



# **ACUSOL™ CB-1 Cleaning Booster Polymer**

Multifunctional Nonionic Polymer for Laundry Detergents

Seek Together™



# Agenda

- Introduction
- Overview of Dow technology portfolio for Laundry/Fabric Care
- Fundamentals and Design of Experiments
- ACUSOL™ CB-1 Cleaning Booster performance testing and results
- Conclusions



# Laundry technology portfolio

Combining expertise across a range of technologies with exceptional innovation and consumer know how to deliver new offerings to the market



## ACRYLATES

- ACUSOL™ Dispersants, Rheology Modifiers, Opacifiers



## SURFACTANTS

- ECOSURF™, TERGITOL™, DOWFAX™, TRITON™ Surfactants

## SOLVENTS

- PO/PG, DOWANOL™, CARBITOL™ Solvent families

## GLYCOLS

- PEGs, CARBOWAX™, SENTRY™ Water Soluble Polymers



## MODIFIED CELLULOSE

- SUPRACARE™ Polymers
- CELLOSIZE™ Hydroxyethyl Celluloses



## SILICONE TECHNOLOGY

- DOWSIL™ Foam Control Agents
- Silicones for Fabric & Surface Care

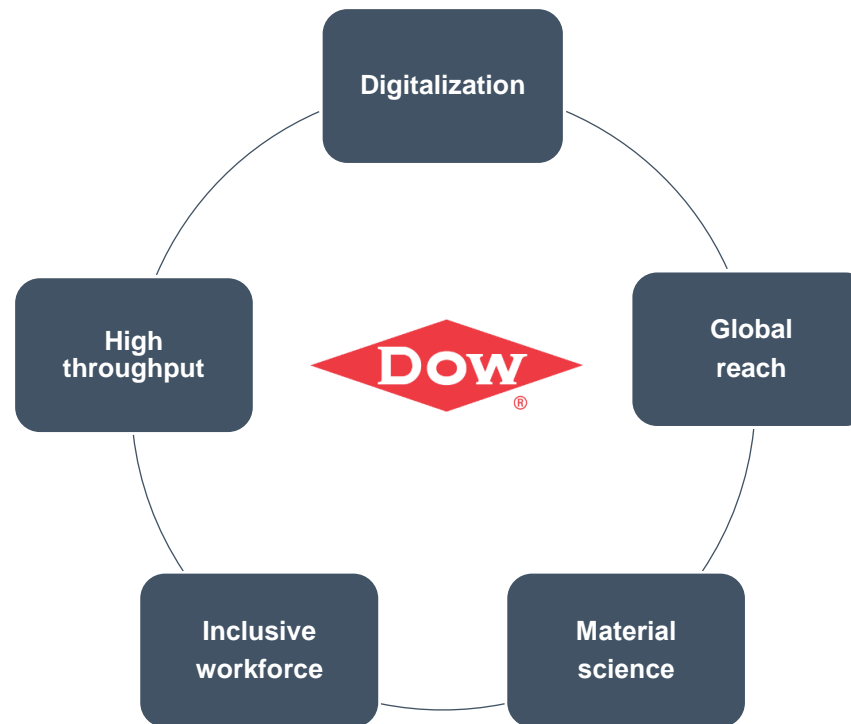


## AMINES

- MEA, DEA, TEA, DIPA

## CHELANTS

- VERSENE™, VERSENEX™, VERSENL™ Chelating Agents



# Dow laundry innovation

*Sustainable cleaning, care and convenience*



## Primary Cleaning

Enhanced removal of tough soils and stains



## Secondary Cleaning

Keeping fabrics white



## Care

Sensorial benefits – look, feel, smell



## Format

Specially designed for new product formats



## Foam Control

Managing foam and the perception of cleaning



## Rheology

Thickening and suspension in liquid formulations

### Sustainable development

Advancing the story from a focus on lower chemical footprint, reduced water use, low ecotoxicity to biodegradable, renewable raw materials.



# Laundry

## *Enabling tomorrow's fabric solutions*

We offer a portfolio of technologies and solutions for fabric care including ingredients for laundry detergents, monodose formats, fabric softeners, laundry aids, fragrance enhancers and pre-treatment products.

Technology	Product enhancement benefit
Solvents	Compatibility with various ingredients, enzyme stability, improved cleaning effectiveness with less product
Care additives ( <i>conditioning agent</i> )	Enhanced sensory feel and softness, fabric conditioning, shape retention, fragrance deposition
Polyethylene glycols ( <i>deposition aid</i> )	Low viscosity formats, solubilizes active ingredients and organic compounds, available in many formats including liquids to high molecular weight waxy solids
Surfactants	Improved performance and cleaning efficacy, biodegradable options available
Foam control agents	Targeted control of foam and easy rinse
Amines	Cleaning efficacy, boosts alkalinity
Rheology modifiers	Controls flow properties, stabilizes formulations, suspends particles
Polypropylene glycols	Solubilizes active ingredients and organic compounds for formulation flexibility, reduced/replaced water activity, added microbial integrity



# Dow laundry innovation platforms – Care benefit aids

Dow is pursuing the next generation of SupraCare™ ingredients to bring outstanding care benefits, beyond softness



- A new family of SupraCare™ Polymers brings sensorial and care benefits into Home Care
- These care benefits include fabric softening, crease reduction, fragrance deposition/longevity and anti-redeposition performance
- A wide variety of SupraCare™ additives can be used in laundry to deliver the benefits

Product	Ionic character	Benefit	Applications
SupraCare™ 133 Polymer	Cationic	Softness, water absorbency	2-in-1 laundry detergents, fabric softeners
SupraCare™ 190 Polymer	Cationic	Softness, fragrance deposition	Liquid laundry
SupraCare™ 212 Polymer	Cationic	Quick drying	Hand dishwashing
SupraCare™ 241 Polymer	Cationic	Softness, fragrance deposition	Liquid laundry
SupraCare™ 307 Polymer	Non-ionic	Foam booster, structurization, sensorial benefits, creamy foam	Hand dishwashing, liquid laundry, automatic dishwashing
SupraCare™ 340 Polymer	Non-ionic	Foam booster, structurization, sensorial benefits, creamy foam	Hand dishwashing, liquid laundry, automatic dishwashing
SupraCare™ 420 Polymer	Non-ionic	Softness, water absorbency, fragrance deposition	Fabric softeners
SupraCare™ 425 Polymer	Non-ionic	Sensorial benefits, shine, creamier foam	Hand dishwashing
SupraCare™ 430 Polymer	Non-ionic	Sensorial benefits, structurization	Manual laundry powders, laundry bars, hand dishwashing liquids
SupraCare™ 435 Polymer	Non-ionic	Sensorial benefits, structurization	Manual laundry powders, laundry bars, hand dishwashing liquids
SupraCare™ 760 Polymer	Non-ionic	Structurization	Liquid laundry, hard surface cleaning, hand dishwashing



# Dow laundry innovation platforms – Surfactants

New specialty, nonionic surfactants to tackle primary cleaning needs in laundry and to enable further concentration of liquid formats

Product series	Key features
ECOSURF™ EH Surfactants	<ul style="list-style-type: none"><li>▪ Excellent aquatic toxicity (EC50 &gt;10 mg/L); readily biodegradable (OECD 301)</li><li>▪ Superior hard surface wetting &amp; oily soil detergency (triglycerides)</li></ul>
ECOSURF™ SA Surfactants	<ul style="list-style-type: none"><li>▪ Biobased hydrophobe; Readily biodegradable (OECD 301)</li><li>▪ Excellent wetting; effective detergency on fabric</li><li>▪ Rapid dissolution and no aqueous gel range</li></ul>
TERGITOL™ 15-S Surfactants	<ul style="list-style-type: none"><li>▪ Secondary alcohol, readily biodegradable (OECD 301)</li><li>▪ Broad family of products (3 EO – 40 EO)</li><li>▪ Extensive FDA clearances</li></ul>
ECOSURF™ LF Surfactants	<ul style="list-style-type: none"><li>▪ Readily biodegradable</li><li>▪ Excellent wetting, low foam, caustic stability</li><li>▪ Rapid dissolution and no aqueous gel range</li></ul>
ECOSURF™ LFE Surfactants	<ul style="list-style-type: none"><li>▪ Branched alcohol ethoxylate; readily biodegradable, low aq. tox.</li><li>▪ Excellent oil removal, good wetting,</li><li>▪ Rapid dissolution and good rinseability, no gel range</li></ul>

Additional information for surfactants is available at [www.dow.com](http://www.dow.com)



# Dow laundry innovation platforms – Cleaning polymers

New specialty cleaning booster polymer(s) to boost the primary cleaning performance of existing surfactant systems for both liquid laundry/monodose and standard liquid

- Body soils (sebum): very hydrophobic and semi-solid at ambient temperature
  - Consumers are sensitive to them because they tend to be concentrated in prominent parts of clothing (collars, cuffs)
- Drive to lower energy, water usage complicates cleaning
- Dow's New Cleaning Booster Polymer will provide fabric care brand owners with the ability to deliver **enhanced sebum stain removal** performance and **excellent anti-redeposition performance**
- A potentially differentiated technology- elevating benefit from ARD to cleaning performance addressing gap in offering in strategic segments of liquid laundry and monodose





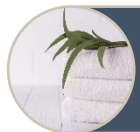
# ACUSOL™ CB-1 Cleaning Booster Multifunctional Nonionic Polymer



Excellent compatibility



Detergency improvement



Anti-redeposition



Viscosity control and anti-gelling



Foam control



100% active



## Physical and chemical properties – ACUSOL™ CB-1 Polymer

Parameter	Range
Appearance	Yellow to brown liquid
Total solids (%)	100
pH as is	Approx. 10
Viscosity	Approx. 1000 cps



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# Fundamental studies and design of experiments

- Compare the primary and secondary cleaning performance of detergents supplemented with various adjuvants
  - ACUSOL™ CB1: alkoxyated aliphatic oligoamine (EO/PO)
  - EPEI: ethoxylated polyethyleneimine (EO)
  - Laureth-X: ethoxylated lauryl alcohol (EO)
- Determine which features correlate with performance
- Identify formulations in which the cleaning enhancement is most significant

# Formulation screening – DOE

## GB sebum

	LAS (%)	AES* (%)	AEO9** (%)	Soap (%)	ACUSOL™ CB1 ΔE/Base ΔE	ACUSOL™ CB1 ALB ΔE/AEO9 ΔE
1	20	0	0	1.5	2.4	1.5
2	13.4	3.4	3.4	1.5	1.9	1.3
3	10	10	0	1.5	1.7	1.4
4	10	6.6	10	1.5	1.5	1.4
5	6.6	3.4	6.6	1.5	1.4	1.2
6	3.4	10	3.4	1.5	1.4	1.3
7	0	10	10	1.5	1.3	1.1
8	0	20	0	1.5	1.2	1.1
9	3.4	3.4	13.4	1.5	1.2	1.2
10	0	0	20	1.5	1.1	0.9

Designed to highlight where the addition of ALB is most impactful on cleaning (ΔE) vs. base alone and vs. base + Laureth-9 (ratios of 1.0 indicate parity)

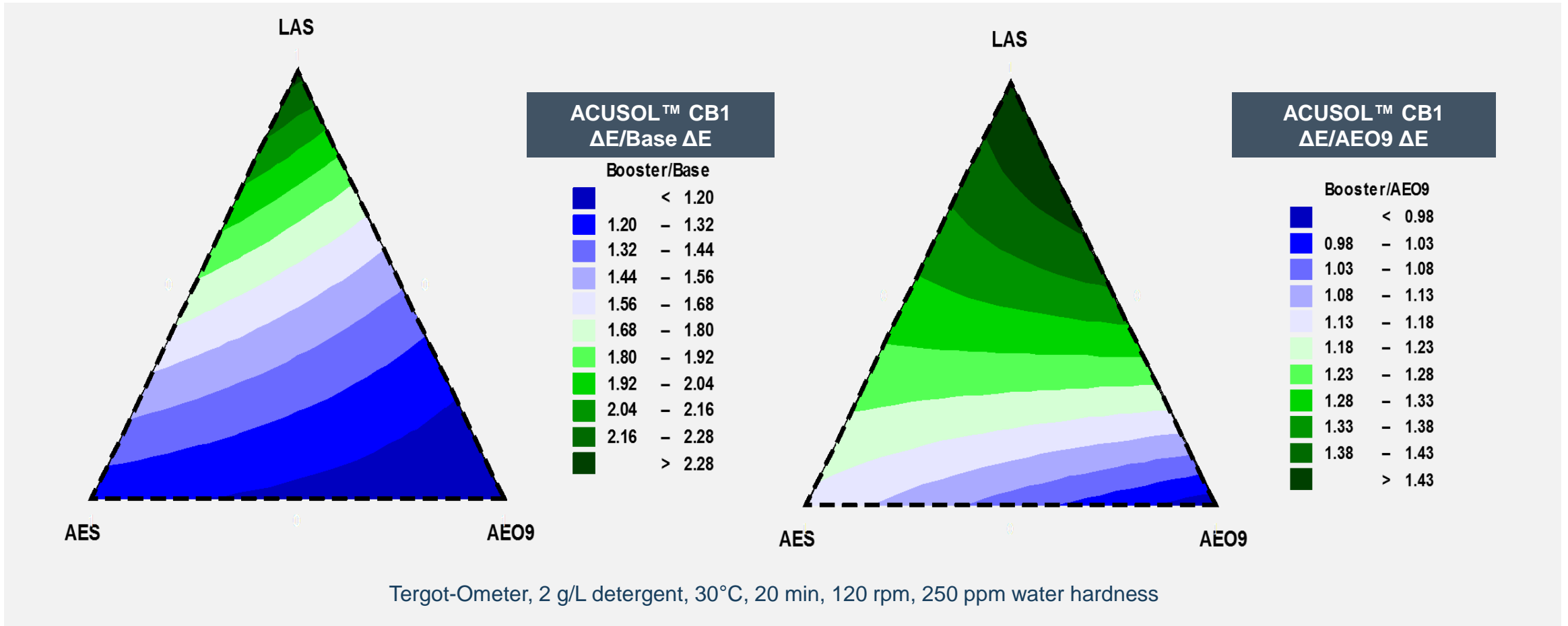
\*Sodium laureth-X sulfate; \*\*Laureth-9

Terg-Ometer, 2 g/L detergent, 30°C, 20 min, 120 rpm, 250 ppm water hardness, **5% adjuvant**

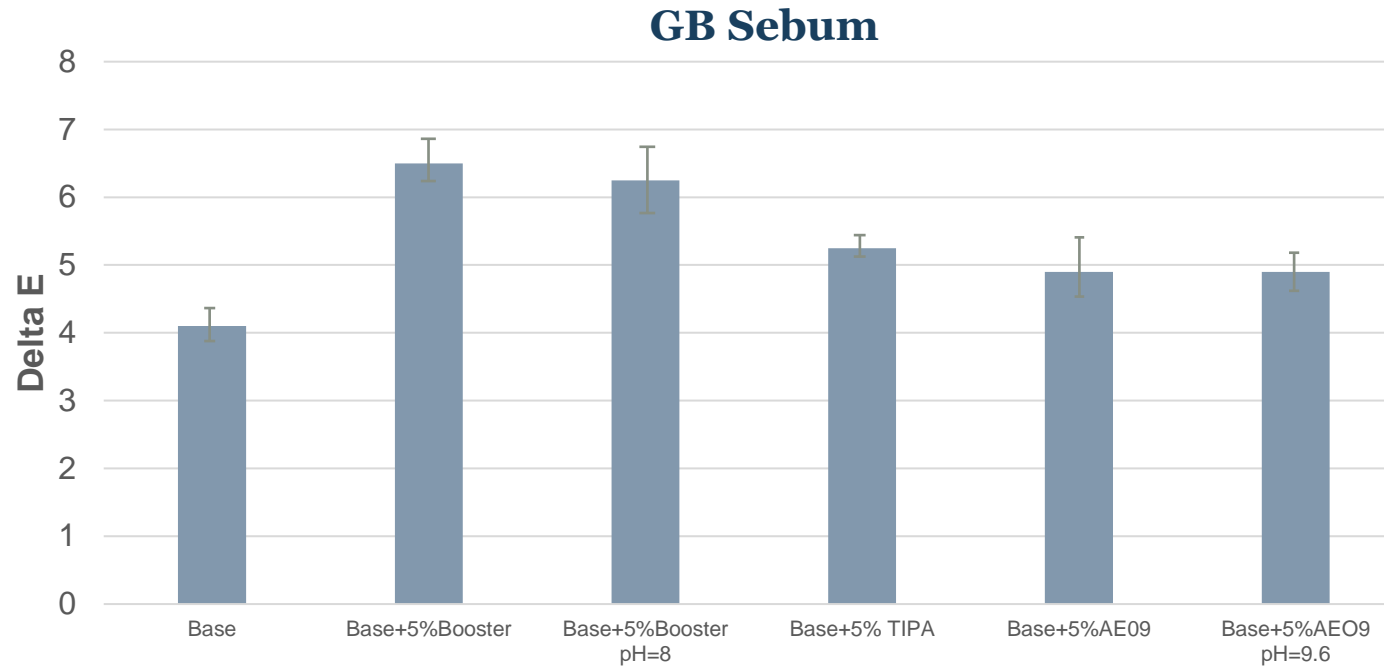


# Effectiveness most pronounced in LAS-Rich formulations

## GB sebum



# ACUSOL™ CB1 Cleaning Booster: Effect of pH on sebum soil removal



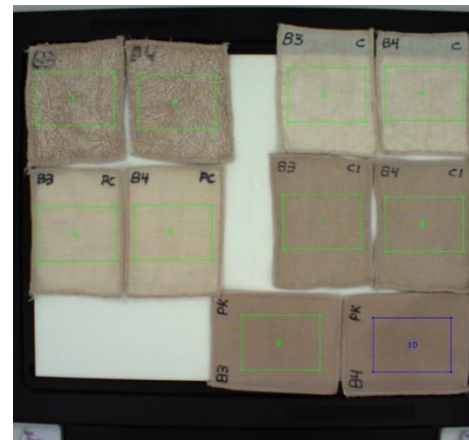
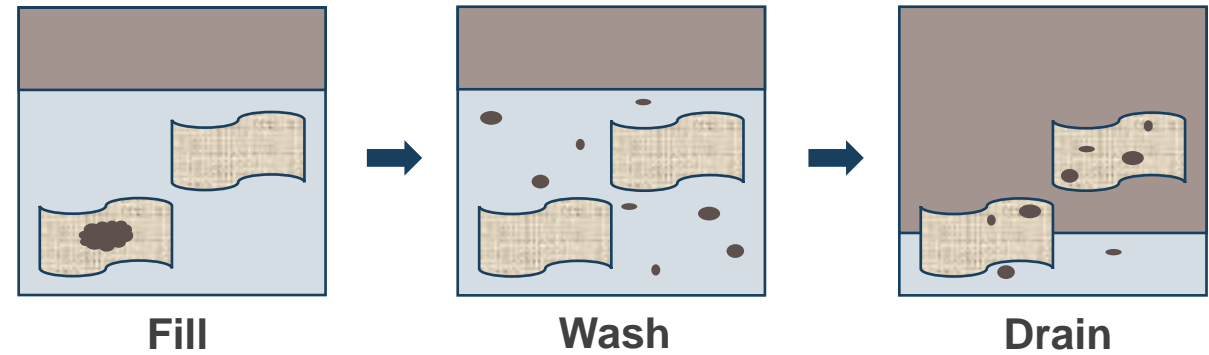
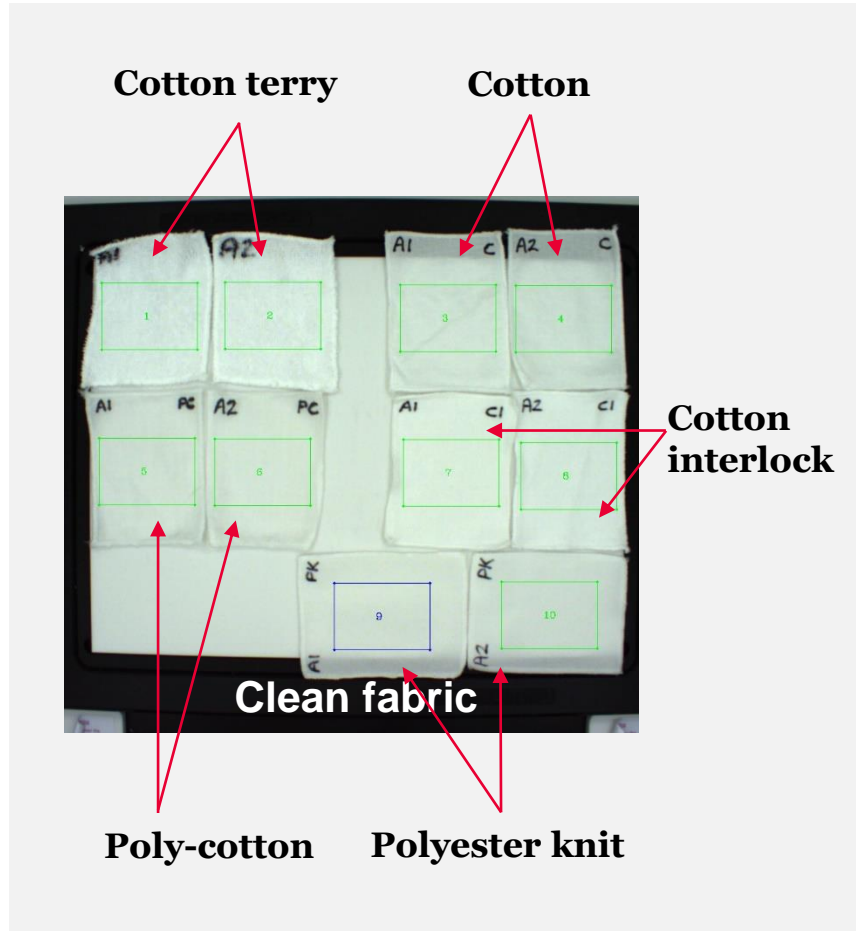
	Base	Base+5%Booster	Base+5%Booster pH=8	Base+5% TIPA*	Base+5%AE09	Base+5%AE09 pH=9.6
<b>Formulation pH</b>	8.21	9.63	8.01	9.52	7.86	9.63
<b>Washing liquor pH</b>	6.75	8.18	6.91	8.65	6.71	7.03
<b>Comment</b>			adjusted by citric acid			adjusted by NaOH

\*Triisopropanolamine

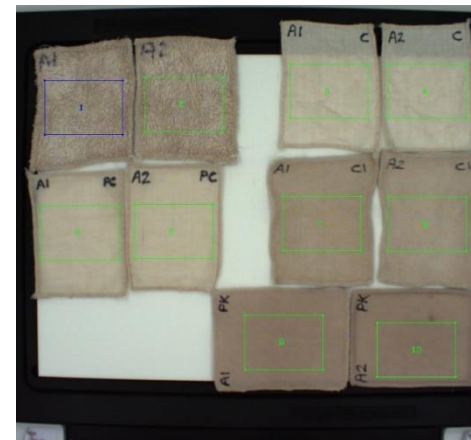
Tergot-Ometer, 2 g/L detergent, 30°C, 20 min, 120 rpm, 250 ppm water hardness



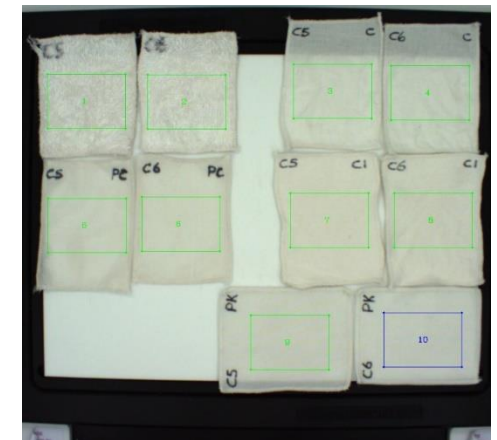
# Redeposition of soils: Effect of additives



No additive



Laureth-9



ALB







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# Laundry detergent formulation – Addition of ACUSOL™ CB-1 Polymer

14% Surfactant Formulation – 12LAS/2AES or 12LAS/AE with & without 5% ACUSOL™ CB-1

14% Generic Surfactant Formulation		
Tradename / Supplier	INCI	Wt. %
DI Water		76.4
Nacconal 90G/Stepan (LAS)	Sodium dodecylbenzenesulfonate [Surfactant]	12
Steol CS-460/ Stepan (AES)	Sodium fatty alcohol ether sulfate [Surfactant]	0 or 2
<b>Propylene Glycol / Dow</b>	<b>Solvent</b>	5
Ethanol	Solvent	2
Tergitol 25-7/ Dow (AE)	Primary alcohol ethoxylate [Surfactant]	0 or 2%
<b>ACUSOL™ CB-1 Polymer / Dow</b>	<b>Cleaning booster polymer</b>	<b>0 or 5%</b>
<b>Monoethanolamine /Dow</b>	<b>Neutralizer</b>	<b>Qs to Ph 8</b>
<b>Total</b>		<b>100</b>

Sample	Surfactant type and polymer
1	12 LAS/2 AES
2	12 LAS/2 AE
3	12AE/2 AES
4	12 LAS/2 AE + 5% CB-1
5	12 LAS/2 AES + 5% CB-1
6	12AE/2 AES + 5% CB-1

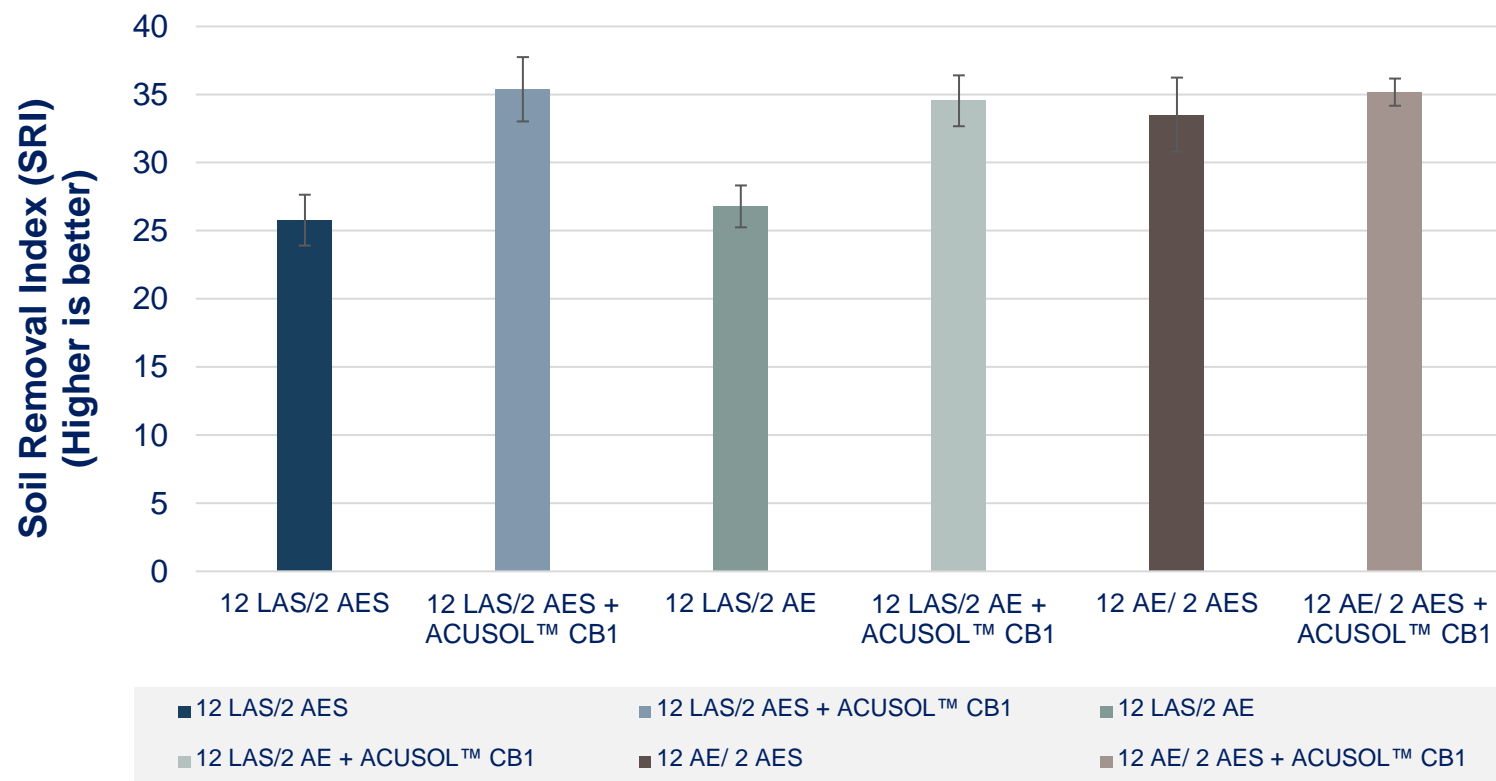
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# Addition of ACUSOL™ CB-1 Polymer – 12LAS/2AES or 12LAS/2AE Detergent

Addition of ACUSOL™ CB-1 Polymer to LAS-rich formulations offers boost to sebum stain removal

## Primary cleaning performance – Sebum/Dust soil



- Sebum/dust soil mix based on ASTM 4265-98.
- Pre-stained substrate: PC-S-94 Polyester/Cotton
- Water hardness: 120 ppm, Ca: Mg 3:1
- Cleaning test method: ASTM D3050

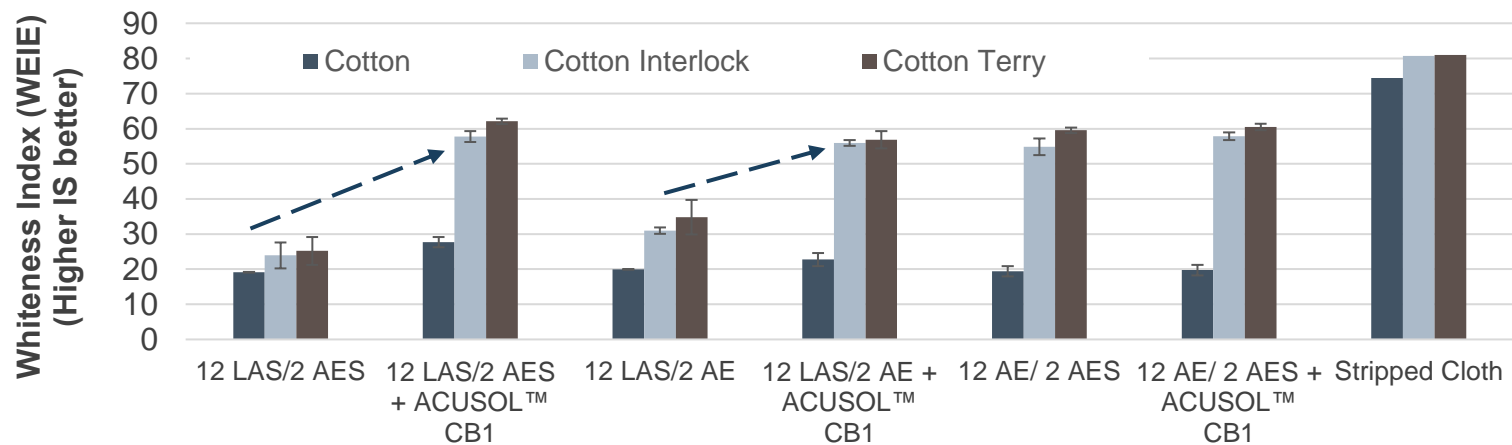
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# Addition of ACUSOL™ CB-1 Polymer – 12LAS/2AES or 12LAS/2AE Detergent

ACUSOL™ CB-1 Polymer offers outstanding boost in ARD performance in LAS-rich laundry formulations

## Anti-redeposition performance – Natural fabrics

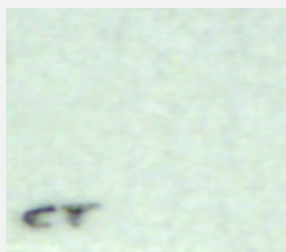


- Terg-o-tometer, 300 ppm, 2:1 Ca: Mg; Cleaning test method: ASTM D3050, 0.65 g/L dosage Soil: 2.5 g Sebum, 0.63 g Red Art Clay

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## Cotton Terry (CT)

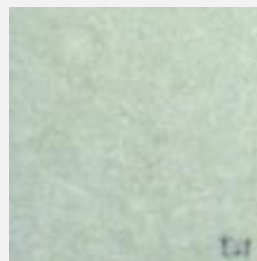
*Before wash*



**With ACUSOL™ CB-1**



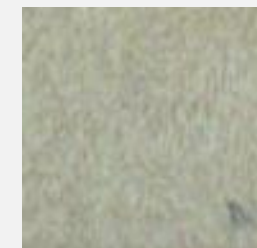
12% LAS /  
2% AES



12% LAS /  
2% AE

*After wash*

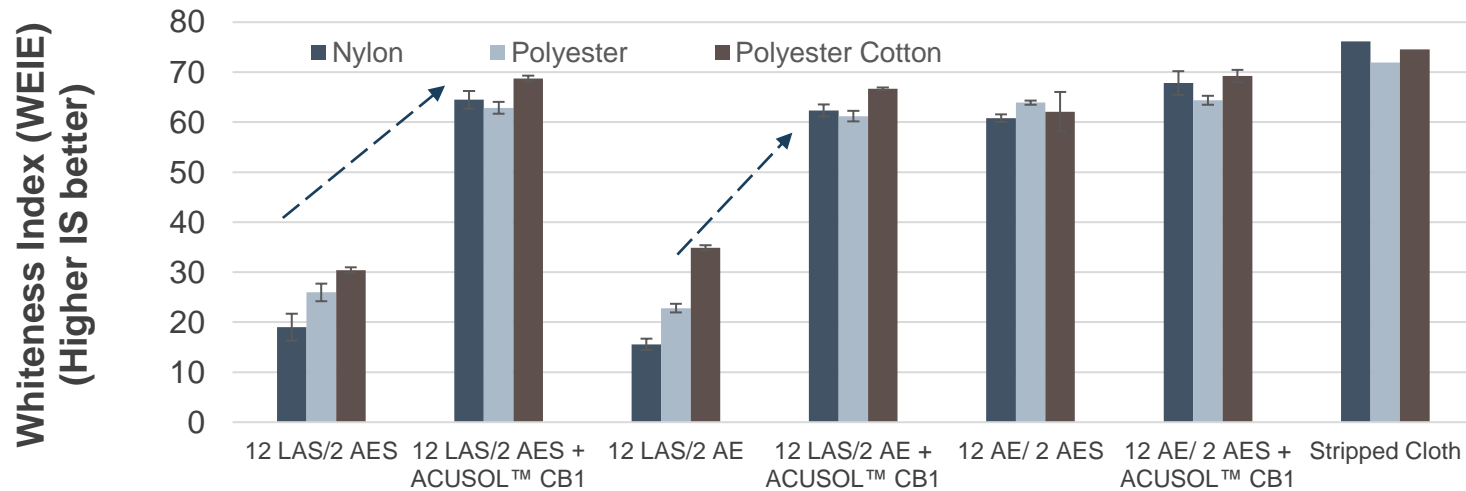
**Without polymer**



# Addition of ACUSOL™ CB-1 Polymer – 12LAS/2AES or 12LAS/2AE Detergent

ACUSOL™ CB-1 Polymer offers outstanding boost in ARD performance in LAS-rich laundry formulations

## Anti-redeposition performance – Synthetic fabrics



- Terg-o-tometer, 300 ppm, 2:1 Ca:Mg; Cleaning Test Method: ASTM D3050, 0.65 g/L dosage Soil: 2.5 g Sebum, 0.63 g Red Art Clay

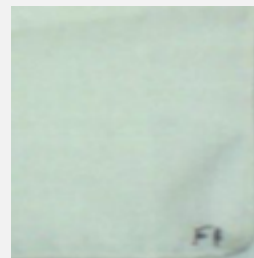
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## Polyester/Cotton (PC)

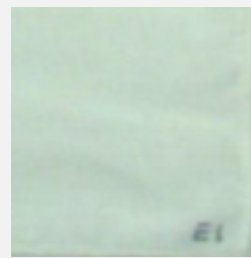
*Before wash*



**With ACUSOL™ CB-1**



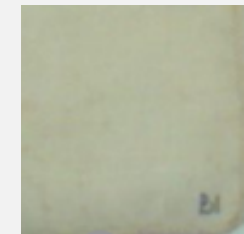
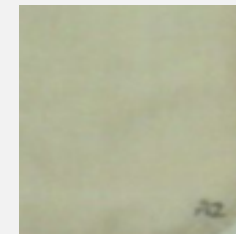
12% LAS /  
2% AES



12% LAS /  
2% AE

*After wash*

**Without polymer**



# Addition of nonionic surfactant or polymer to 12LAS/2AES detergent

14% Surfactant Formulation–12LAS/2AES with nonionic polymer

14% Generic Surfactant Formulation		
Tradename / Supplier	INCI	Wt.%
DI Water		76.4
Nacconal 90G/Stepan (LAS)	Sodium dodecylbenzenesulfonate [Surfactant]	12
Steol CS-460/ Stepan (AES)	Sodium fatty alcohol ether sulfate [Surfactant]	0 or 2
<b>Propylene Glycol / Dow</b>	<b>Solvent</b>	5
Ethanol	Solvent	2
Tergitol 25-7/ Dow (AE)	Primary alcohol ethoxylate [Surfactant]	0 or 2%
<b>ACUSOL™ CB-1 Polymer / Dow</b>	<b>Cleaning booster polymer</b>	<b>0 or 5%</b>
<b>Monoethanolamine /Dow</b>	<b>Neutralizer</b>	<b>Qs to Ph 8</b>
<b>Total</b>		<b>100</b>

Sample	Surfactant type and polymer
1	12 LAS/2 AES
5	12 LAS/2 AES + 5% ACUSOL™ CB-1 Polymer
5	12 LAS/2 AES + 5% EPEI Nonionic Polymer

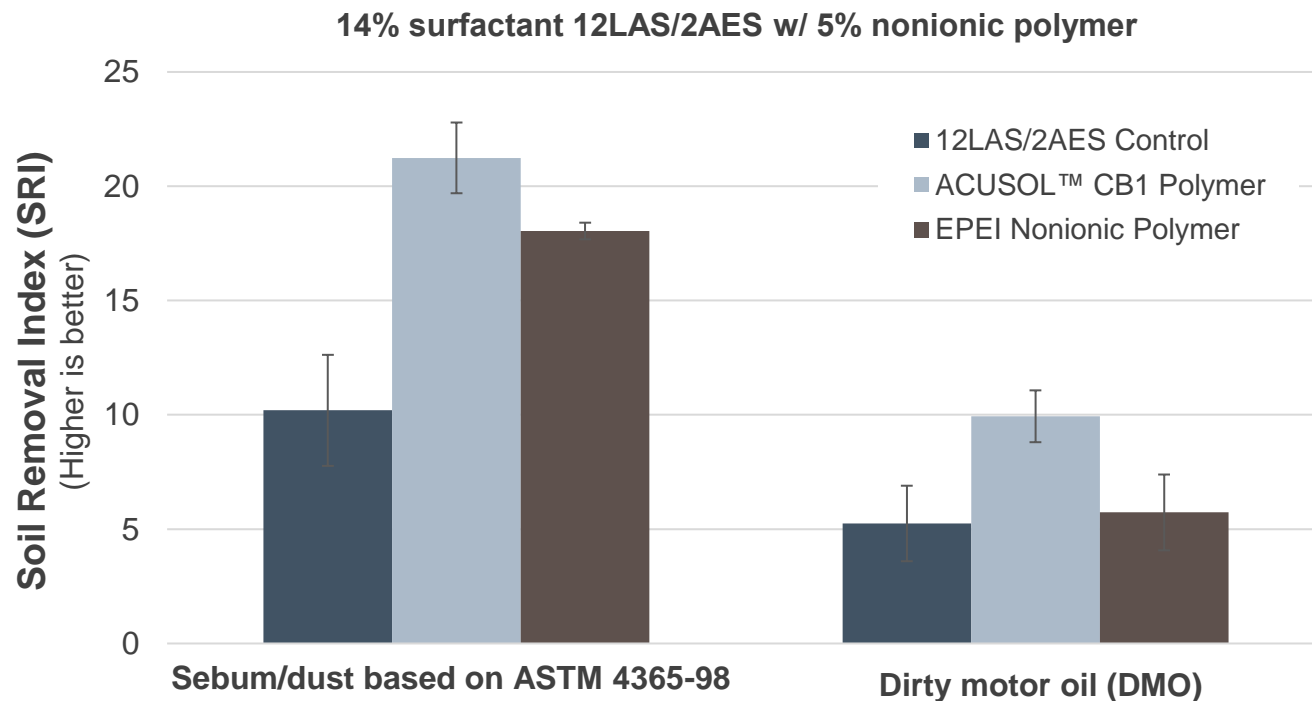
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# Addition of ACUSOL™ CB-1 Polymer – 12LAS/2AES or 12LAS/2AE Detergent

Addition of ACUSOL™ CB-1 Polymer to LAS-rich formulations offers boost to sebum stain removal

## Primary cleaning performance – Greasy soil removal



- Cleaning test method: ASTM D4265
- Top loader washing machine with 6lb ballast
- Soil – 22 stains on Polycotton on PN-33 carrier (CFT-MON-ASTM-02)
- Hardness = 120 ppm, Ca:Mg 3:1, Dose = 45.5 g/L

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# Laundry detergent formulation – Addition of ACUSOL™ CB-1 Polymer

22% Surfactant Formulation-10LAS/4AES/AE with & without 5% ACUSOL™ CB-1

Generic Surfactant Formulation		
Tradename / Supplier	INCI	Wt.%
DI Water		
Nacconal 90G / Stepan (LAS)	Sodium dodecylbenzenesulfonate Surfactant	10
Steol CS-460 / Stepan (AES)	Sodium fatty alcohol ether sulfate Surfactant	4
<b>Propylene Glycol / Dow</b>	<b>Solvent</b>	<b>5</b>
Ethanol	Solvent	2
<b>Nonionic Surfactant</b>	<b>Primary alcohol ethoxylate surfactant</b>	<b>8</b>
<b>ACUSOL™ CB-1 Polymer</b>	<b>Cleaning booster polymer</b>	<b>0 or 5%</b>
<b>Monoethanolamine / Dow</b>	<b>Neutralizer</b>	<b>Qs to Ph 8</b>
<b>Total</b>		<b>100</b>

	Nonionic surfactants (Alcohol Ethoxylate (AE))
Nonionic-1 (C12-C15, 7EO)	TERGITOL™ 25-7 /Dow
Nonionic-2 (C12-C15, 9EO)	BIO-SOFT N25-9 /Stepan
Nonionic-3 (C9-C11, 6EO)	TERGITOL™ 91-6 /Dow
Nonionic-1 + <b>ACUSOL™ CB-1</b>	8% TERGITOL™ 25-7 + 5% ACUSOL™ CB-1
Nonionic-2 + <b>ACUSOL™ CB-1</b>	BIO-SOFT N25-9 (AE-2) + 5% ACUSOL™ CB-1
Nonionic-2 + <b>ACUSOL™ CB-1</b>	TERGITOL™ 91-6(AE-3) + 5% ACUSOL™ CB-1

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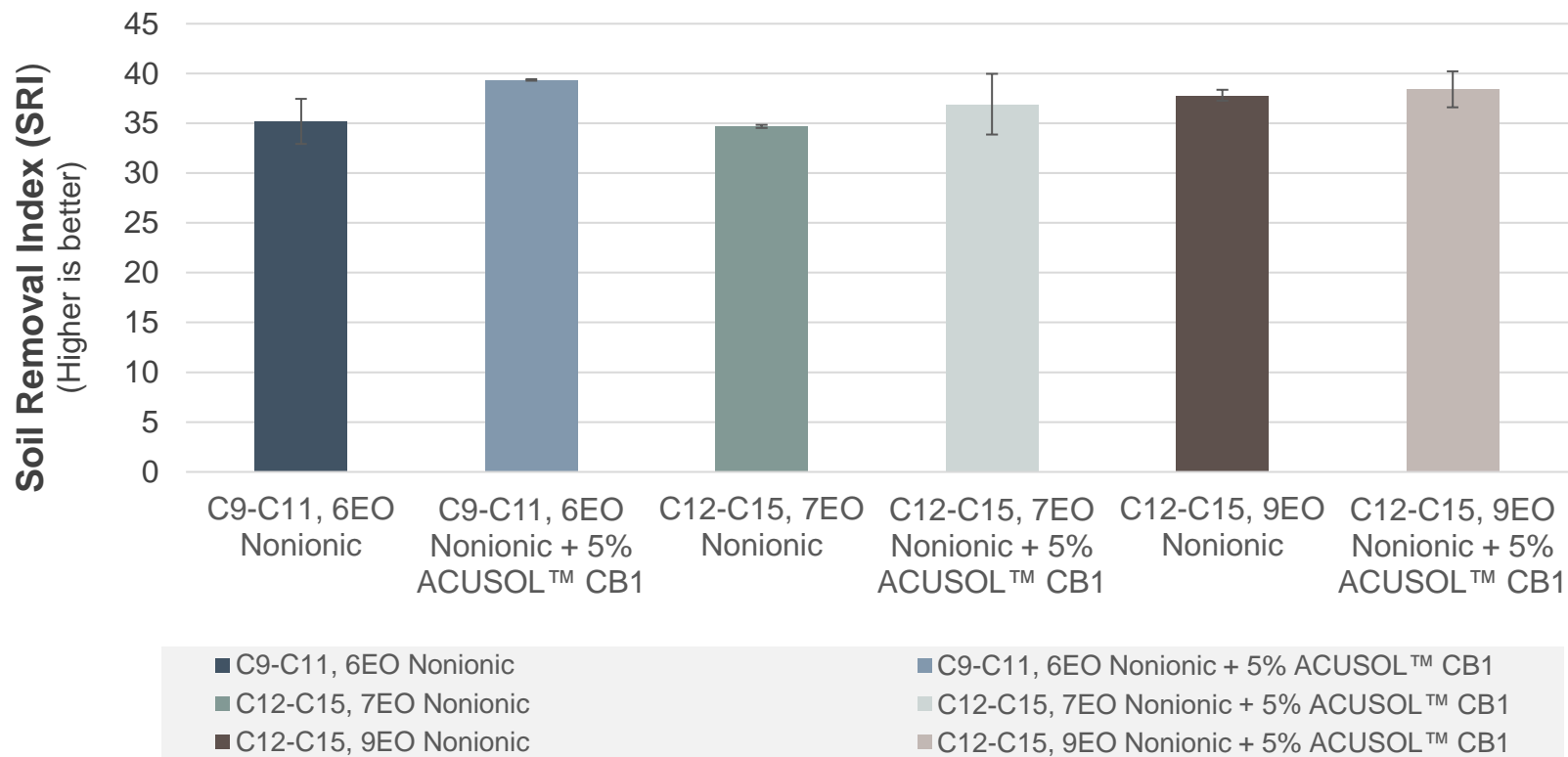




# Addition of ACUSOL™ CB-1 Polymer – 10LAS/4AES/8AE Detergent

Adding ACUSOL™ CB-1 Polymer on top of various nonionics gives additional soil removal

## Primary Cleaning Performance – Sebum/Dust Soil



- Sebum/dust soil mix based on ASTM 4265-98
- Pre-stained substrate: PC-S-94 Polyester/Cotton
- Water hardness: 120 ppm, Ca:Mg 3:1
- Cleaning test method: ASTM D3050

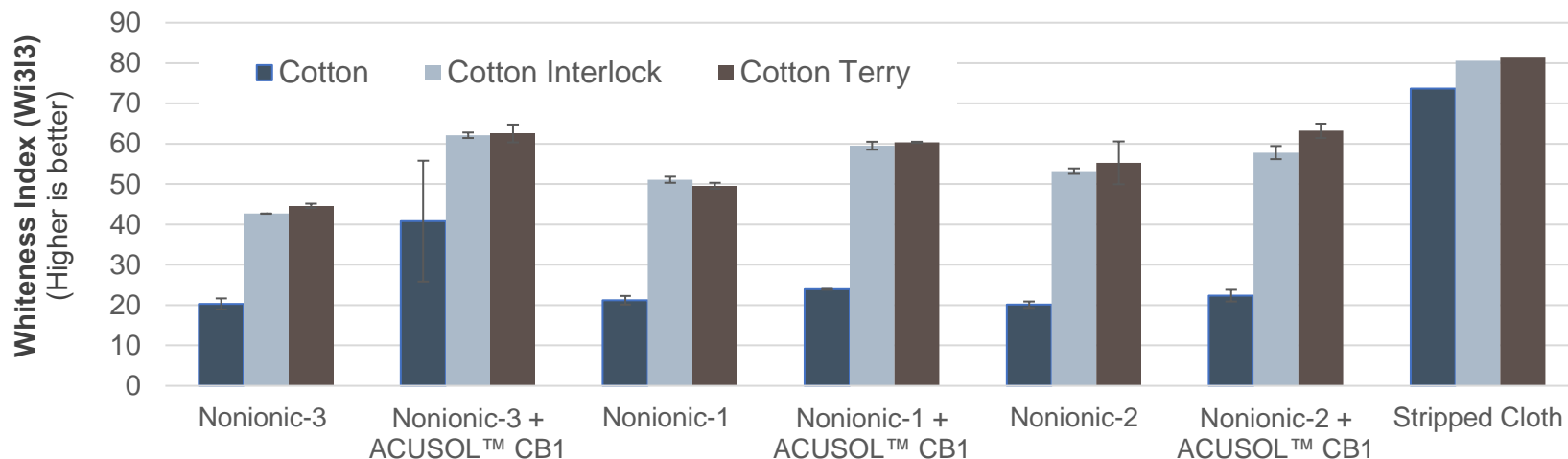
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# Addition of ACUSOL™ CB-1 Polymer – 10LAS/4AES/8AE Detergent

ACUSOL™ CB-1 Polymer boosts anti-redeposition performance in high surfactant formulations

## Anti-redeposition performance – Natural fabrics



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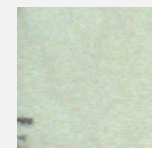
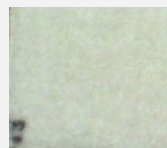
### Cotton terry

Nonionic-3 (C9-C11, 6EO)

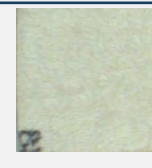
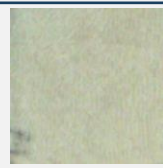
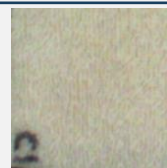
Nonionic-1 (C12-C15, 7EO)

Nonionic-2 (C12-C15, 9EO)

With ACUSOL™ CB-1



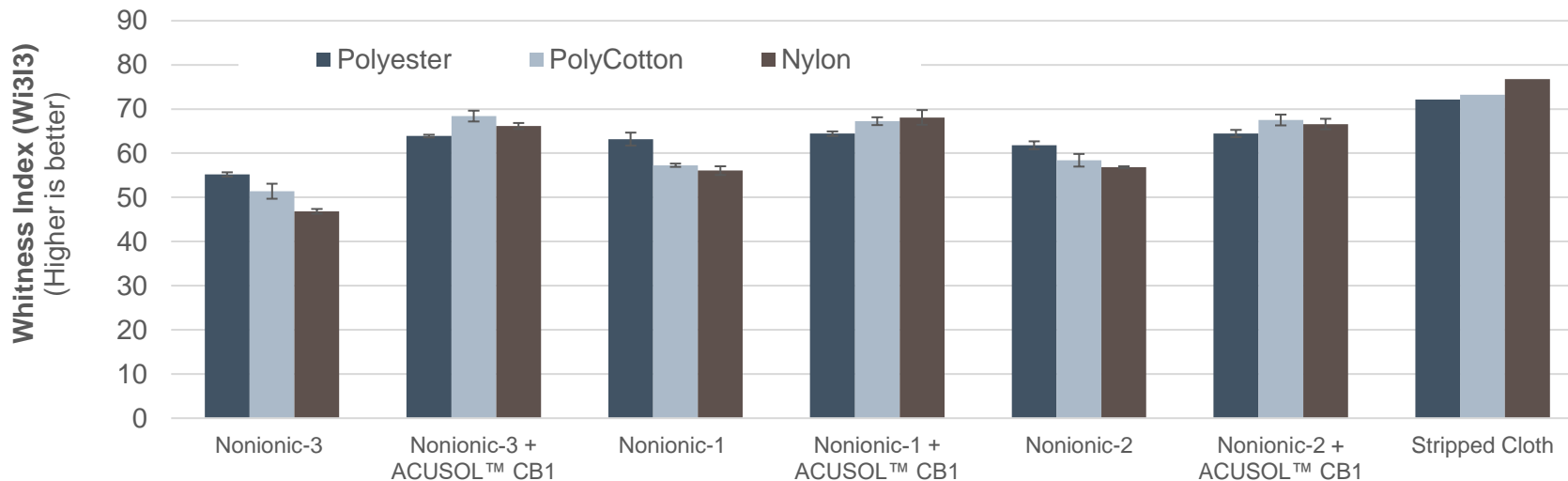
Without polymer



# Addition of ACUSOL™ CB-1 Polymer – 10LAS/4AES/8AE Detergent

ACUSOL™ CB-1 Polymer boosts anti-redeposition performance in high surfactant formulations

## Anti-redeposition performance – Synthetic fabrics



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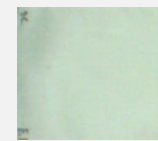
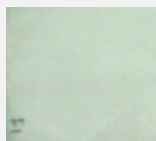
### Polyester/Cotton

Nonionic-3 (C9-C11, 6EO)

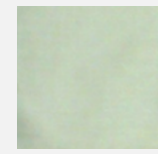
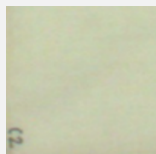
Nonionic-1 (C12-C15, 7EO)

Nonionic-2 (C12-C15, 9EO)

With ACUSOL™ CB-1



Without polymer



# Replacing nonionic surfactant with ACUSOL™ CB-1 Polymer

22% Surfactant Formulation – 10LAS/4AES with 8% Nonionic Surfactant or 8% ACUSOL™ CB-1 Polymer

Generic surfactant formulation		
Tradename / Supplier	INCI	Wt.%
DI Water		
Nacconal 90G / Stepan (LAS)	Sodium dodecylbenzenesulfonate [Surfactant]	10
Steol CS-460 / Stepan (AES)	Sodium fatty alcohol ether sulfate [Surfactant]	4
<b>Propylene Glycol / Dow</b>	<b>Solvent</b>	<b>5</b>
Ethanol	Solvent	2
<b>Nonionic Surfactant</b>	<b>Primary alcohol ethoxylate surfactant</b>	<b>8</b>
<b>Monoethanolamine / Dow</b>	<b>Neutralizer</b>	<b>Qs to Ph 8</b>
<b>Total</b>		<b>100</b>

Nonionic surfactant or polymer		Description
1	C12-C15, 7EO	Nonionic surfactant
2	C12-C15, 9EO	Nonionic surfactant
3	EPEI	Ethoxylated polyethyleneimine
4	ACUSOL™ CB-1	Ethoxylated polyamine

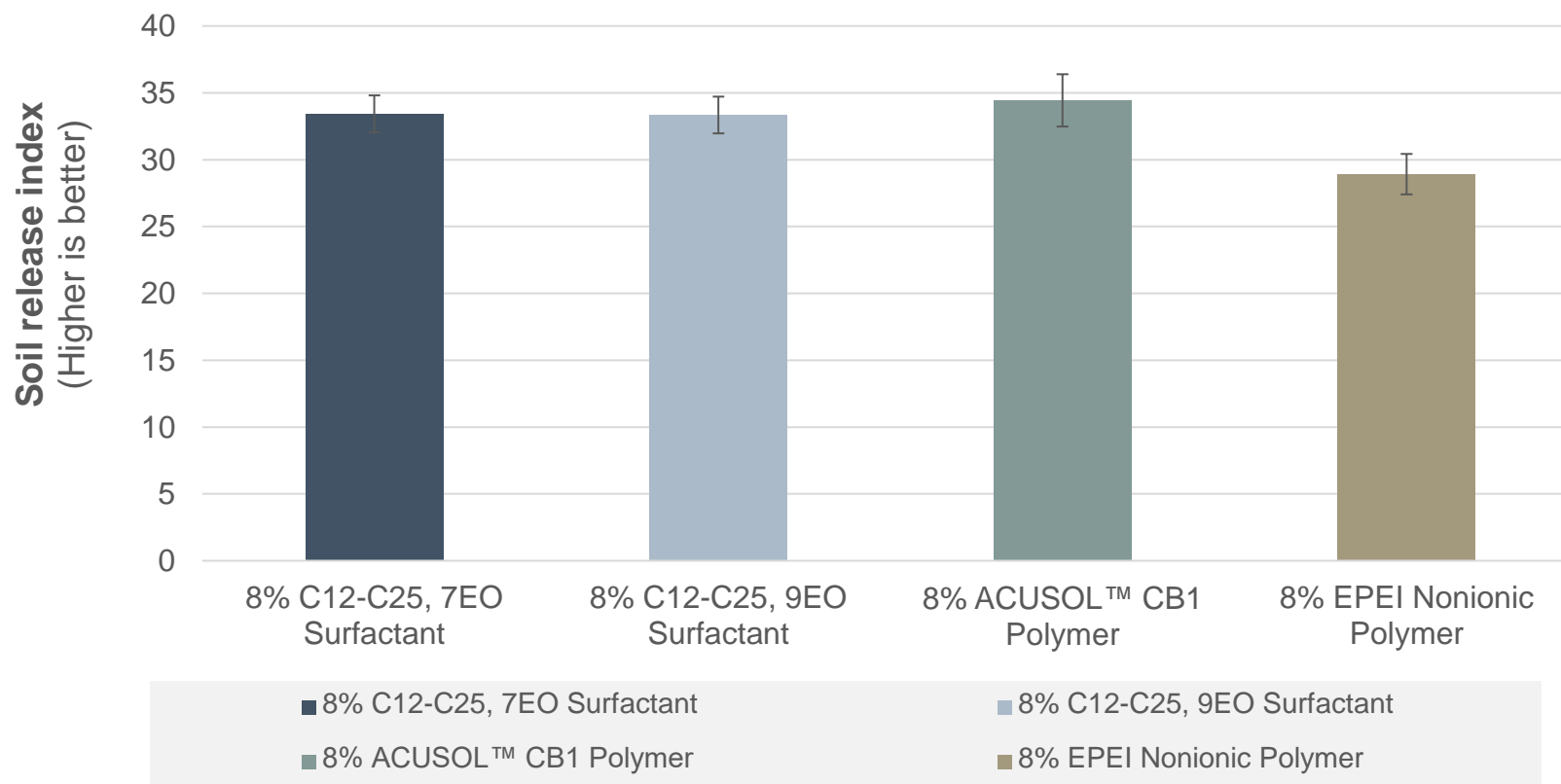
**Disclaimer:** This suggested formulation is only a representative formulation, and it is not a commercialized product. Dow believes that the information and data on which this formulation is based are reliable, but it has not been subjected to extensive testing for performance, efficacy or safety.



# Replacing nonionic surfactant with nonionic polymer – 10LAS/4AES

ACUSOL™ CB-1 Polymer can replace the nonionic surfactant in the laundry detergent formulation

## Primary cleaning performance – Sebum/Dust soil



- Sebum/dust soil mix based on ASTM 4265-98
- Pre-stained substrate: PC-S-94 Polyester/Cotton
- Water hardness: 120 ppm, Ca:Mg 3:1
- Cleaning Test Method: ASTM D3050

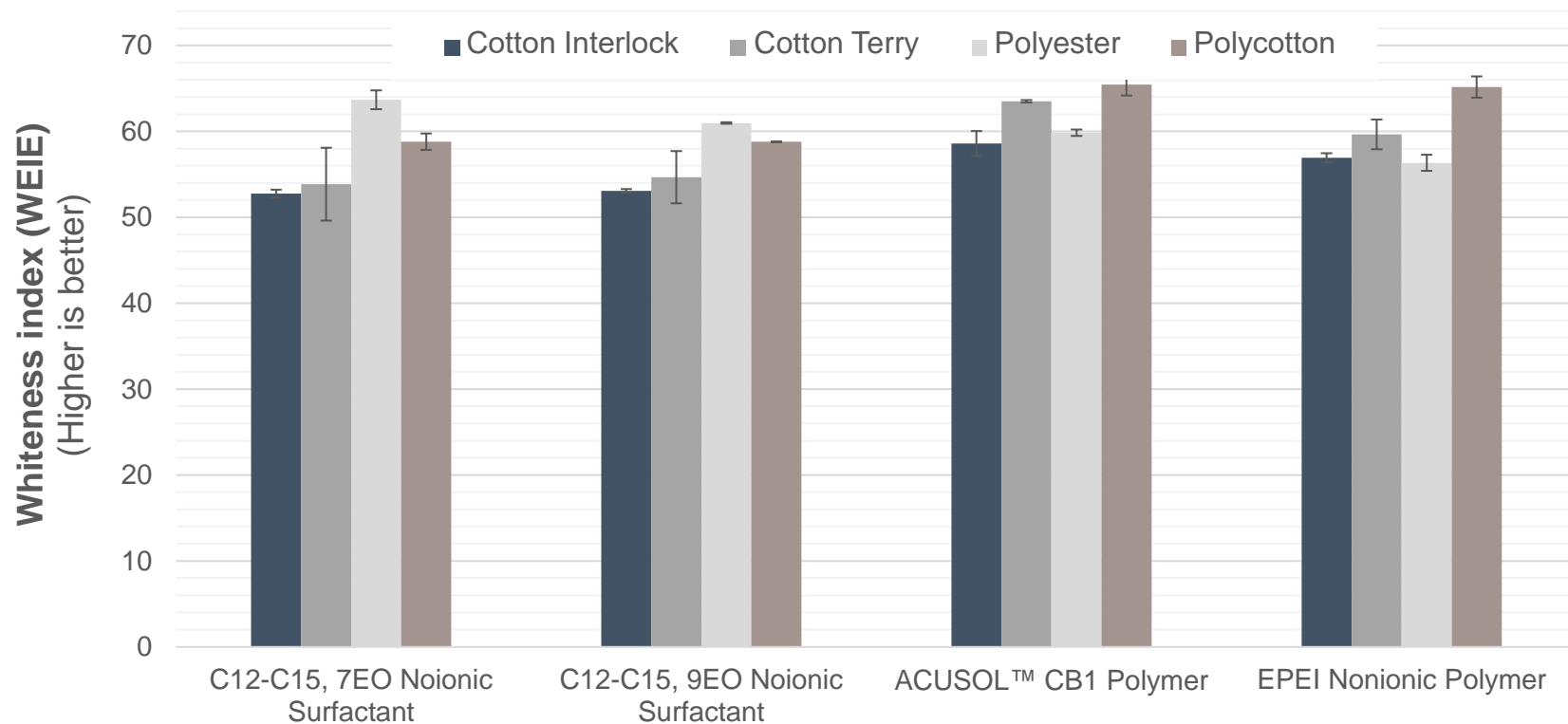
NOTE: The graphic representations are presented here for illustrative purposes only and should not be construed as product specifications.



# Replacing nonionic surfactant with nonionic polymer – 10LAS/4AES

Replacing nonionic surfactant with ACUSOL™ CB-1 Polymer can boost both primary and secondary cleaning performance

## Anti-redeposition performance – Natural & Synthetic



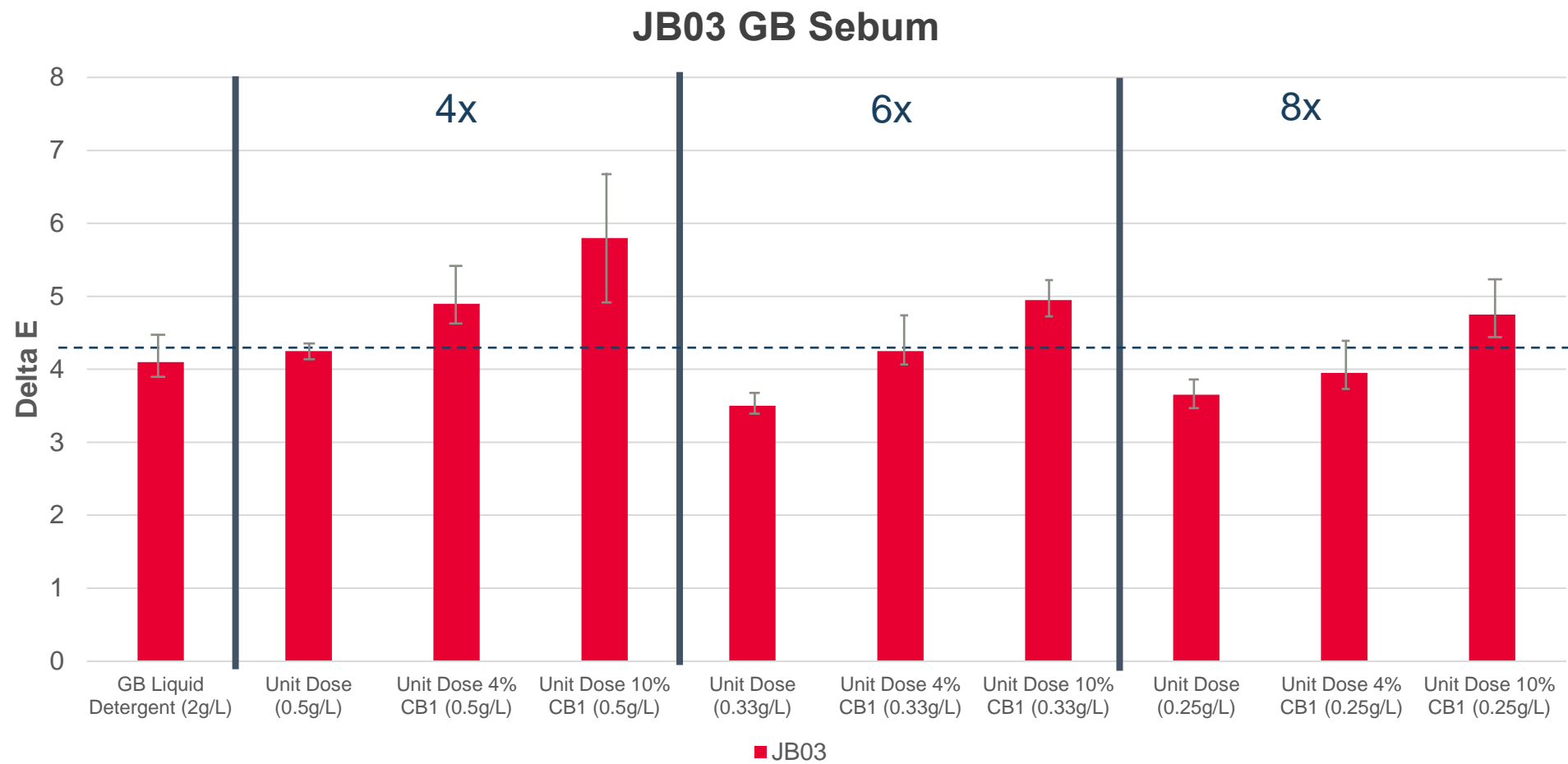
- Terg-o-tometer, 300 ppm, 2:1 Ca:Mg;
- Cleaning Test Method: ASTM D3050, 0.65 g/L dosage
- Soil: 2.5 g Sebum, 0.63 g Red Art Clay

NOTE: The graphic representations are presented here for illustrative purposes only and should not be construed as product specifications.



# Detergency improvement – Unit dose laundry detergent formulations

Replacing nonionic surfactants with CB-1 can improve GB sebum soil removal significantly



Tergot-Ometer, 30°C, 20 min, 120 rpm, 250 ppm water hardness

## Additional benefits – Viscosity control and anti-gelling

Addition of ACUSOL™ CB-1 Polymer can help reduce the viscosity of concentrated formulations, more efficiently than branched alcohol alkoxylates.

Sample	Viscosity (cP)
Conc. Detergent* with 5% Benchmark**	468
Conc. Detergent with 5% ECOSURF™ EH-9 Nonionic Surfactant	454
Conc. Detergent with 5% ACUSOL™ CB-1 Cleaning Booster	376

\*Concentrated Detergent: 45% surfactants (23% anionic surfactants, 22% nonionic surfactants), 6% propylene glycol

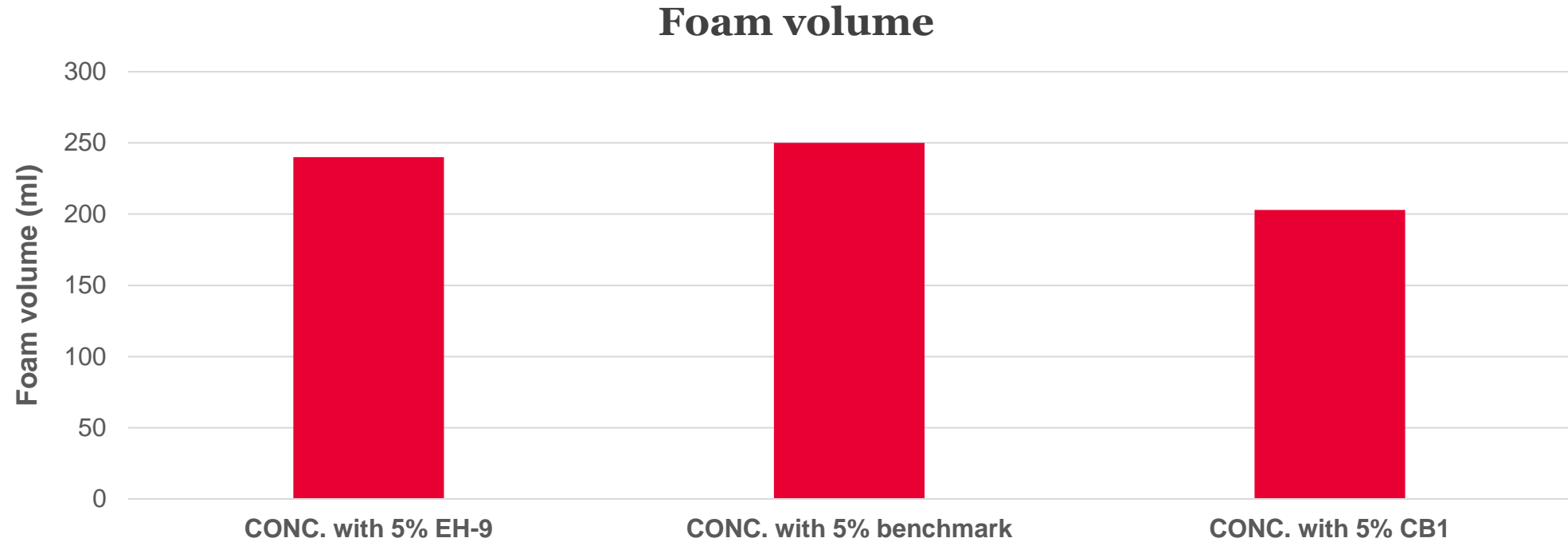
\*\*Benchmark:C10-Guerbet Alcohol Alkoxylate





# Foam control

ACUSOL™ CB-1 Polymer can help reduce the foam volume of concentrated formulations



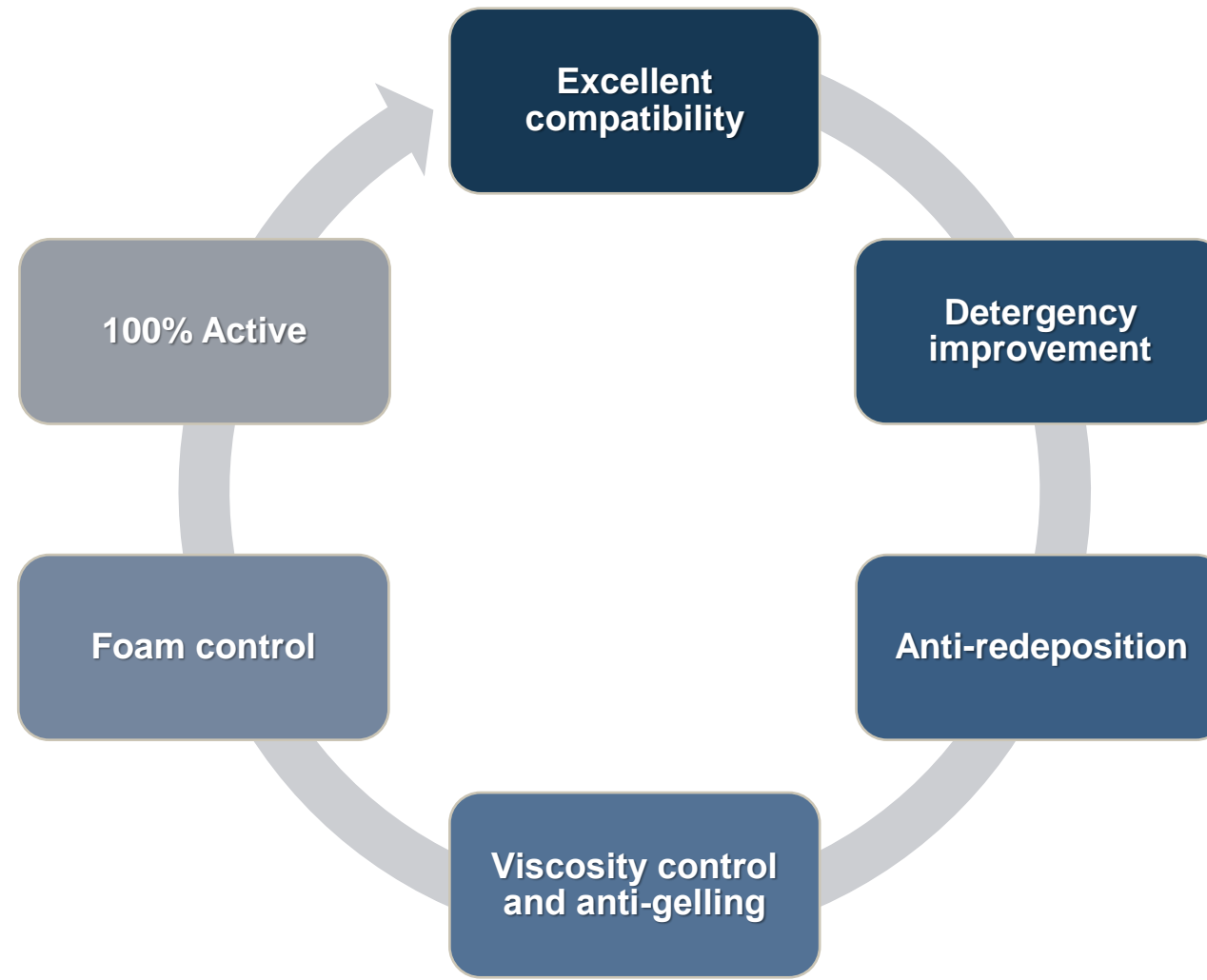
\*Concentrated Detergent: 45% surfactants (23% anionic surfactants, 22% nonionic surfactants), 6% propylene glycol

\*\*SITA R-2000, 0.8g/L conc. detergents, 30°C, 120ppm water hardness

\*\*\*Benchmark: C10-Guerbet Alcohol Alkoxylate



# ACUSOL™ CB-1 Cleaning Booster – Summary



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