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Personal Care

Time is Precious: Using DOE to Get New Products on the Shelf Faster

Presented by
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Stepan Company
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Agenda

Ingredient Trends in Personal Care Cleansers

Introduction to Design of Experiments (DOE)

Using DOE to Develop a Modern Shampoo

Ingredient Trends in Personal Care Cleansers

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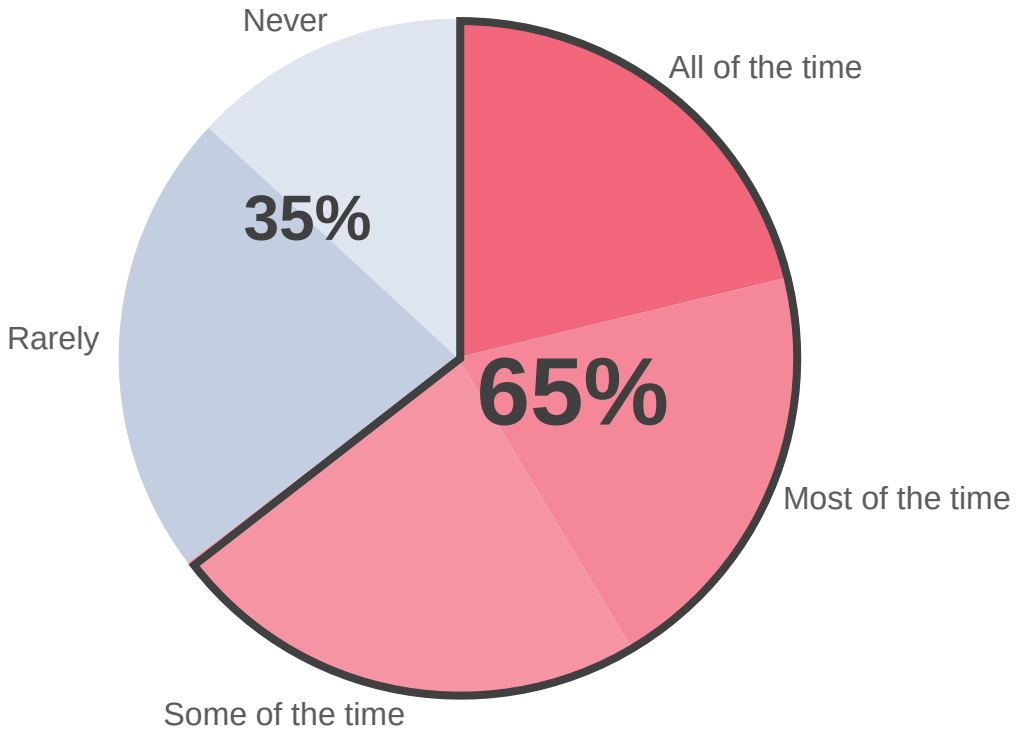
The Scrutinous Consumer

Consumers regularly research their ingredients by checking the product label.

"I research the ingredients in my personal care and beauty products…"



Product packaging remains the main resource for ingredient information

Ingredients: Water, Sodium Lauryl Sulfate, Sodium Laureth Sulfate, Cocamidopropyl Betaine, Glycol Distearate, Dimethicone, Sodium Chloride, Panthenol, Fragrance, Sodium Benzoate, Glycerin, Citric Acid, Tetrasodium EDTA

Mintel Report. Ingredient Trends in Beauty and Personal Care – US – 2022

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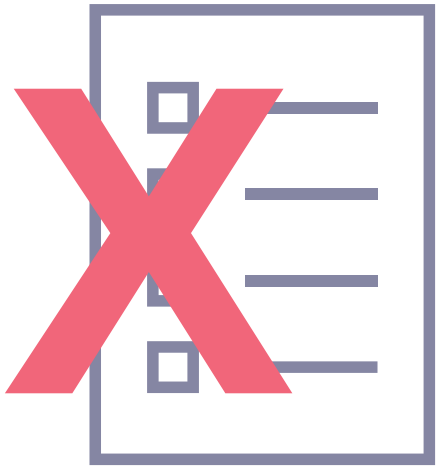
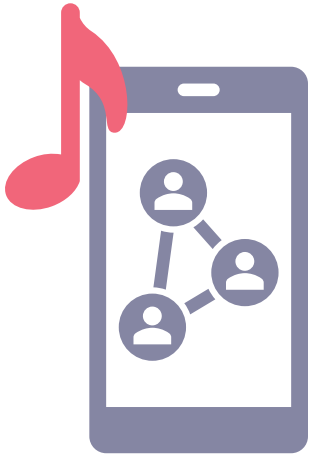
Media, Social Attention Leads to Greater Scrutiny

Consumers may take steps to avoid ingredients receiving negative publicity



Retailers' "Banned Ingredient" Lists

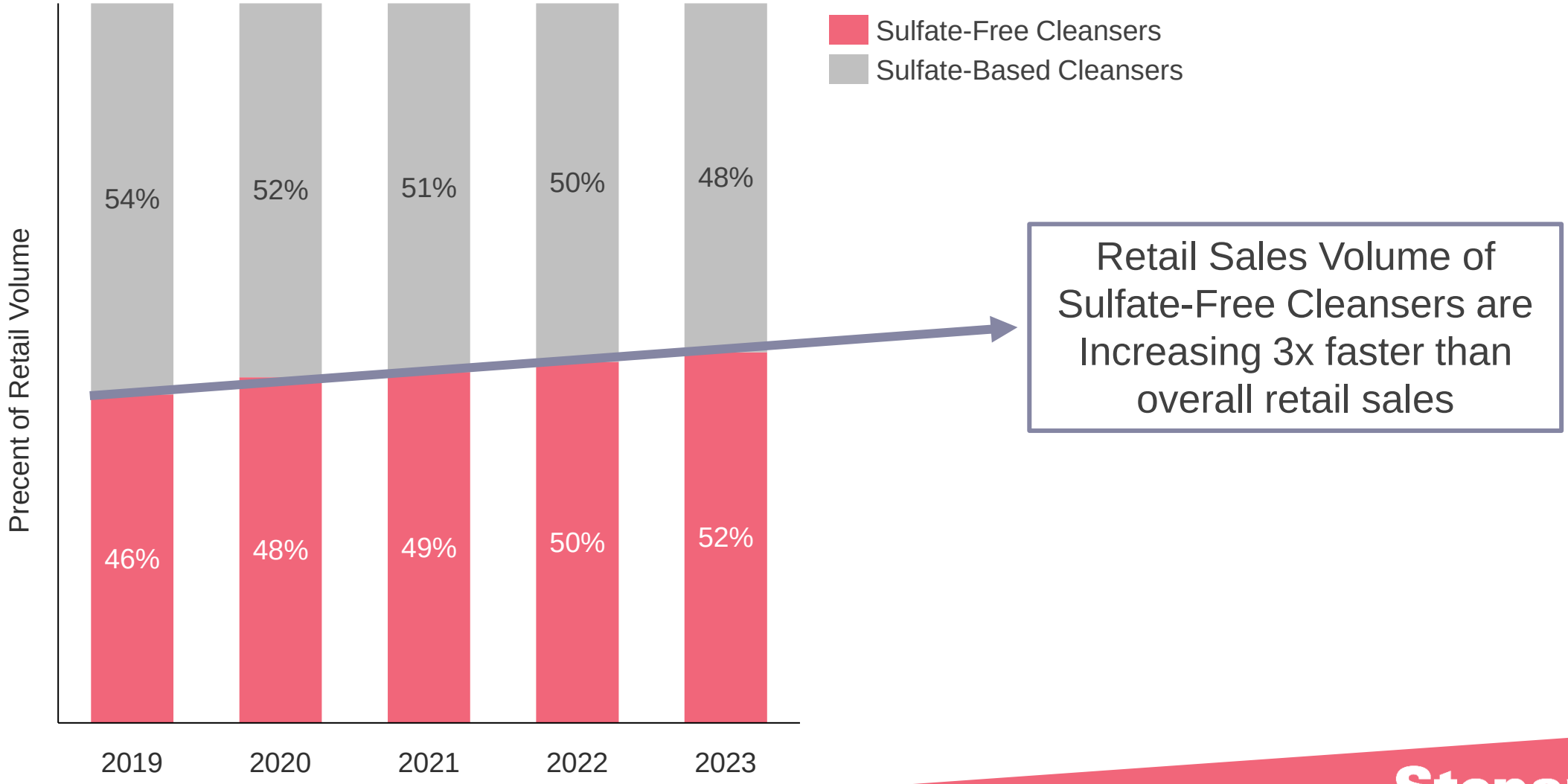


Social Media

Government Regulations

Consumers Are Buying Products with Perceived “Safer” Ingredients

For cleansers, retail sales of sulfate-free products continue to overtake traditional sulfate-based products



Nielsen US Retail Sales for Shampoo, Body Wash, and Liquid Hand Soap

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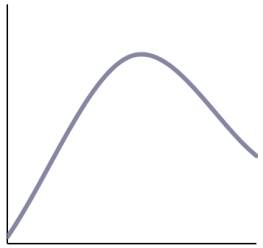
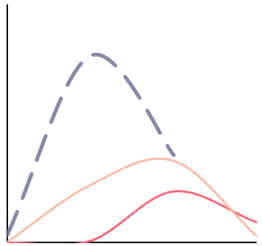
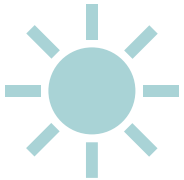
Formulating Sulfate Free Cleansers Can Be Challenging

High levels of residual salt, poor viscosity building characteristics can lead to an iterative development process

	Sulfate-Based Systems Primary + Secondary Surfactant	**Modern Sulfate Free Systems** 2+ Co-Surfactants
Viscosity Response		
Clarity, Stability		
Development Time		

Modern Formulating Demands Modern Solutions

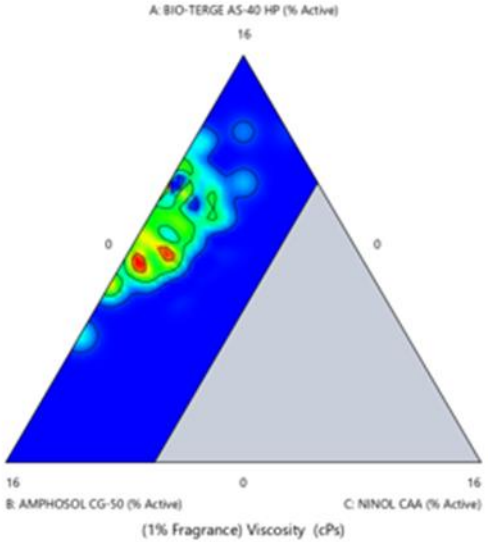
Mild, powerful secondary surfactants drive performance gains while computer modeling cuts down development time

Overcome Performance Challenges: NINOL® CAA

- Maximizes performance
- Enables “no salt added” formulations
- Creates denser, more luxurious foam

Shorten Development Time: Design of Experiments (DOE)

- Efficient, systematic process
- Can act as a reference for future formulas with similar cleansing ingredients



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An Introduction to Design of Experiments (DOE)

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Overview of DOE

- Design of Experiments: A systematic, efficient methodology that studies the relationship between multiple inputs (factors) and key outputs (responses)
- Factors – surfactants
- Responses – viscosity, clarity, foam, function, etc.
- Multiple programs available for modeling
  - JMP
  - Minitab
  - StatEase

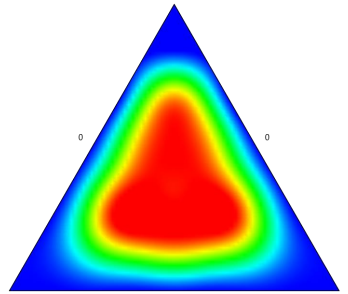
Process of Using DOE

Choose Factors
(Surfactants)

Indicate Responses
(Viscosity, Clarity)

Defines DOE space, suggests screening points

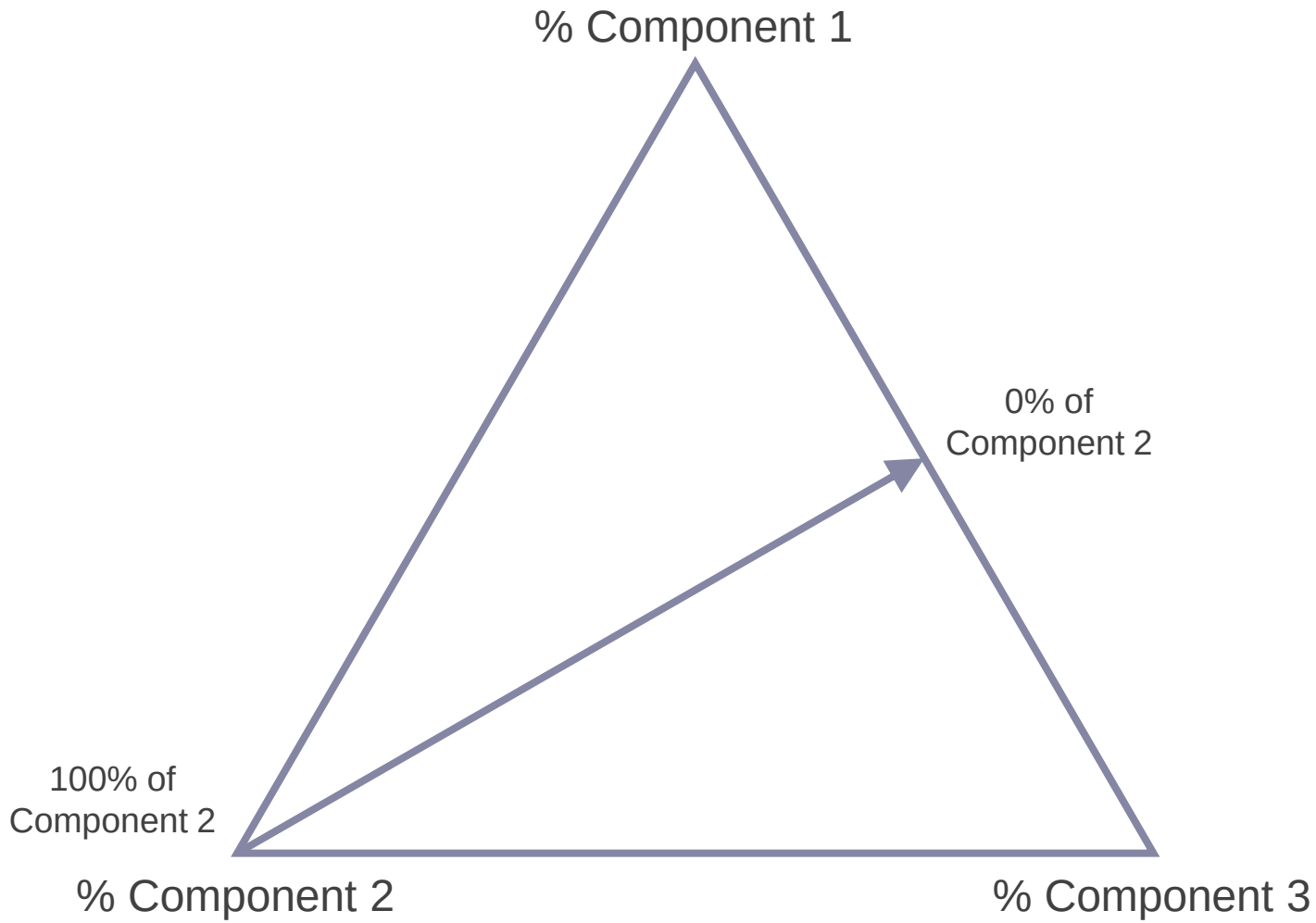
Model may require tweaks, additional data



Response Map/
DOE Triangle

Reading a Design Triangle

- Each **COMPONENT** is a modifiable part of the formulation
- Each **VERTEX**, or corner of the triangle, represents 100% of a component (unless otherwise stated)
- As you move away from a vertex, the concentration of that component decreases to 0% (unless otherwise stated)



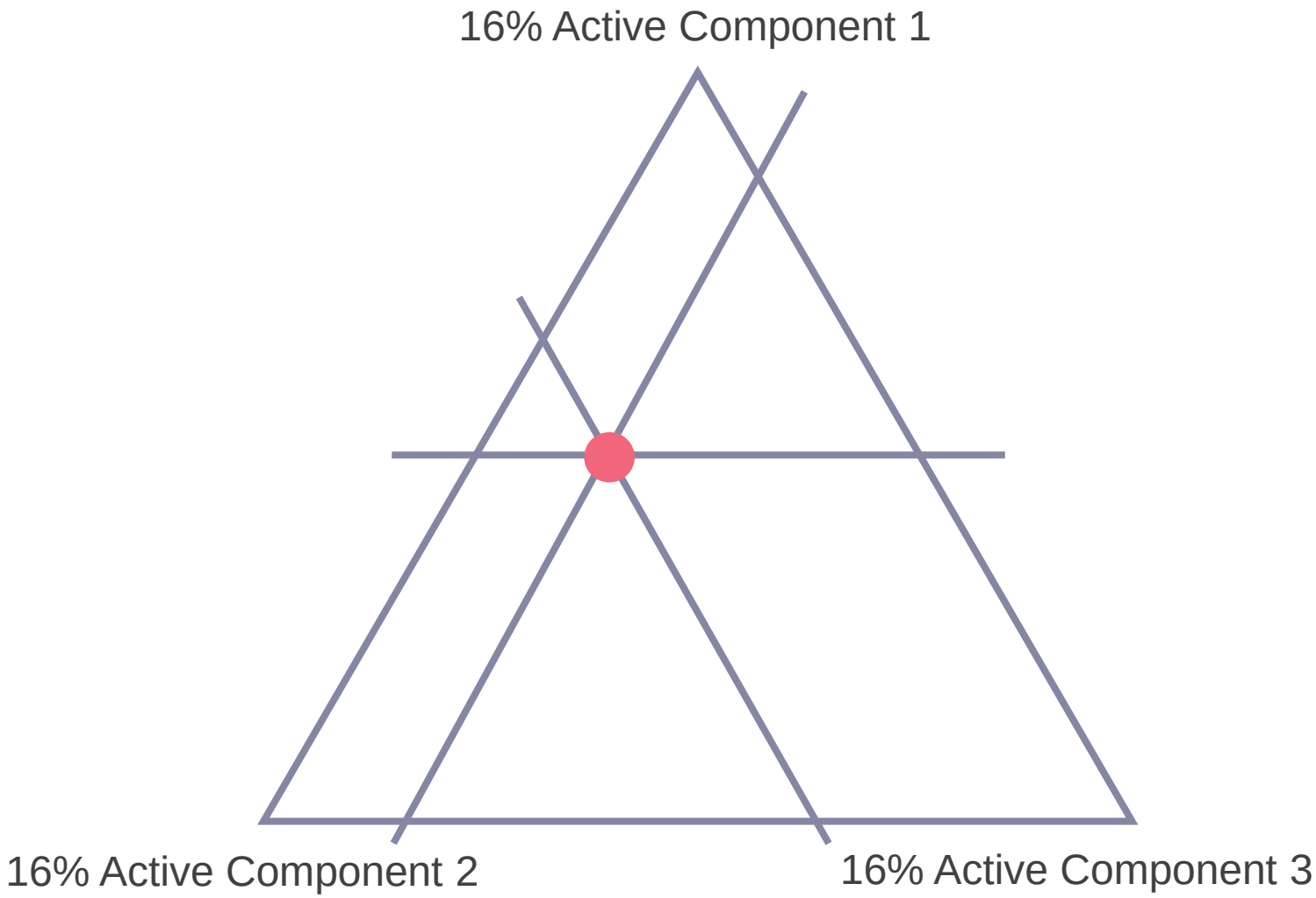
Example: Two Co-Surfactants Plus Value-Added Surfactant

Chosen Point Shows:

Component 1
Co-Surfactant: 10% active

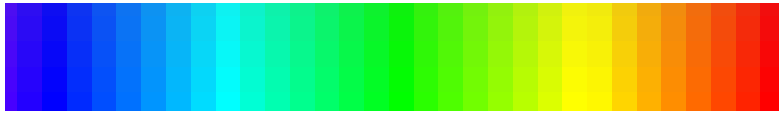
Component 2
Co-Surfactant: 8% active

Component 3
Value-Added Surfactant: 1% active

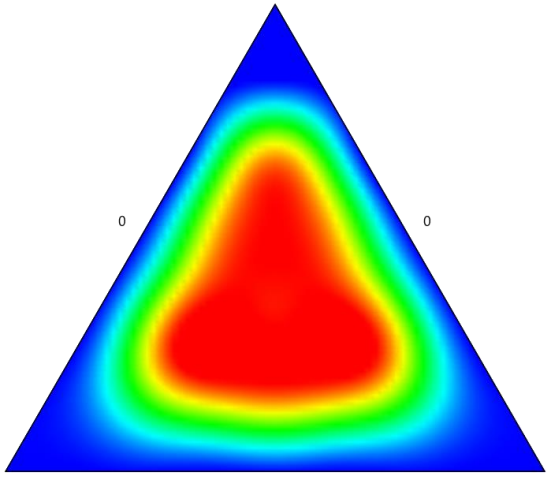


Interpreting a Design Triangle

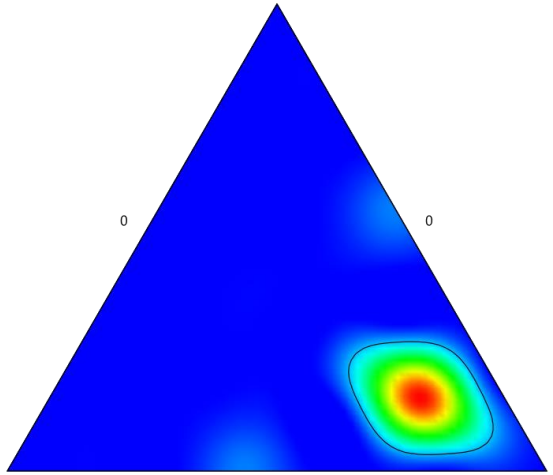
Low Values



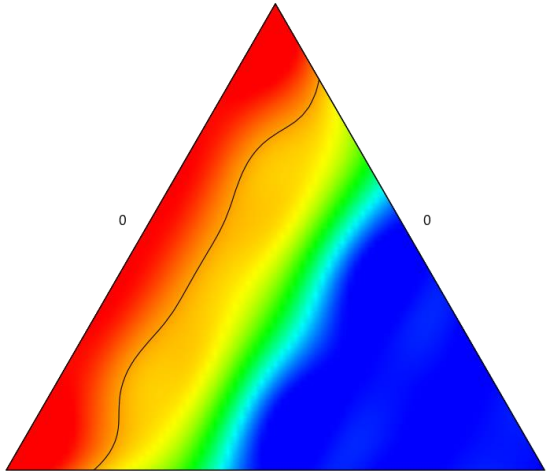
High Values



Ideal design triangles have medium and high values in the center, low values around the perimeter



Higher values towards a vertex can indicate unique functionality of that specific component



High values along an exterior side indicates the component on the opposing vertex has a depreciating effect

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DOE in Action: Crafting a Modern, Sulfate-Free Shampoo

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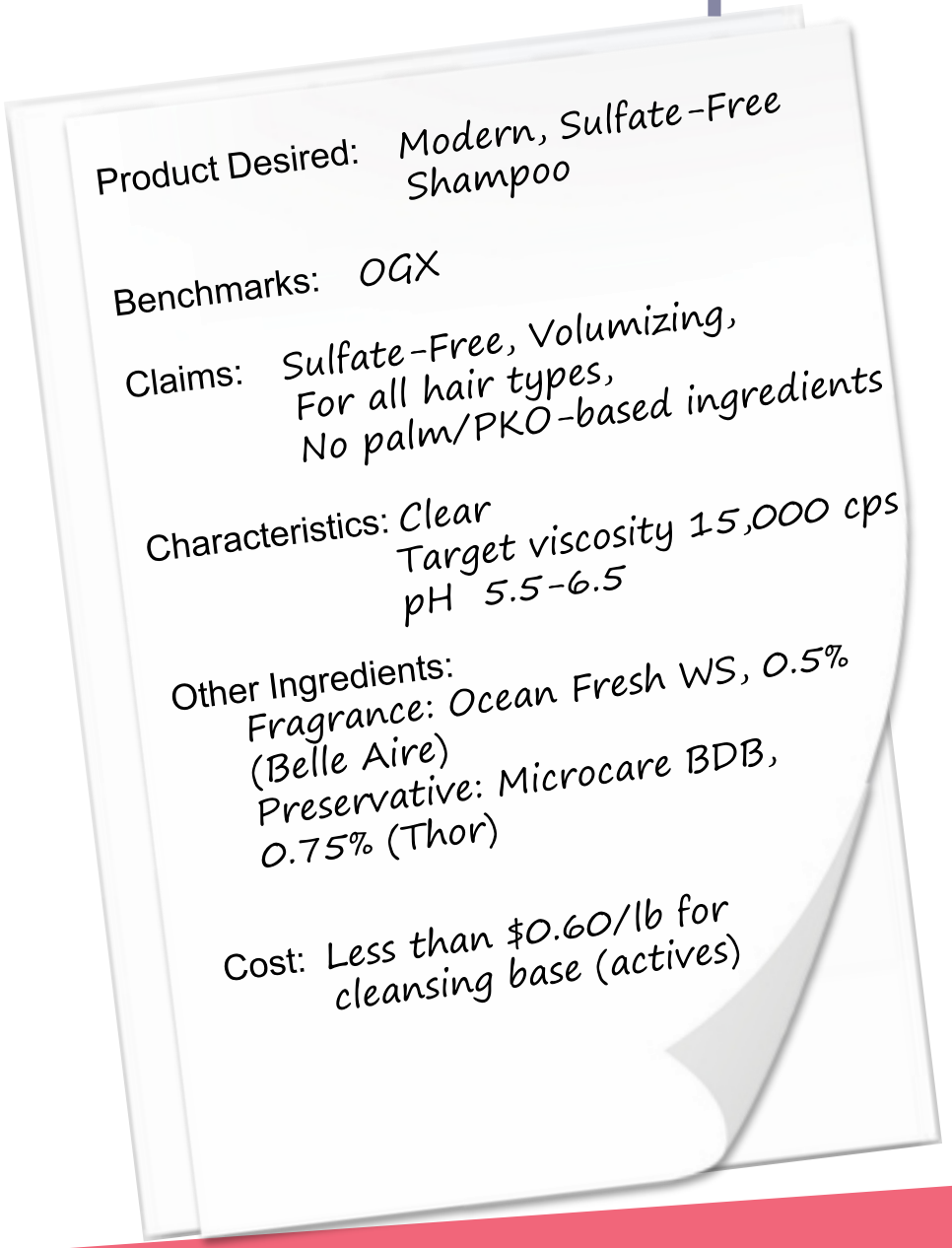
Product Development Brief: Modern Shampoo



Factors (Inputs):

- Component 1: BIO-TERGE® AS-40 HP
  (Sodium C14-16 Olefin Sulfonate)
- Component 2: AMPHOSOL® CG-50
  (Cocamidopropyl Betaine)
- Component 3: NINOL CAA
  (Dimethyl Lauramide/Myristamide)

Responses (Outputs):

- Viscosity
- Clarity
- Formula Cost

Choosing the Right Ingredients

Product Name	INCI Name	Preservative	Active, %	Natural Source	BCI, %
AMPHOSOL CG-50	Cocamidopropyl Betaine	None	43	Coconut	60
BIO-TERGE AS-40 HP	Sodium C14-16 Olefin Sulfonate	None	40	Synthetic	0
NINOL CAA	Dimethyl Lauramide/Myristamide	None	100	Coconut	86

Preservative flexibility for final formulation

Only coconut as natural source

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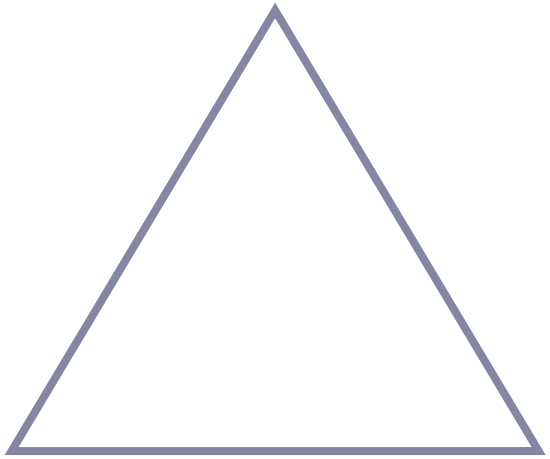
Setting Up the DOE Triangle - Viscosity

% BIO-TERGE AS-40 HP



% AMPHOSOL CG-50

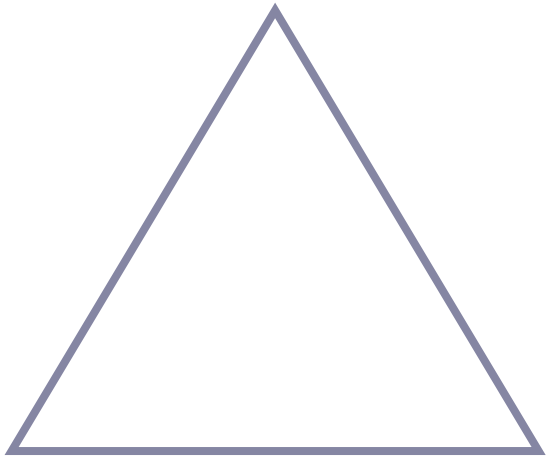
% NINOL CAA

pH = 5.5
Active = 16%
Response Type: Viscosity

Balance:
Water, Fragrance,
Preservative, Other

Setting Up the DOE Triangle - Viscosity

% BIO-TERGE AS-40 HP



% AMPHOSOL CG-50

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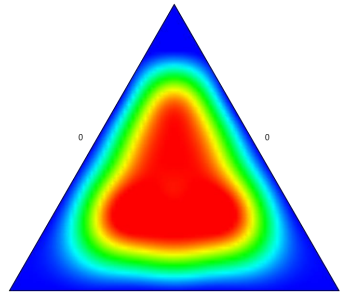
Process of Using DOE

Choose Factors
(Surfactants)

Indicate Responses
(Viscosity, Clarity, etc.)

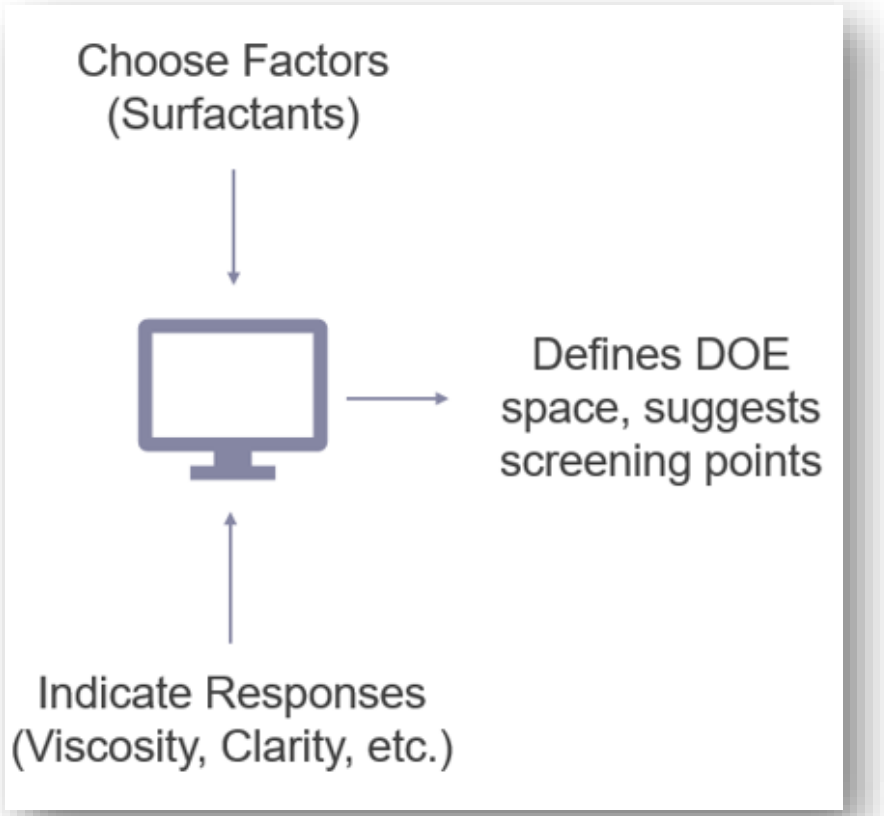
Defines DOE space, suggests screening points

Model may require tweaks, additional data



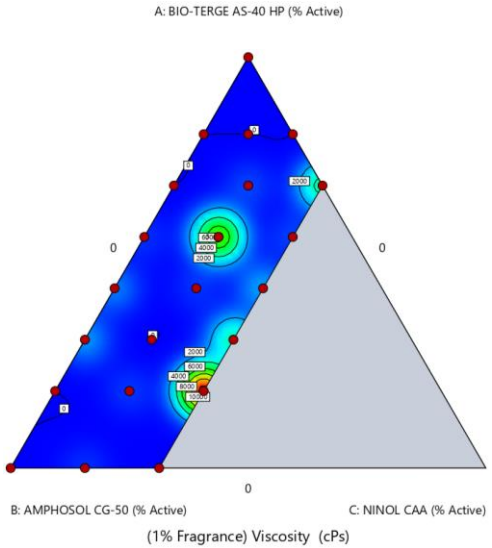
Response Map/
DOE Triangle

Shampoo Viscosity Initial Results



22 points

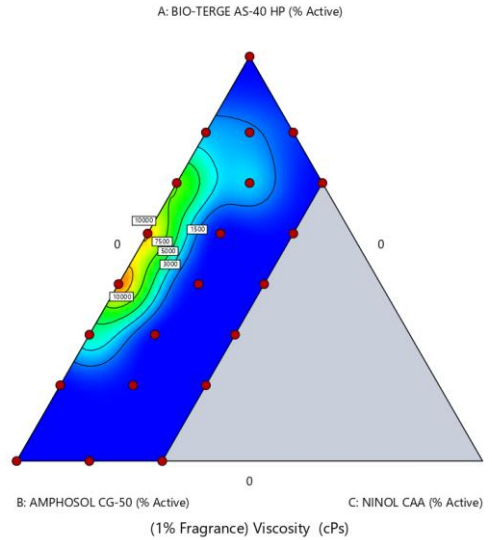
AOS/CAPB/CAA Initial Viscosity (Without NaCl)



pH = 5.5
Active = 16%
Data Points = 22
Response Type = Viscosity

Balance:
Water, 1.0% Fragrance, Preservative, Citric Acid

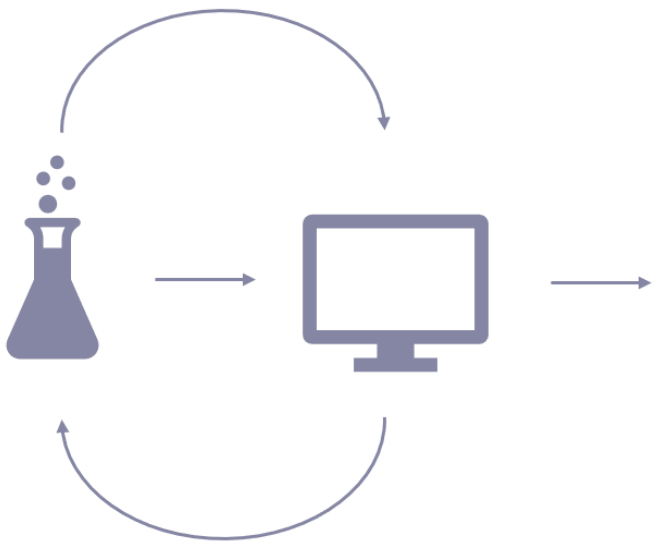
AOS/CAPB/CAA Viscosity (With NaCl)



pH = 5.5
Active = 16%
Data Points = 22
Response Type = Viscosity

Balance:
Water, 1.0% Fragrance, Preservative, Citric Acid (Max. Sodium Chloride)

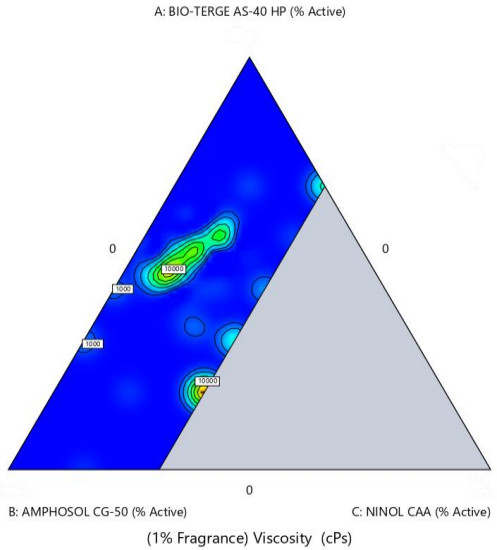
Shampoo Viscosity Results with Additional Data



Model may require tweaks, additional data

72 points

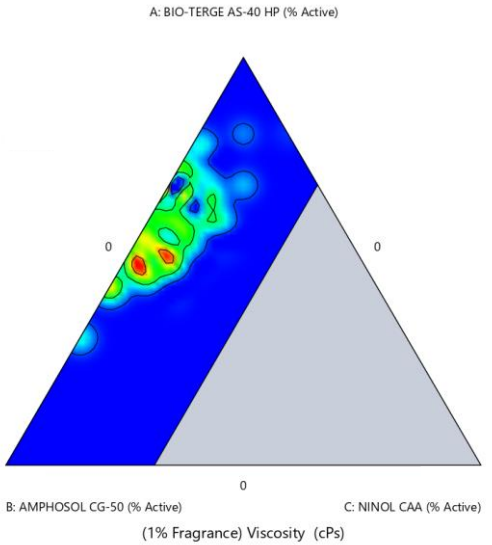
AOS/CAPB/CAA Initial Viscosity (Without NaCl)



pH = 5.5
Active = 16%
Data Points = 72
Response Type = Viscosity

Balance:
Water, 1% Fragrance, Preservative, Citric Acid

AOS/CAPB/CAA Viscosity (With NaCl)



pH = 5.5
Active = 16%
Data Points = 72
Response Type = Viscosity

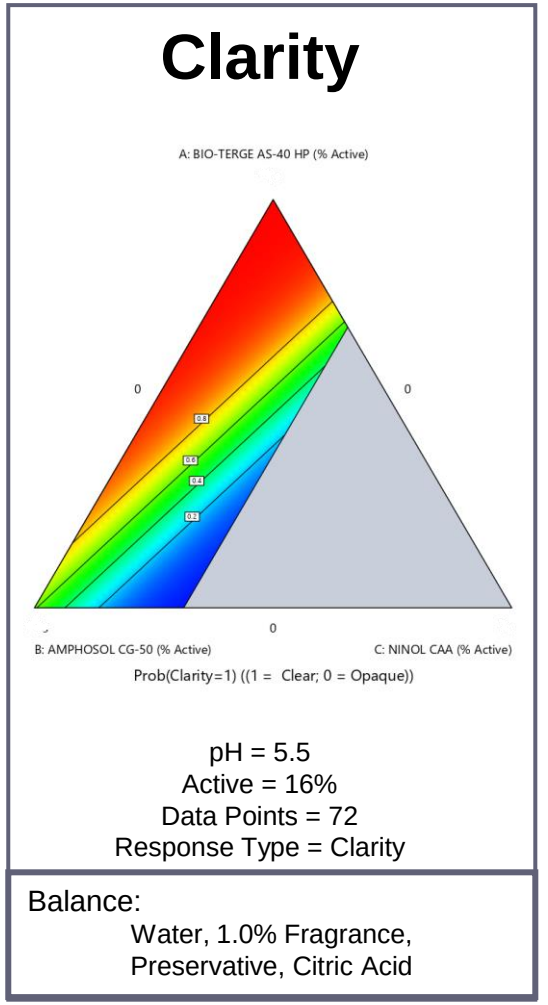
Balance:
Water, 1% Fragrance, Preservative, Citric Acid (Max. Sodium Chloride)

Maximizing Shampoo Clarity

Can use subjective (visual) or objective (turbidity) methods to evaluate clarity

- Visual analysis needs distinct differentiation – responses are designated "1" for crystal clear and “0” for any amount of haze
- Modeling program then shows values between 0 and 1 to reference the highest probability of getting a clear product

Alternatively, turbidity measurements can be used for response values



pH = 5.5
Active = 16%
Data Points = 72
Response Type = Clarity

Balance:
Water, 1.0% Fragrance, Preservative, Citric Acid

Combining Clarity & Viscosity to Define Cleansing Base

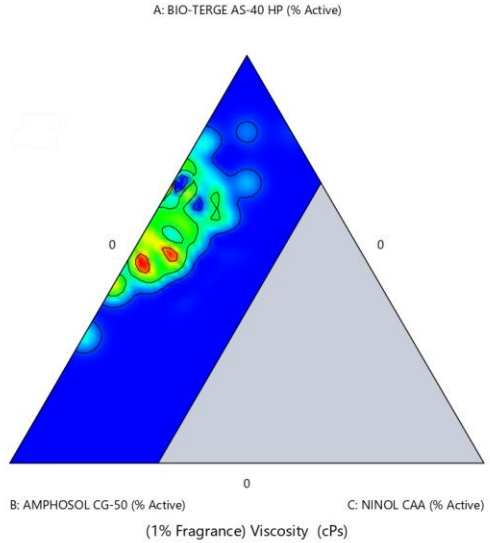
Clarity

General
pH = 5.5
Active = 16%
Data Points = 72
Response Type = Clarity

Balance:
Water, 1.0% Fragrance,
Preservative, Citric Acid

+

Viscosity

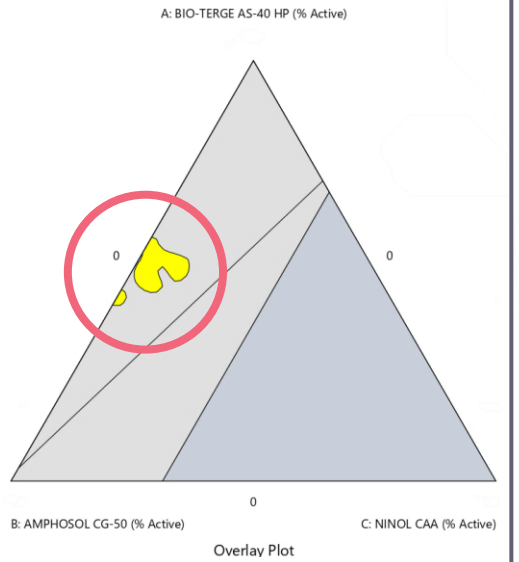


General
pH = 5.5
Active = 16%
Data Points = 72
Response Type = Viscosity

Balance:
Water, 1.0% Fragrance,
Preservative, Citric Acid

=

Overlap



General
pH = 5.5
Active = 16%
Data Points = 72
Sampling = Clarity and
Viscosity

Balance:
Water, 1.0% Fragrance,
Preservative, Citric Acid

Combining Clarity & Viscosity to Define Cleansing Base

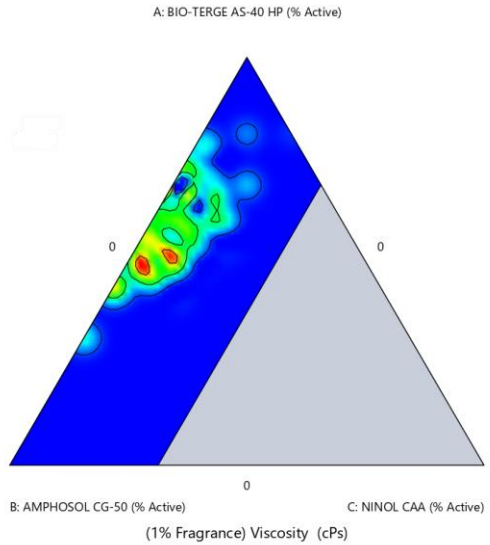
Clarity

General
pH = 5.5
Active = 16%
Data Points = 72
Response Type = Clarity

Balance:
Water, 1.0% Fragrance,
Preservative, Citric Acid

+

Viscosity



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pH = 5.5
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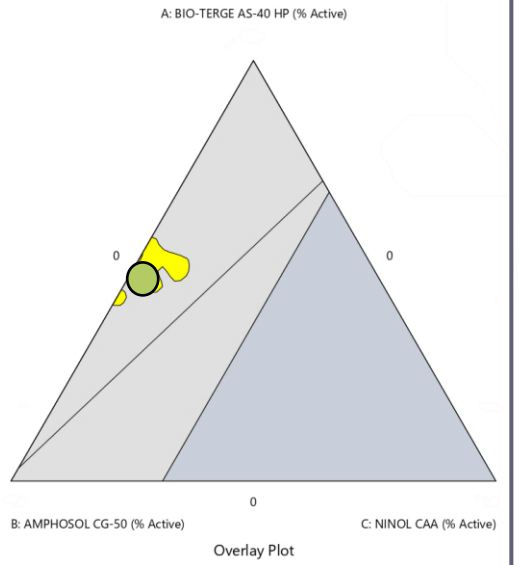
Overlap



Ingredient	DOE Actives Ratio (w/ salt)
BIO-TERGE AS-40 HP *Sodium C14-16 Olefin Sulfonate*	**0.50**
AMPHOSOL CG-50 *Cocamidopropyl Betaine*	**0.47**
NINOL CAA *Dimethyl Lauramide/Myristamide*	**0.03**

Optimizing Shampoo Cost

Ingredient	Price ($/Lb)* *100% Active*
BIO-TERGE AS-40 HP *Sodium C14-16 Olefin Sulfonate*	$5.40
AMPHOSOL CG-50 *Cocamidopropyl Betaine*	$8.85
NINOL CAA *Dimethyl Lauramide/Myristamide*	$5.40

From Brief:

Viscosity of 15,000 cps

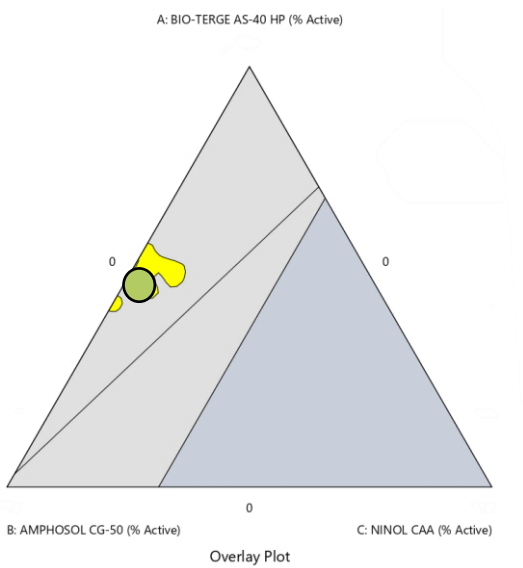
Cost <$0.60/lb for cleansing base (actives)

Ingredient	DOE Actives Ratio (w/salt)	Optimization Trial 1: 6% Total Actives	Optimization Trial 2: 8% Total Actives
AS-40 HP	0.50	3.00%	4.00%
CG-50	0.47	2.80%	3.75%
CAA	0.03	0.20%	0.25%
Total Cost Per Lb	--	$0.421	$0.562
Viscosity, Clarity	--	?	?

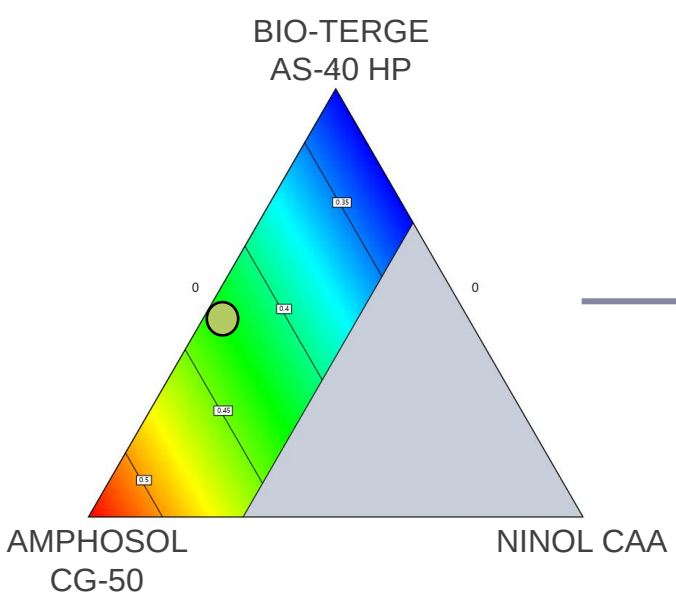
**Prices indicated are for reference only; please contact your Stepan Sales Representative for an official price quote for any Stepan material.*

DOE Can Optimize Formula Cost

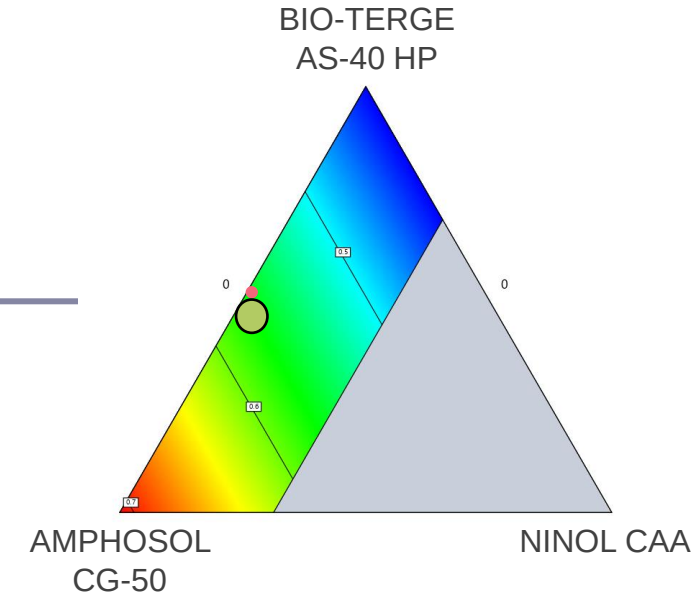
The sum of ratios = 1.0



Viscosity/Clarity Overlap



6% Actives



8% Actives

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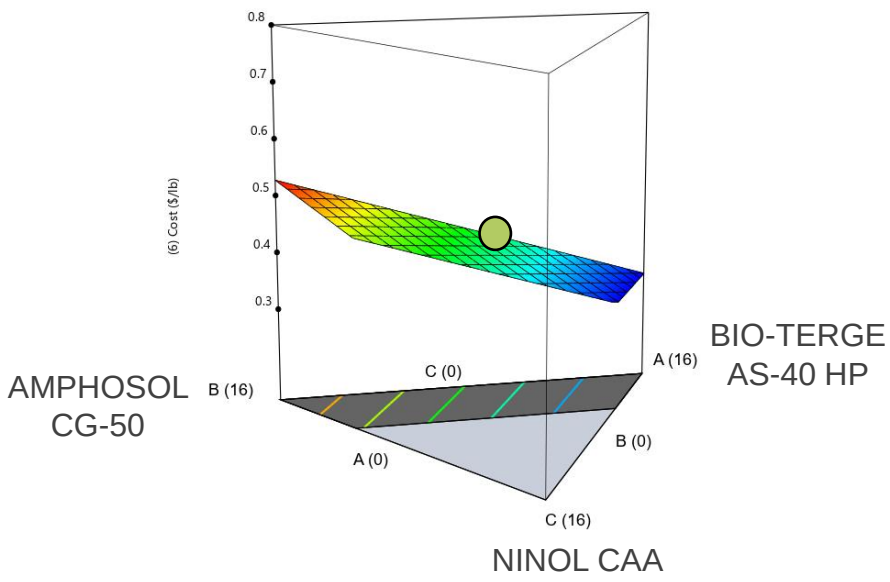
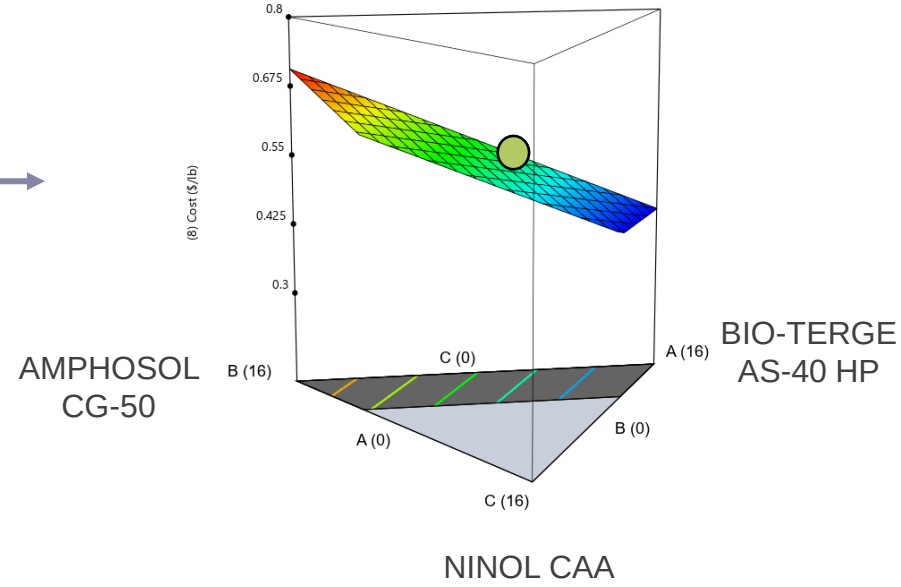
DOE Can Optimize Formula Cost

The sum of ratios = 1.0



6% Actives



8% Actives

Optimizing Shampoo Cost

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Cost <$0.60/lb for cleansing base (actives)

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CG-50	0.47	2.80%	3.75%
CAA	0.03	0.20%	0.25%
Total Cost Per Lb	--	$0.421	$0.562
Viscosity, Clarity	--	<1,000 cps Clear	16,300 cps Clear

Prices indicated are for reference only; please contact your Stepan Sales Representative for an official price quote for any Stepan material.

The Final Result: Modern Sulfate Free Shampoo

Finished project after making only 2 formulas

Final Steps:

- Minor formula adjustments to achieve marketing targets
- Verify accelerated, long-term and elevated temperature stability
- Verify performance claims with panel and/or consumer testing
- Component stability
- Scale up and processing

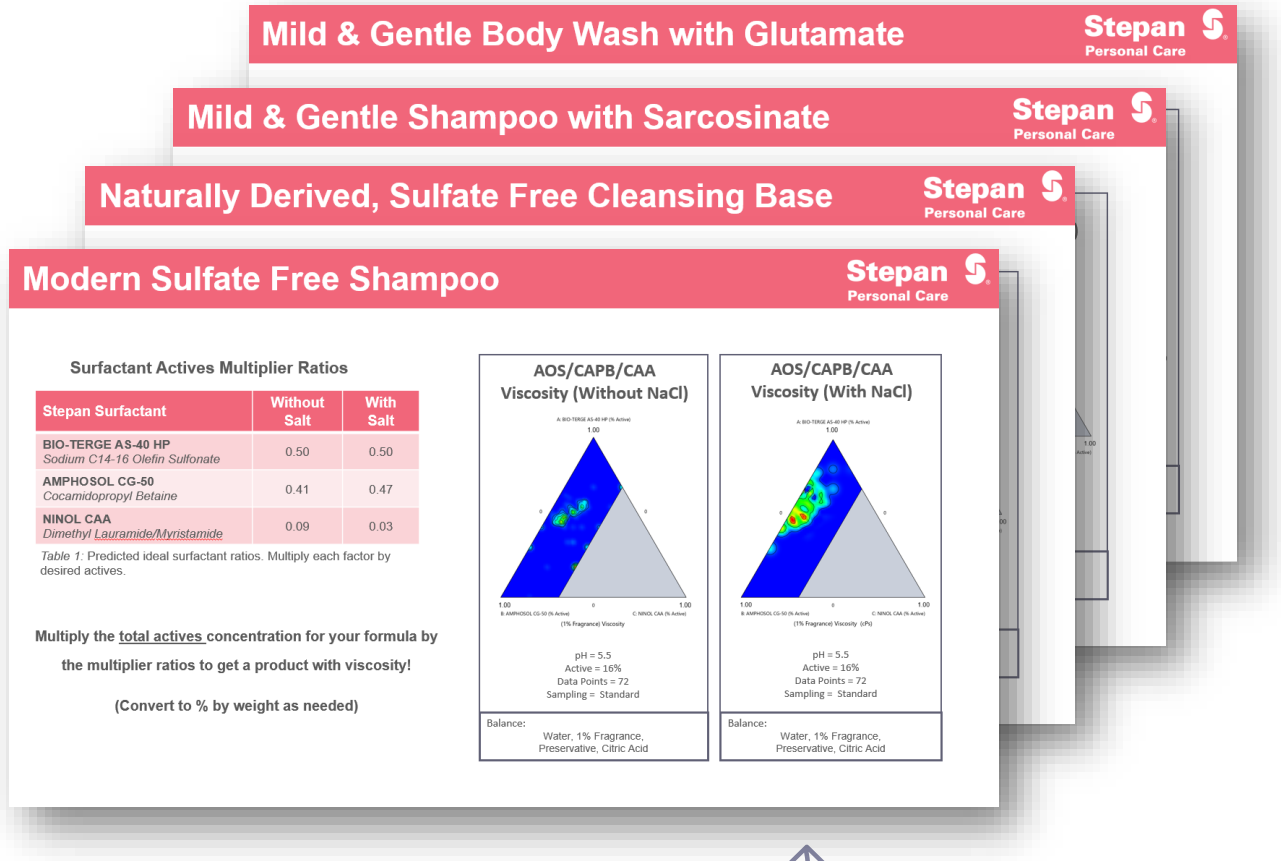
Using DOE response triangles can expedite range expansion – new fragrances, additives

Stepan Has Done the Hard Work For You

Stepan's expertise in DOE can accelerate your new product development

DOE summaries with surfactant ratios, viscosity response maps available for various sulfate free systems, more to come

Simply multiply each surfactant ratio by desired total actives to start formulating!



Interested in receiving one of these summaries?

Leave a note in the chat!

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In Summary:

- Consumer-desired, sulfate free cleansers can require lengthy development processes due to performance challenges
- DOE provides a systematic approach to product development, streamlining the process and creating comprehensive foundation for SKU expansion
- Stepan has created viscosity response maps for multiple sulfate free systems to put you steps ahead in the development process

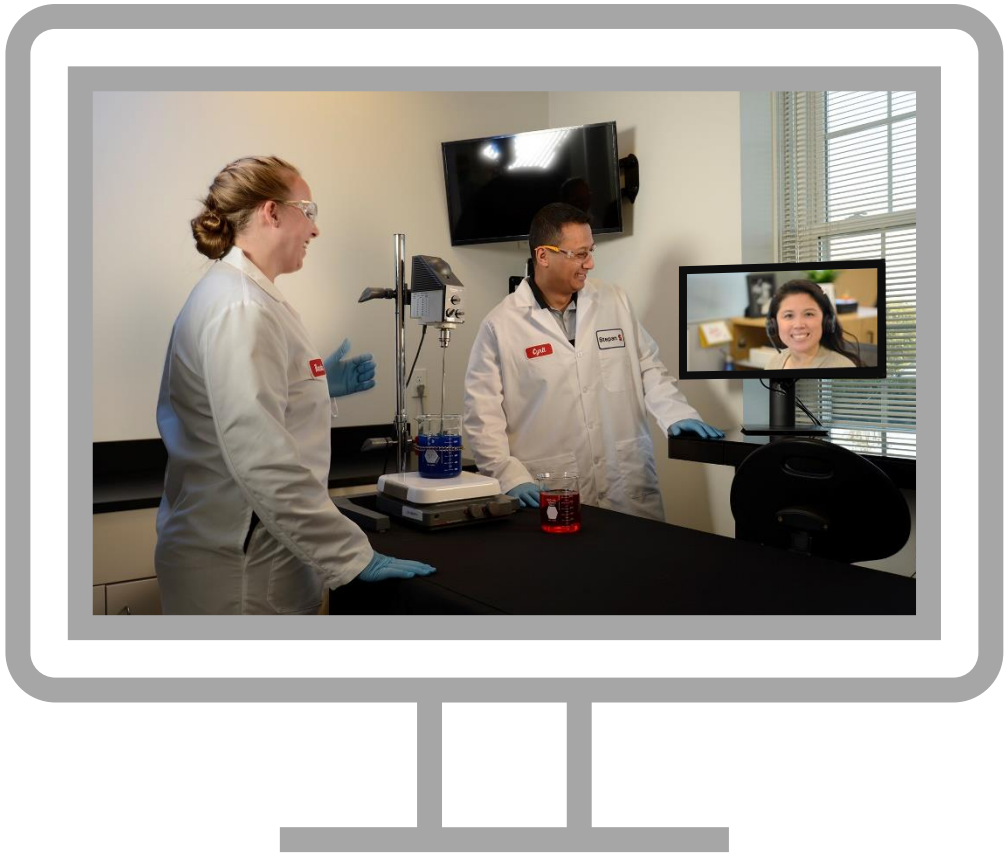
What sulfate free surfactants are giving you trouble?
Let us know in the chat!

Struggling with a Sulfate Free Cleanser?

Take advantage of Stepan's Virtual Lab

Stepan's **Virtual Collaboration Lab** is available to you for live demonstrations or formulation troubleshooting!

- Reach out to your local sales representative
- Contact us through UL Prospector



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