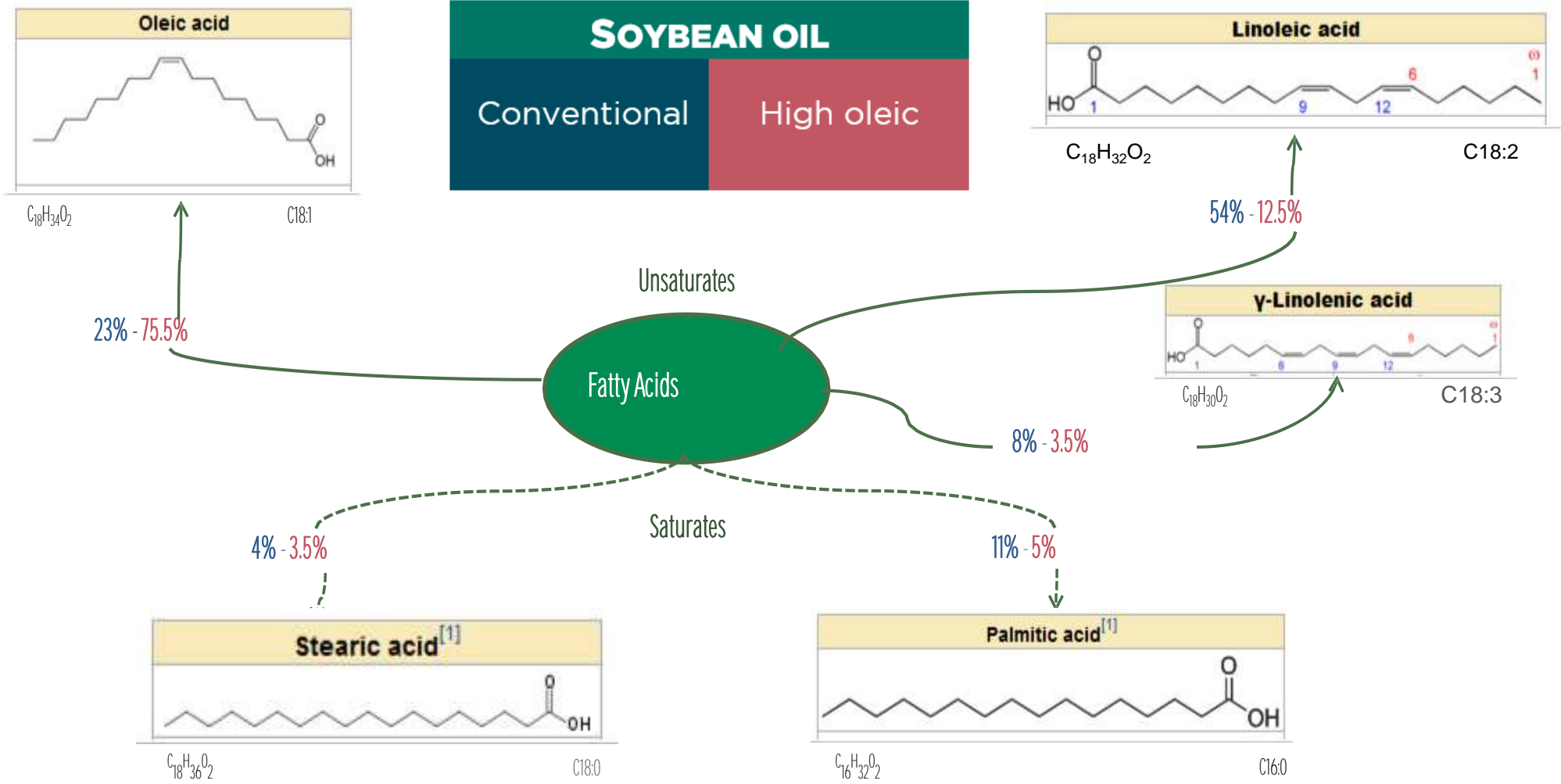
SOY IMPROVES PAINTS & COATINGS

Soybean oil has been used as a major ingredient in coatings for over 70 years

Provides unique benefits:

- ✓ Flexibility
- ✓ Improved water repellency and water resistance
- ✓ Resistance to polar solvents, acids and bases
- ✓ Improved film hardness
- ✓ Increased durability
- ✓ Impact resistance
- ✓ Low VOCs

FATTY ACIDS FOR ENHANCED CHEMISTRY



SOY ATTRIBUTES AND PERFORMANCE BENEFITS

C18 Fatty Acid

- Hydrophobicity - Improved Water Contact Angle
- Water Repellency and Chemical Resistance

C18 Chain Length

- Film Flexibility
- Less Rigidity & Embrittlement Impact Resistance

Multiple Unsaturation Sites

- Enhanced Reactivity
- Crosslinking and Additional Functionality

Epoxidized Sites

- Expanded Chemistry Reactions
- Advance Functionality and Novel Structures

Solvency

- Derivatized soybean oil replacement for solvents
- VOC reduction

Wood Stains

• TRUSTED QUALITY SINCE 1921 •

RUST-OLEUM®



Powder Coatings

BATTELLE



Plasticizers

VALTRIS
SPECIALTY CHEMICALS

Cargill



Dispersants

Lamberti surfactants
Lubrizol
EVONIK
Leading Beyond Chemistry



Latex Paints



Coalescence

Cargill
ACS
TECHNICAL PRODUCTS



Traffic Paint

REICHOLD Aexcel



Solvents

VERTEC BIOSOLVENTS
SOYSOLV® BIOSOLVENTS



USB FUNDED PROJECT

(2321-106-0101)

- Test commercially available soy vs. petro-based coating materials
- Demonstrate effectiveness
 - ✓ Real world formulations
 - ✓ Key performance properties
- Share results with coatings industry
 - ✓ Raw material suppliers-coating manufactures-end users
- Key materials
 - ✓ **Coalescing Solvents for water-based architectural and industrial paints**
 - ✓ **Dispersions & emulsions for water-based architectural paints**
 - ✓ Solvents for alkyd, epoxy & urethane industrial paints
 - ✓ Dispersants for solvent-based industrial paints



1. BIO-BASED COALESCING SOLVENTS

Coalescents:

B1 – Biomass, 100% BC, 0 VOC

B2 – Soybean oil, 95% BC, 0 VOC

B3 – Soybean oil, 96% BC, 0 VOC

P1 – TMPMB

P2 – Proprietary

P3 -- DPnB / DPM (3:1)



Coatings:

A. Industrial Coatings

- Semi-gloss Direct to Metal (DTM) Paint

B. Architectural Coatings

- Interior/exterior Flat House Paints
- Interior/exterior Semi-Gloss Trim Enamels



1A. SEMI-GLOSS DIRECT TO METAL FORMULATION

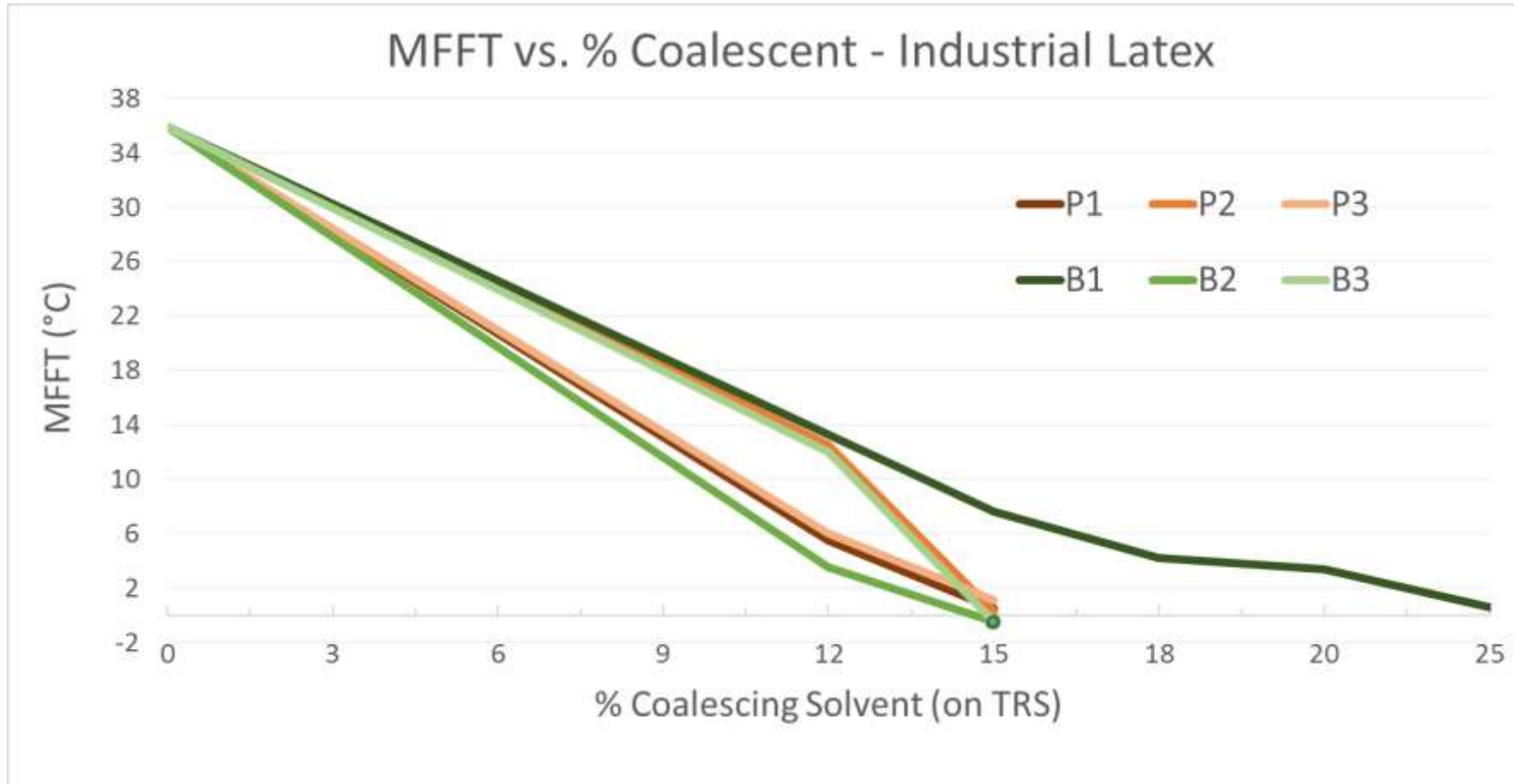
Substrates CRS & Aluminum
 Application Drawdown
 DFT 2 - 2.5 mils, single coat
 Cure 7 Days Ambient

PVC Ratio = 16.0
 % Weight Solids = 51.4
 Density = 9.9
 Lb/Gal VOC = 0.42
 g/L VOC = 51

| Description | Weight (Lbs) | Volume (Gals) |
|-------------------------------------|--------------|---------------|
| DI Water | 37.93 | 4.54 |
| Dispersant | 10.31 | 1.17 |
| Buffer | 1.10 | 0.15 |
| Surfactant | 1.63 | 0.18 |
| Defoamer | 1.69 | 0.20 |
| Flow Control | 4.93 | 0.61 |
| Titanium Dioxide | 211.28 | 6.33 |
| DI Water | 12.99 | 1.56 |
| Coalescing Solvent (15% TRS) | 42.51 | 5.36 |
| Industrial Latex | 566.74 | 67.90 |
| Buffer | 2.17 | 0.29 |
| DI Water | 84.65 | 10.14 |
| Defoamer | 2.71 | 0.33 |
| Flash Rust Inhibitor | 9.75 | 1.06 |
| Rheology Modifer | 1.61 | 0.19 |
| Totals | 992 | 100 |



Semi-gloss Direct to Metal (DTM) Paint



Target MFFT = 0°C

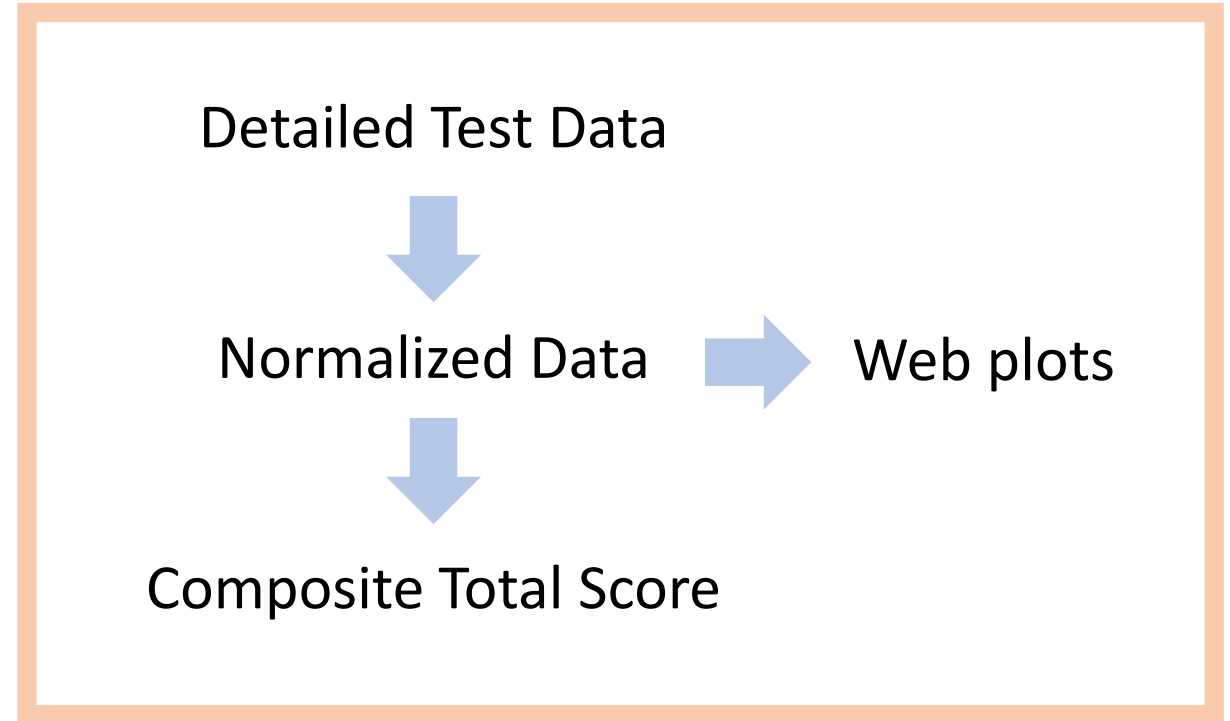
% CS = 15%

B1 > 15%

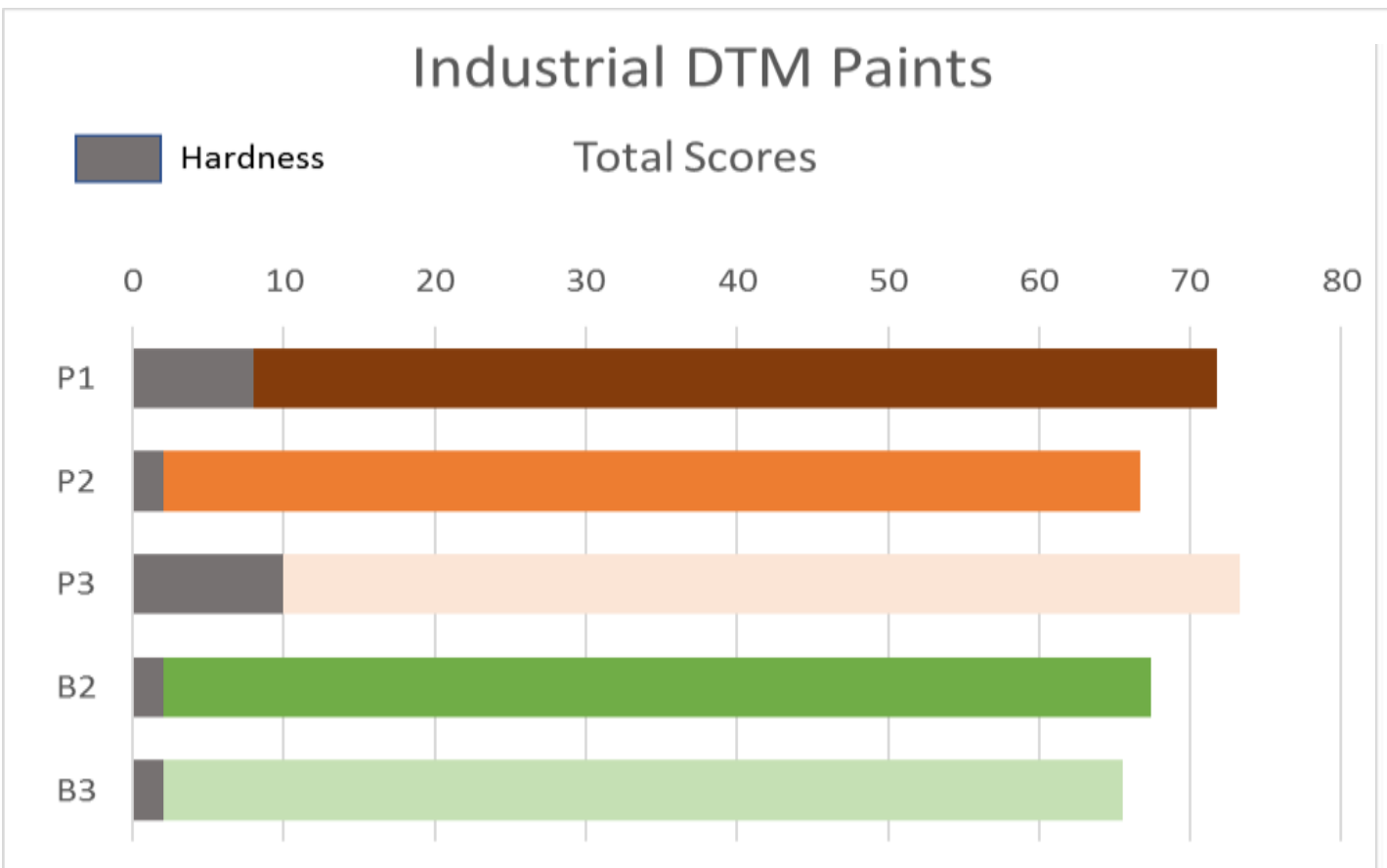
25% Tacky, Not testable

Semi-gloss Direct to Metal (DTM) Paint

Adhesion
Appearance
Hardness
Flexibility & Impact Resistance
Corrosion Resistance
UV Resistance



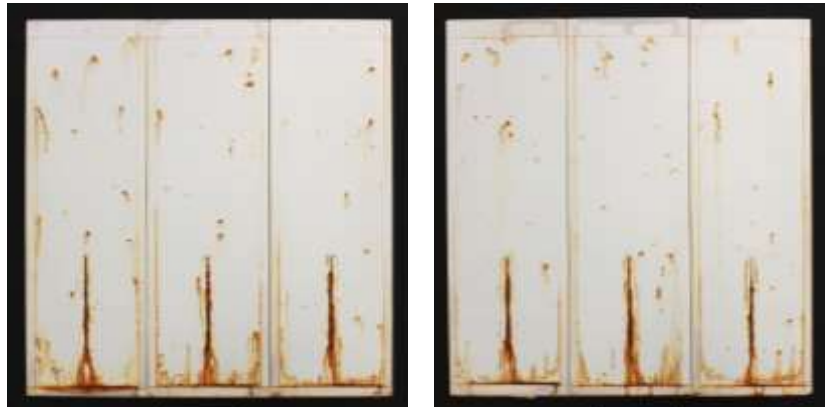
Semi-gloss Direct to Metal (DTM) Paint



Note: Formula: Not optimized for soy coalescent
Lower levels of coalescent increases hardness

Salt Spray (ASTM B117)

100 HOURS



200 HOURS



Conclusion: Semi-gloss DTM Paint – Bio vs Petro

- ✓ Adhesion
- ✓ Appearance
- ✓ Hardness
- ✓ Flexibility & Impact Resistance
- ✓ + **Corrosion Resistance**
- ✓ UV Resistance

Next steps

- Optimize % coalescent (lower is optimal)
- Harder polymers
- Corrosion inhibiting pigments
- Extender pigments
- Increase film build



1B. Architectural Interior/Exterior Paints

- Interior/exterior Flat House Paints
- Interior/exterior Semi-Gloss Trim Enamels

Application

Appearance

Block Resistance

Dirt Pick-Up

Scrub Resistance

UV Resistance



Architectural Coating Formulations

1. Flat House Paint

| Description | Weight (Lbs) | Volume (Gals) |
|--------------------|--------------|---------------|
| DI Water | 75.22 | 9.01 |
| Dispersant | 5.09 | 0.58 |
| Surfactant | 1.51 | 0.17 |
| Defoamer | 2.49 | 0.30 |
| Flow Control | 5.86 | 0.68 |
| Titanium Dioxide | 163.04 | 4.88 |
| Calcium Carbonate | 177.17 | 7.85 |
| Talc | 84.33 | 3.61 |
| Nepheline syenite | 83.05 | 3.83 |
| DI Water | 66.88 | 8.01 |
| Buffer | 0.10 | 0.01 |
| Coalescing Solvent | 15.31 | 1.93 |
| DI Water | 123.68 | 14.81 |
| Defoamer | 1.50 | 0.18 |
| Latex Resin | 382.51 | 43.21 |
| Rheology Modifier | 8 | 1 |
| Buffer | 0.33 | 0.04 |
| Totals | 1196 | 100 |

Latex 1 @ 10% CS & Latex 2 @ 7.5% CS
 VOC (lb/gal) 0.15 (0) VOC (g/L) 18 (0)

2. Semi-Gloss Trim Enamel

| Description | Weight (Lbs) | Volume (Gals) |
|--------------------|--------------|---------------|
| DI Water | 61.2 | 7.33 |
| Dispersant | 2.38 | 0.27 |
| Surfactant | 1.83 | 0.20 |
| Defoamer | 3.05 | 0.37 |
| Flow Control | 5.06 | 0.58 |
| Titanium Dioxide | 198.59 | 5.95 |
| Kaolin Clay | 13.74 | 0.63 |
| Calcium Carbonate | 27.49 | 1.22 |
| DI Water | 8.63 | 1.03 |
| Buffer | 0.15 | 0.02 |
| Coalescing Solvent | 18.72 | 2.35 |
| DI Water | 222.30 | 26.62 |
| Defoamer | 1.83 | 0.22 |
| Latex Resin | 465.62 | 52.59 |
| Rheology Modifier | 5.42 | 0.62 |
| Totals | 1036 | 100 |

Latex 1 @ 10% CS & Latex 2 @ 7.5% CS
 VOC (lb/gal) 0.19 (0) VOC (g/L) 22 (0)

Architectural Interior/Exterior Paints

| Commercial Latex Resins | Petroleum-Based Coalescing Solvents | Bio-renewable Coalescing Solvents |
|---|-------------------------------------|-----------------------------------|
| Latex 1 – 100% Acrylic 50% NVW, MFFT 17°C | P1 – TMPMB | B1 – Biomass-based |
| Latex 2 – Acrylic Copolymer 50% NVW, MFFT 14°C | P2 – Proprietary | B2 – Soy-based |
| | P4 – TMPDB | B3 – Soy-based |

Flat & Semi-Gloss

2 Latexes

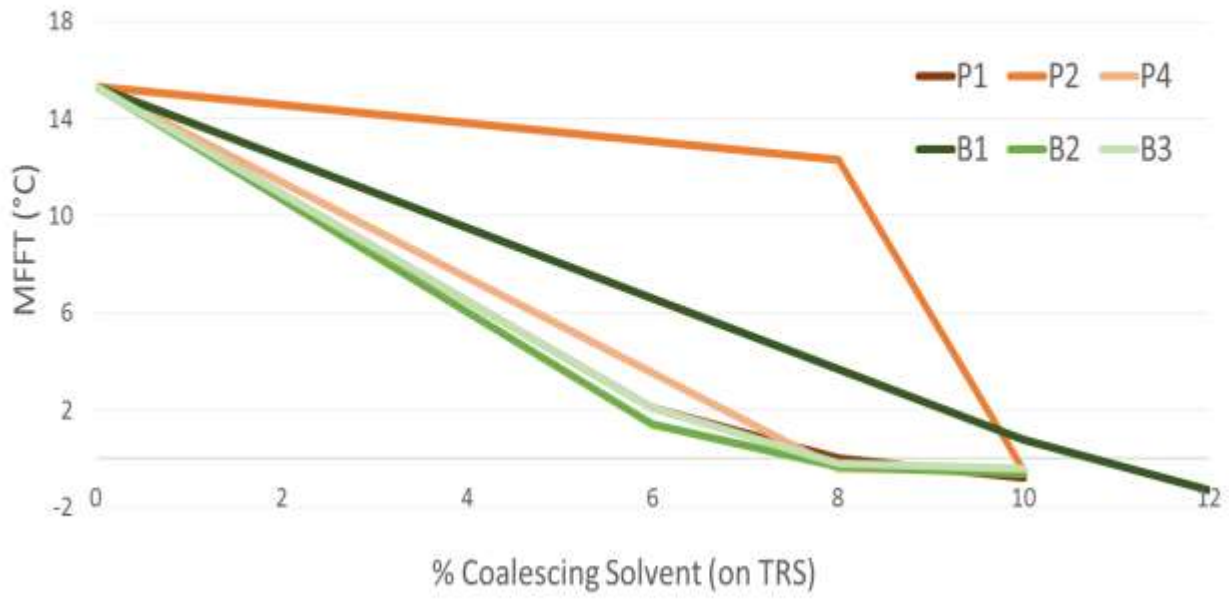
6 Coalescing Solvents

2 Formulations

24 Paints

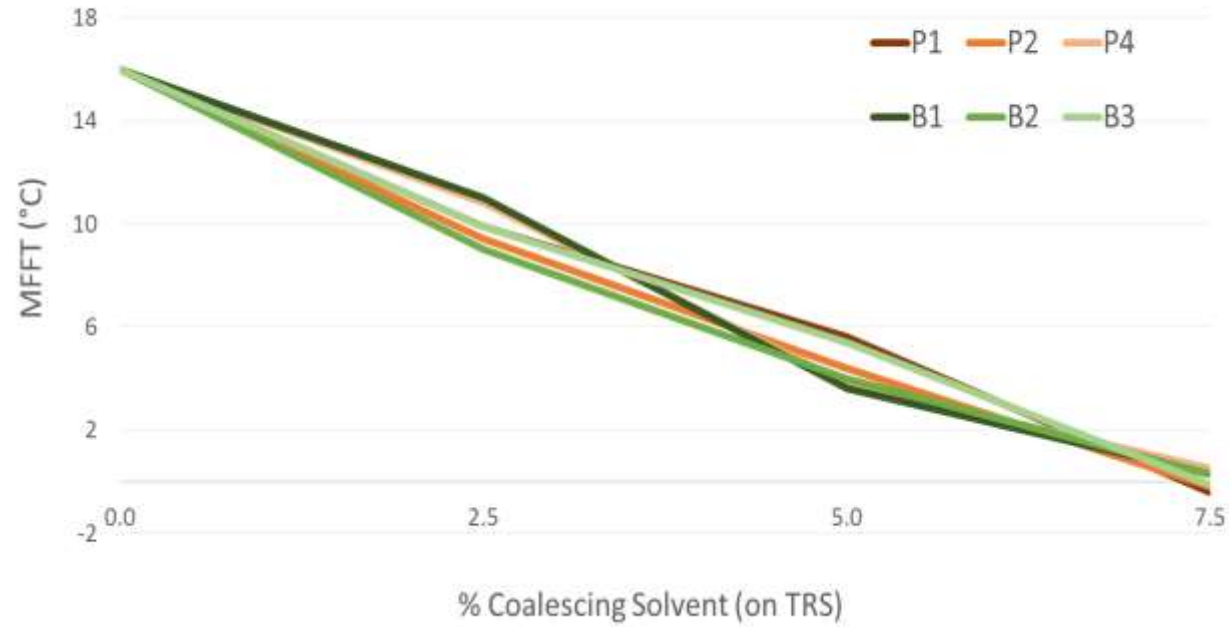
Architectural Interior/Exterior Paints

MFFT vs. % Coalescent - Architectural Latex 1



Target MFFT = 0°C
% CS = 10%
B1 = 12%

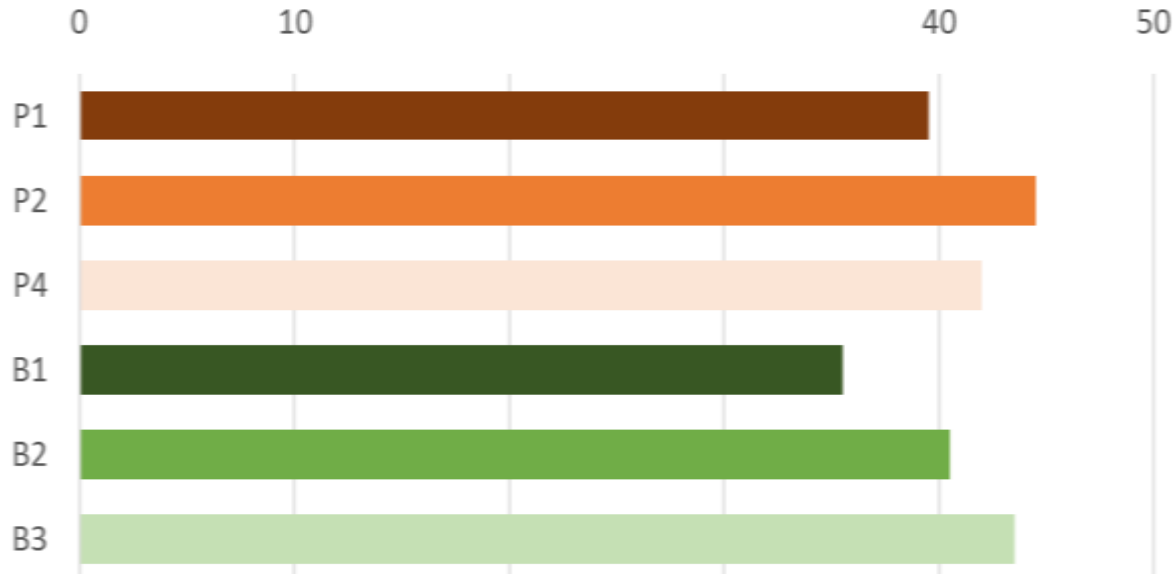
MFFT vs. % Coalescent - Architectural Latex 2



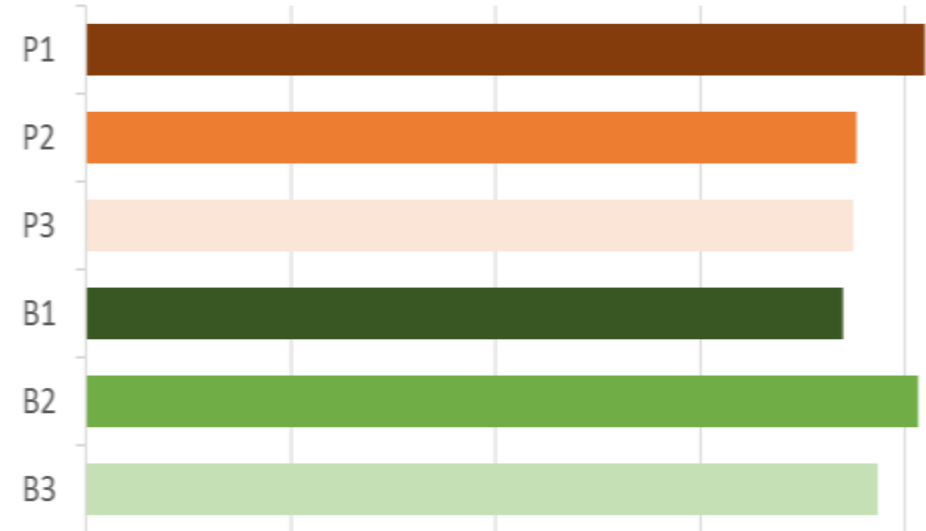
Target MFFT = 0°C
% CS = 7.5%

Architectural Flat House Paint Composite Score

Latex 1



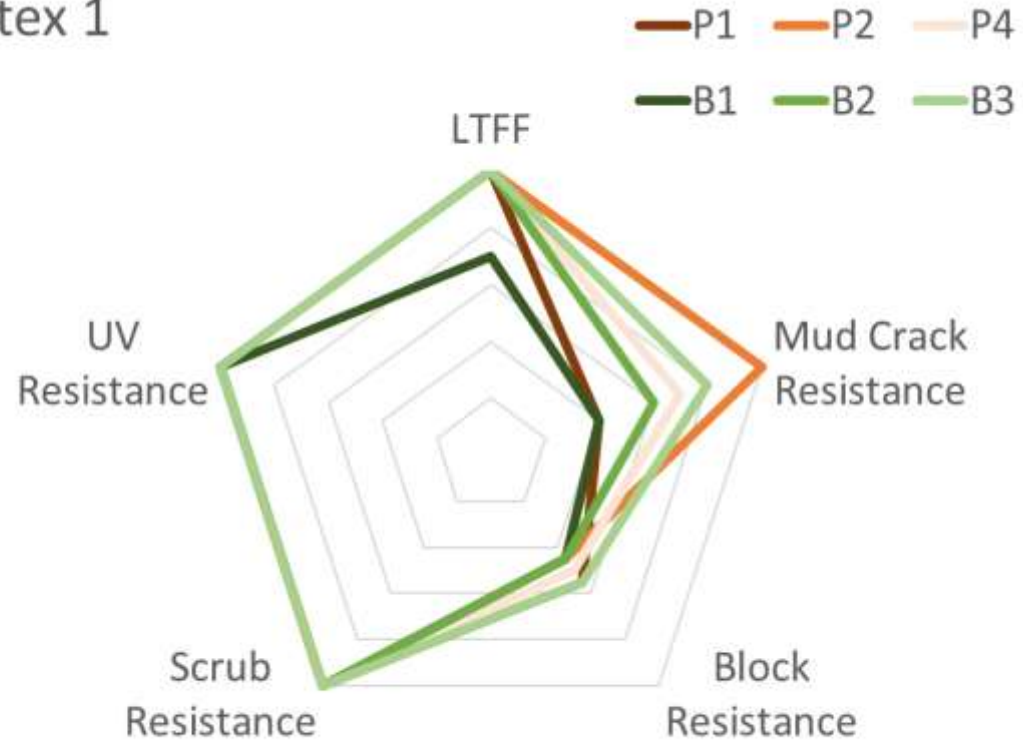
Latex 2



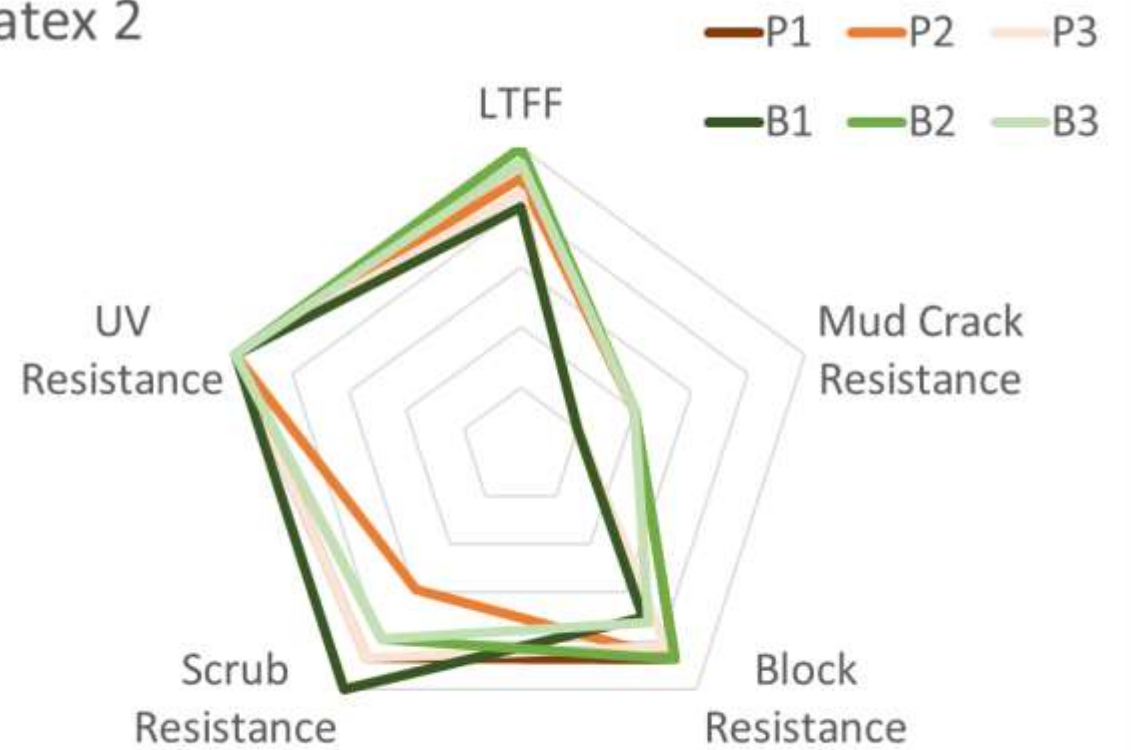
- Low Temperature Film Formation (LTFF)
- Mud Crack Resistance
- Block Resistance
- Scrub Resistance
- UV Resistance

ARCHITECTURAL FLAT HOUSE PAINT

Latex 1



Latex 2



Architectural Flat House Paints – Soy vs Petro

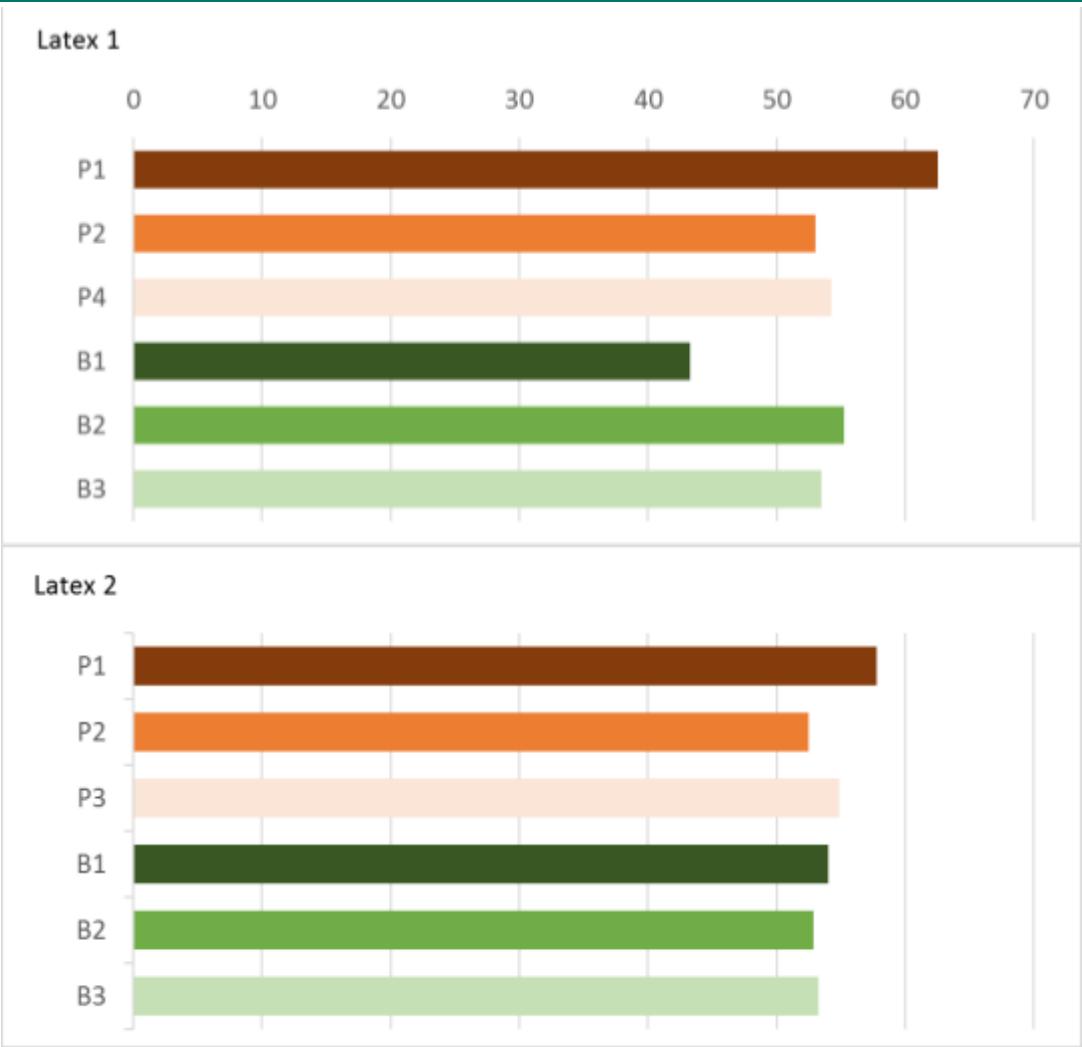
- ✓ Application
- ✓ Appearance
- ✓ Block Resistance
- ✓ Scrub Resistance
- ✓ UV Resistance

Summary

- Effective MFFT Reduction
- Equivalent Performance
- Latex Specific



Semi-Gloss Trim Enamel-Composite Score



- Application
- Appearance
- Hardness
- Block Resistance
- Dirt Pick-Up
- Scrub Resistance
- UV Resistance

Semi-Gloss Trim Enamels – Bio vs Petro

- ✓ Application
- ✓ Appearance
- ✓ Hardness
- ✓ Block Resistance
- ✓ Dirt Pick-Up
- ✓ Scrub Resistance
- ✓ Weather Resistance
- ✓ Package Stability

Summary



- Effective MFFT Reduction
- Equivalent Performance
- Latex Specific



2. WB Soy-Alkyd Dispersions

Semi-Gloss Trim Enamels

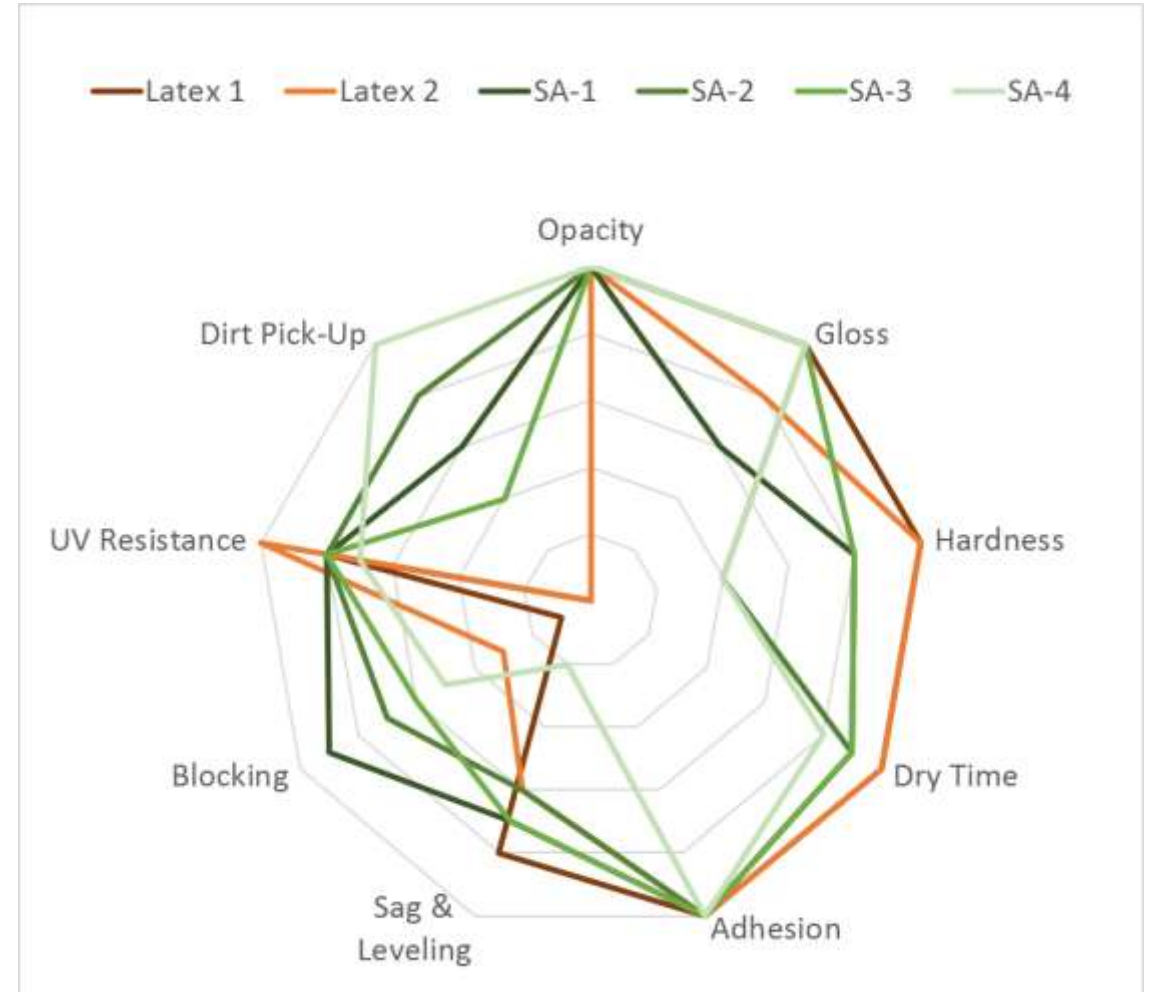
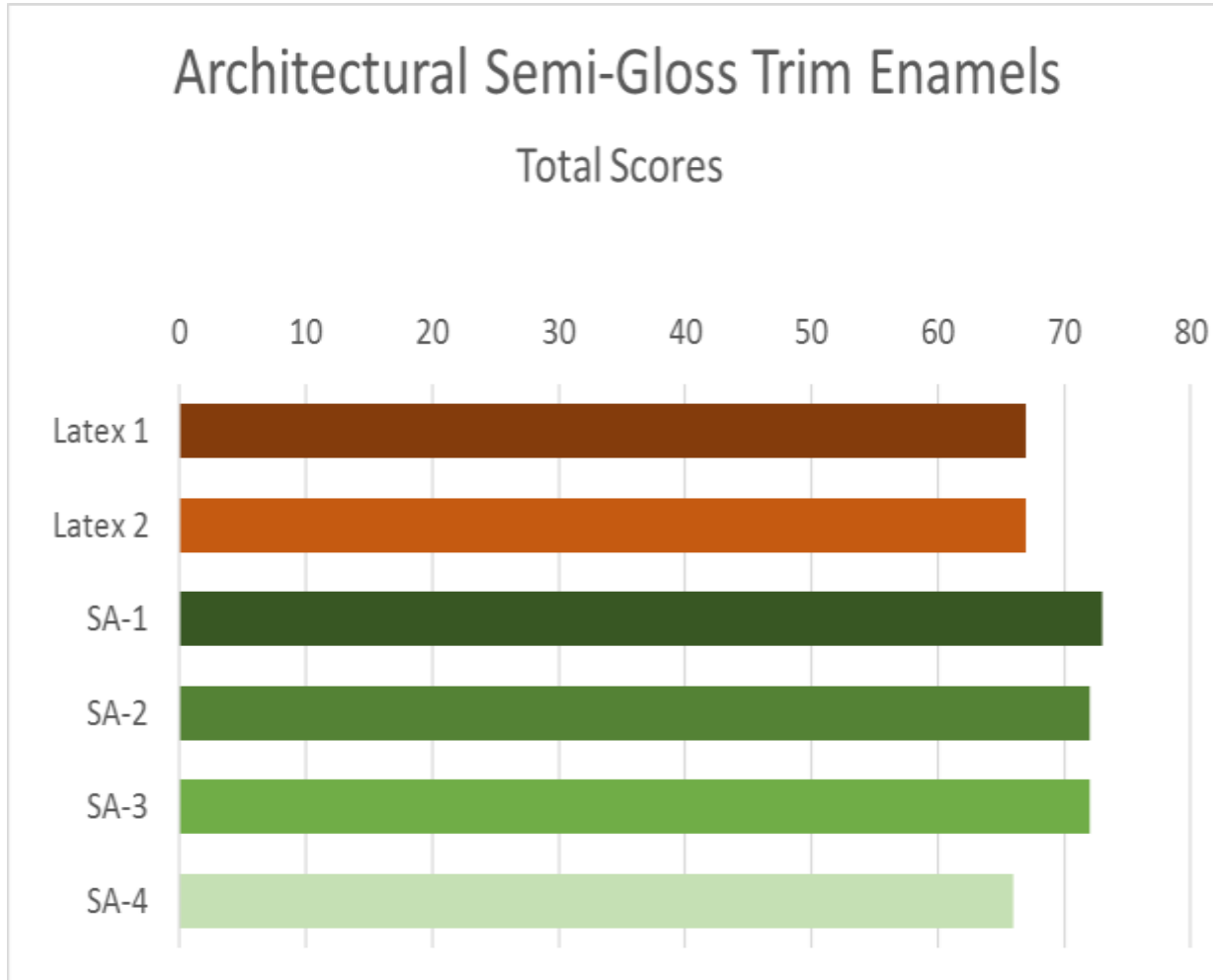
- Soy Long Oil Alkyds (55-70% Soy Oil)
- Soy Medium Oil Alkyds (40-55% Soy Oil)
- Soy Short Oil Alkyds (<40% Soy Oil)
- Resins 45-55% NV in Water
- Semi-gloss Paints ~35-40% Resin
- 4 WB soy-alkyd dispersions
- 2 Petroleum-based latex emulsions

| Description | Weight (Lbs) | Volume (Gals) |
|-------------------|--------------|---------------|
| DI Water | 232.39 | 27.83 |
| Thickener | 5.79 | 0.87 |
| Dispersant | 10.24 | 1.16 |
| Surfactant | 2.04 | 0.23 |
| Defoamer | 2.74 | 0.33 |
| Flow Control | 4.59 | 0.53 |
| Titanium Dioxide | 179.14 | 5.36 |
| Kaolin Clay | 12.56 | 0.57 |
| Calcium Carbonate | 25.12 | 1.11 |
| DI Water | 48.27 | 2.82 |
| Buffer | 0.16 | 0.02 |

| | |
|---------|--------|
| PVC | 22.7 |
| NVW | 45.1% |
| NVV | 32.7 |
| Density | 10.1 |
| VOC | 0 lb/g |
| VOC | 0 g/l |

| | | |
|-------------------------|--------|-------|
| WB Soy-Alkyd Dispersion | 387.68 | 44.13 |
| DI Water | 85.61 | 10.25 |
| Drier Complex | 4.24 | 0.49 |
| Defoamer | 1.87 | 0.22 |
| Freeze-Thaw Stabilizer | 7 | 1 |
| Defoamer | 2.82 | 0.32 |
| Totals | 1012 | 97 |

WB Soy-Alkyd Dispersions – Semi-Gloss Trim Enamels



Interior/Exterior Semi-Gloss Trim Enamels

Bio vs Petro

- ✓ Application
- ✓ Appearance
- ✓ Hardness
- ✓ Block Resistance
- ✓ Dirt Pick-Up
- ✓ Weather Resistance
- ✓ Package Stability
- ✓ % Biobased Content



What's Next for Soy...

- **Water-based Coatings**
 - Soy dispersions for wood deck sealers & stains
 - Soy dispersions for wood trim stains & clears
 - Soy dispersions for masonry floor sealers & stains
 - Soy dispersions for DTM applications
- **Solvent-based Coatings**
 - Soy solvents in industrial coatings
 - Soy dispersants in architectural & industrial paints



Waterborne Soy Resin Dispersions for Wood Coatings

6 Soy dispersions vs 1 acrylic latex benchmark exterior wood decking

- Clear sealers & stains
- Soy wax emulsion
- Treated pine & cedar



6 Soy dispersions vs acrylic latex & PUD benchmarks interior wood trim

SSOY

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Visit with us at Table 35



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