

Formulating Sulfate Free

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WASH YOUR HANDS

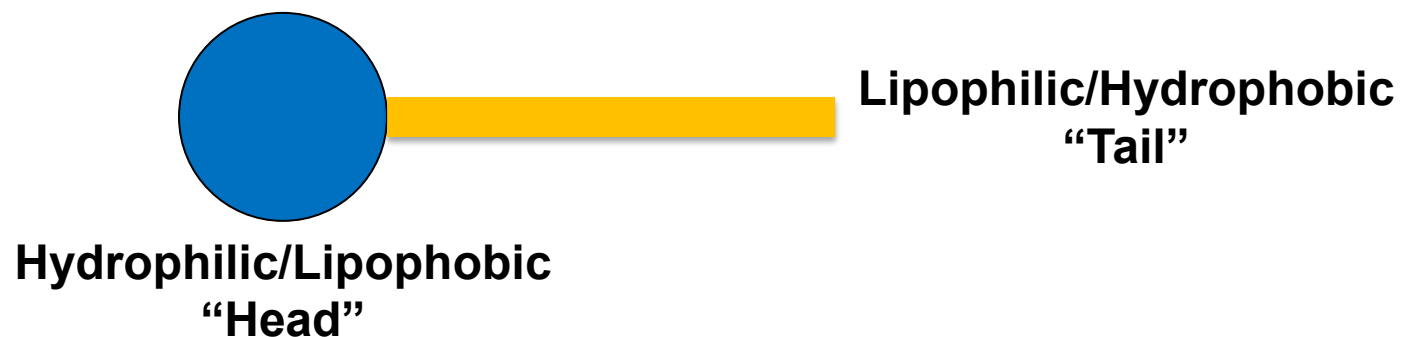


Outline

- Brief Surfactant Review
- Why Sulfate-Free?
- Sulfate-Free Surfactant Examples
- Thickening Sulfate-Free Systems
- Other Sulfate-Free Concerns
- Wrap-Up.

How Surfactants Work

- “Tadpole” structure is key to functionality



- Relative and absolute sizes of groups dictates function.

Chain Length

Increasing Length



High Detergency

High Water Solubility

High Viscosity

Ethoxylation

Increasing Ethoxylation



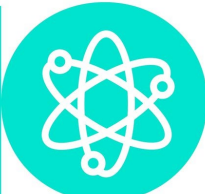
Why Sulfate-Free?



**SULFATES,
YOUR
HAIR
& YOU**

Why sulfates are bad for your hair and how to find the best, healthiest shampoo for you



NO 

SULFATES
(SLES or SLS)

WHAT ARE
SULFATES
AND
WHY ARE THEY
BAD FOR YOU?



Gro-Fit.com

Going Sulfate-Free

- There are many challenges associated with moving from traditional sulfate surfactants to next generation products
 - Different impurities
 - Different foam properties
 - Different functional groups
 - Different packing capabilities
 - Different salt responsiveness
 - Different solubility parameters.

Considerations for Replacement Selection

- Bio-renewable content
- Toxicity
 - Human
 - Environmental
- Brand positioning
- Ease of use
- Efficiency
- Cost.

Common Sulfate Replacements

- Anionic 
 - High foaming for personal care
 - Combine with amphoteric surfactants for optimum aesthetics
- Watch for:
 - Acid pKa values
 - Instable groups
 - Impurities
 - Hard water tolerance
 - Size of head group.

Sulfate Free Examples - Sulfonate

- **Key Benefits**

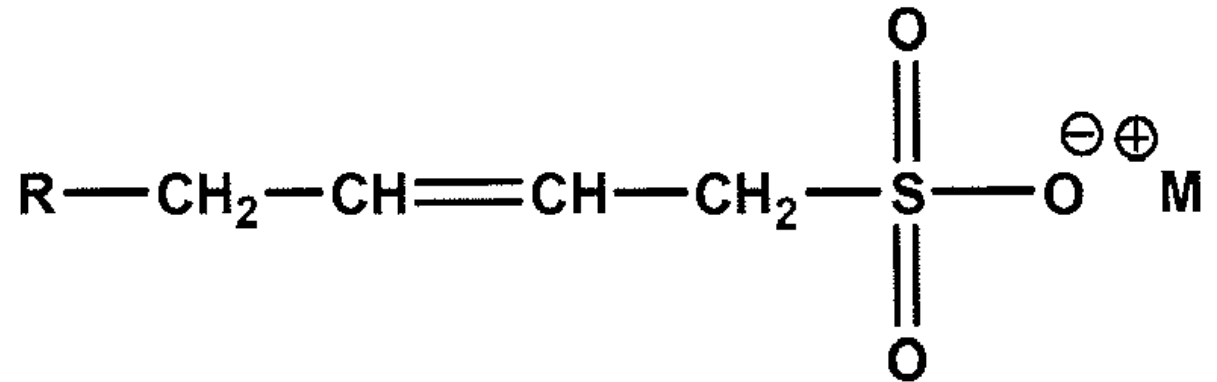
- Can be very low cost
- Extremely stable

- **Key Drawbacks**

- Petrochemical olefins dominate
- Slower viscosity response

- **Watchouts**

- Sultones should be kept as low as possible
- Start with ratio higher secondary surfactants
- Krafft point issues.



Sulfate Free Examples - Isethionate

- **Key Benefits**

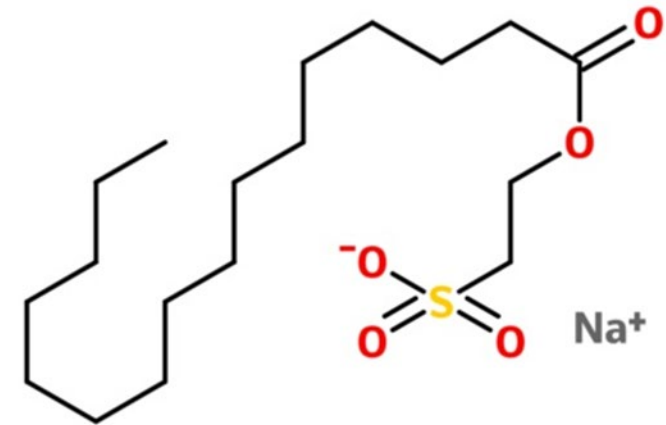
- Widely used
- Residual fatty acid offers added benefits

- **Key Drawbacks**

- Ester functionality can be instable
- Residual fatty acid offers added challenges

- **Watchouts**

- Try to keep pH near neutral
- Formulate with chelant
- Watch fatty acid content.



Sulfate Free Examples - Glutamate

- **Key Benefits**

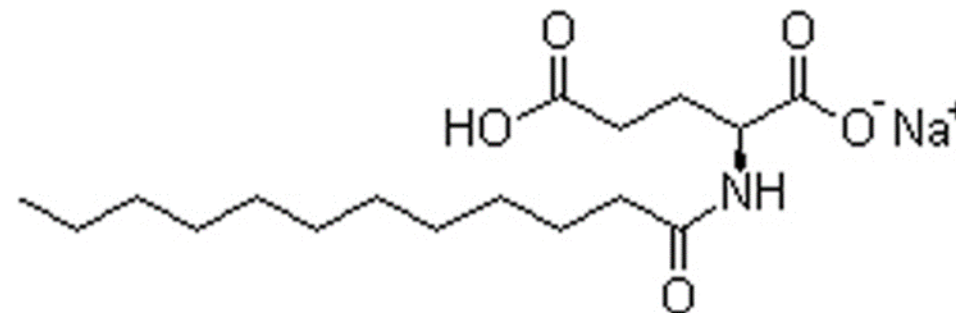
- High biobased content
- Low irritation

- **Key Drawbacks**

- Relatively costly
- Poor viscosity response

- **Watchouts**

- Multiple pKa values
- Combine with additional sulfate-free surfactants
- Check biobased content if important.



Sulfate Free Examples - Sarcosinate

- **Key Benefits**

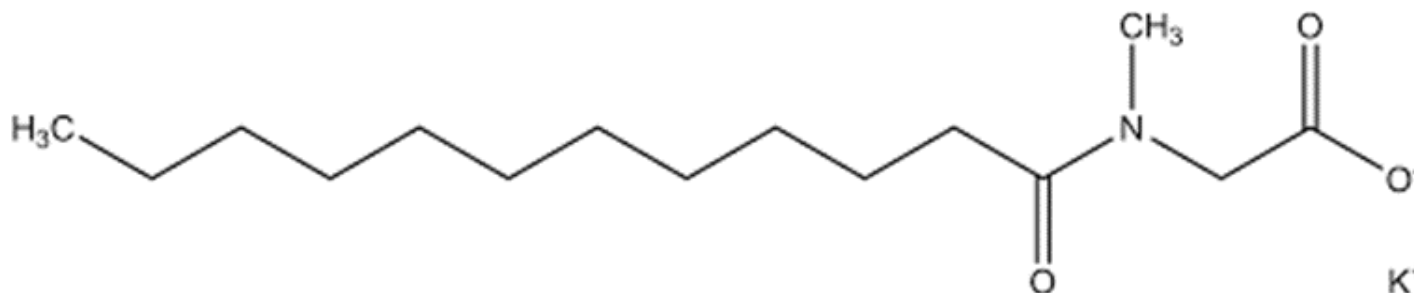
- Unique advantages in syndet bars
- Low in-use toxicity

- **Key Drawbacks**

- Partially petrochemical
- Poor viscosity response

- **Watchouts**

- Avoid using too much in gel cleansers
- Foaming can be enhanced by salt addition
- Synergistic surface tension reduction has been observed.



Sulfate Free Examples - Phosphate

- **Key Benefits**

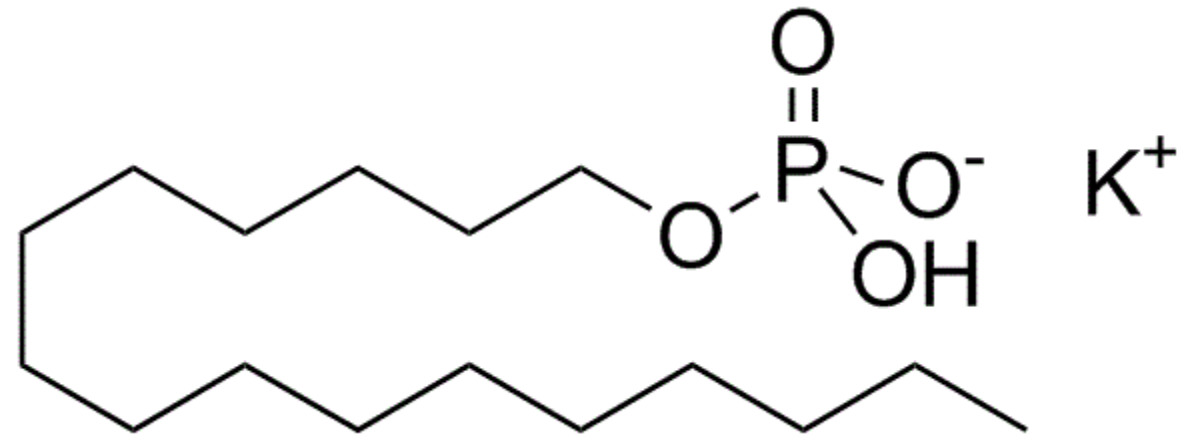
- Can be high biobased
- Low irritation

- **Key Drawbacks**

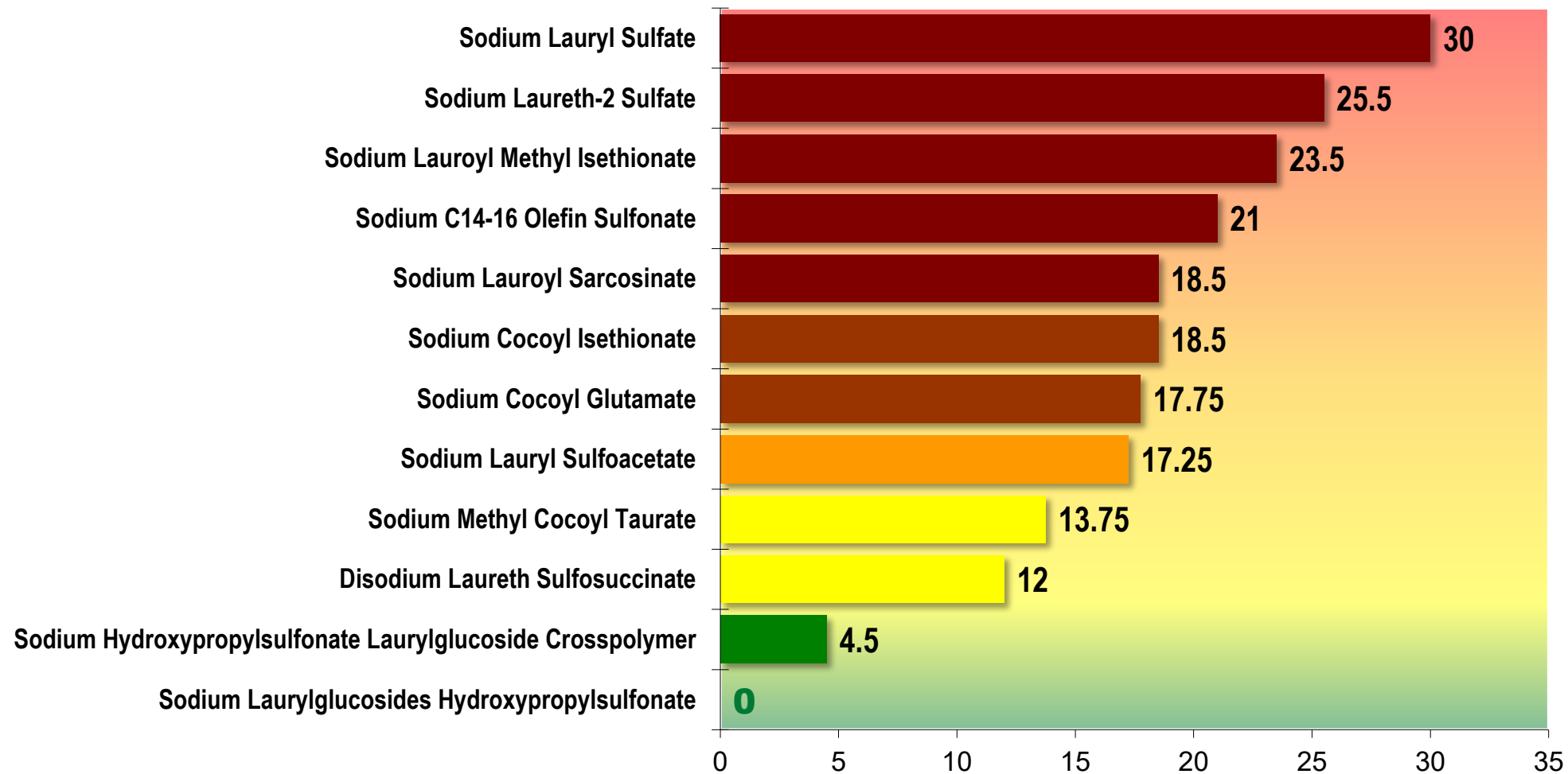
- Association with inorganic phosphates
- Typically need to be ethoxylated

- **Watchouts**

- Water hardness may impact solubility
- Can be supplied in acid or neutral forms
- Poor viscosity response.



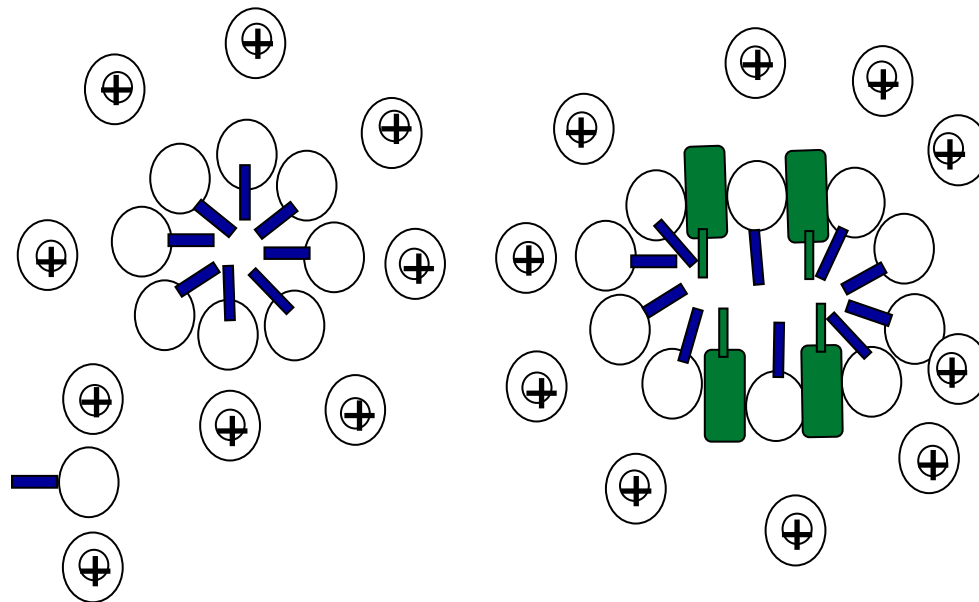
Comparative Irritation of Several Sulfates and Replacements – HET-CAM



10% solids, pH 5.5 - 6.5

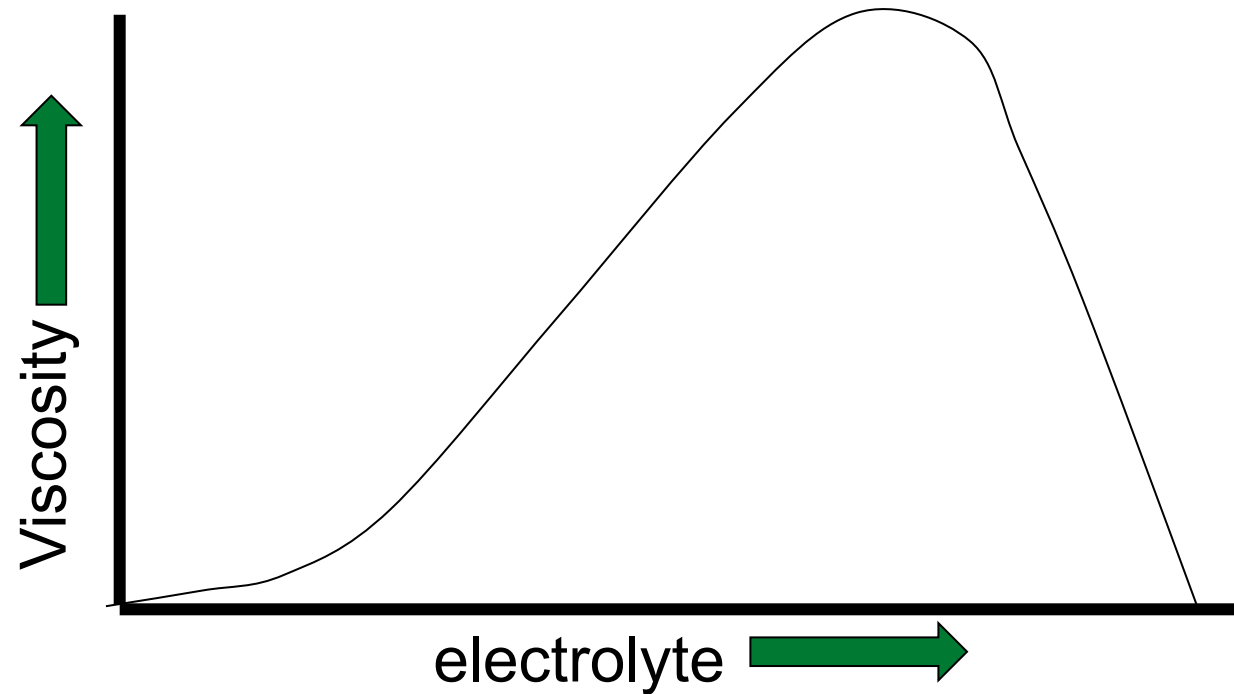
Surfactant Thickening

- Micelles can contain dozens or thousands of surfactant “monomers”
- As surfactant concentration increases, new micelle shapes can form
- Charged hydrophilic “heads” are kept apart by electrostatic repulsion
 - Salt reduces electrostatic repulsion
 - Nonionic surfactants (amides) increase packing



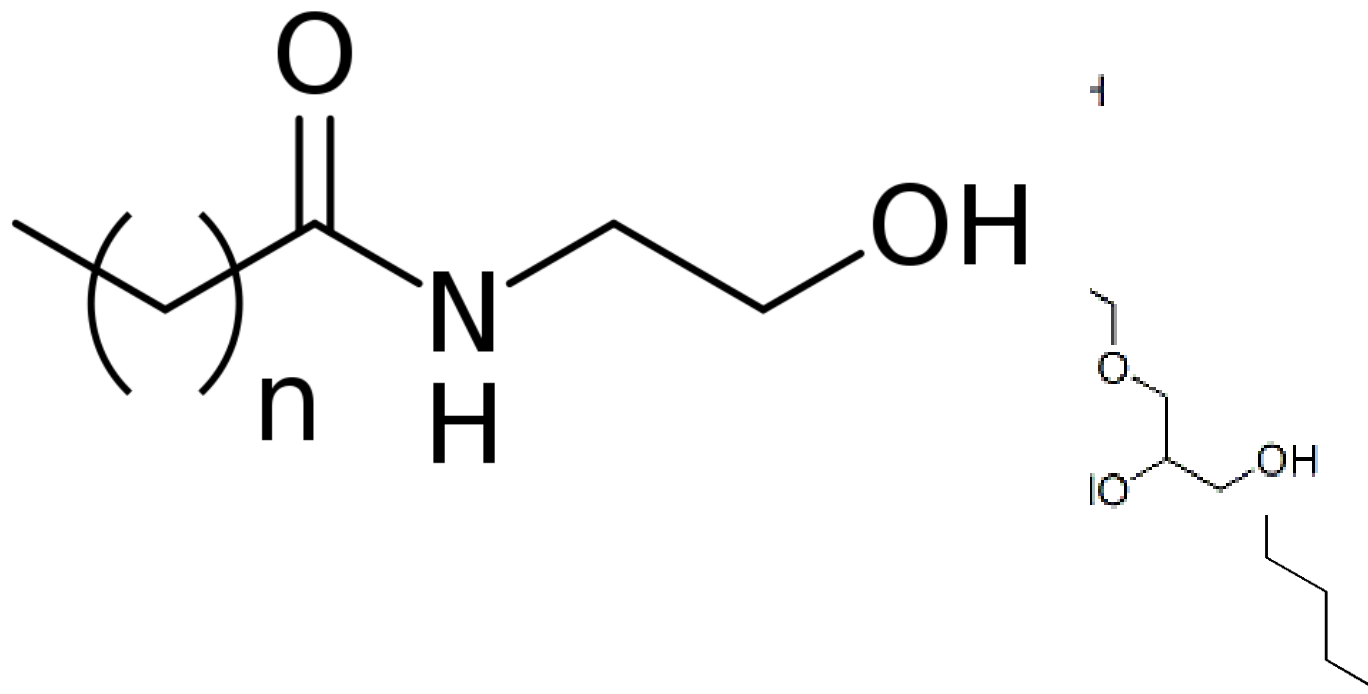
Surfactant Thickening

- Surfactant packing dictates micelle shape and size
- Micelles are always in flux
- Over-salting reduces viscosity



Types of Surfactants

- Nonionic 
 - Huge variety of chemistry
 - Include ethoxylates
 - Low irritation potential
- Alcohol ethoxylates
- PEG esters
- Polyglyceryl esters
- Alkanolamides
- Glucosides.



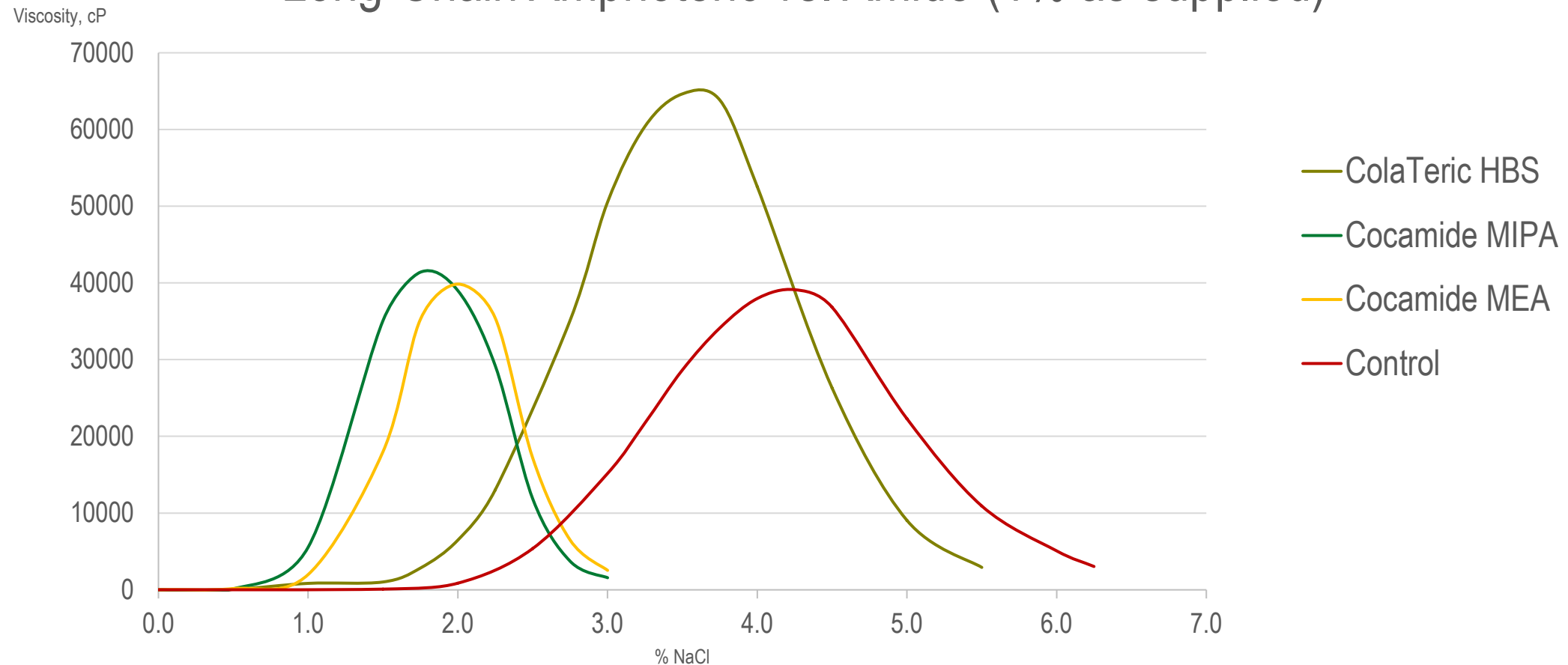
Surfactant Thickening

- **Natural Polymers (Gums)**
 - Key benefit: Natural
 - Key drawback: Non-Newtonian flow characteristics
- **Synthetic Polymers (HASE/HEUR)**
 - Key benefit: Highly customized performance
 - Key drawback: Petrochemical feedstocks
- **Alkanolamides**
 - Key benefit: Economical
 - Key drawback: Potential secondary amine issues
- **Amine Oxides**
 - Key benefit: Excellent performance
 - Key drawback: Not well characterized for personal care
- **Long-Chain Amphoterics**
 - Key benefit: Very effective viscosity boosters
 - Key drawback: Low active products or contain solvents.



Comparative Efficacy of Nonionics vs Long-Chain Amphoteric

Long-Chain Amphoteric vs. Amide (1% as supplied)



Wrap-up

- The transition to sulfate-free formulating continues to gain momentum
- There is a wide variety of alternate technologies already available
- Thickening sulfate-free systems is the dominant challenge, again with many solutions available
- Formulators need to weigh pros and cons of each solution to determine what's best for them.

Webinar Series – Coming Events

- June 11 – The Other Side of Fear
- June 25 – Reduced Irritation in Rinse off Cleansers

• <https://bit.ly/2XXTbEO>



Colonial Chemical Presents

Personal Care Formulation Trends

Live Webinars for
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Led by **Dennis Abbeduto**

Thursdays, April through May



Thank you!

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