

Long-Chain Amphoteric Surfactants as Safe, Effective Additives for Cleansing Formulations (Part Two)

Dennis Abbeduto and Molly McEnery,
Colonial Chemical, Inc.



Overview

Amphoteric surfactants are likely the least understood, yet most commonly used class of surfactants in personal care. Their benefits in formulation are well known, but only a subset of these products have been very well characterized. The coconut derived products are ubiquitous in personal care, but their longer chain and soft-oil derived counterparts are not. This poster will demonstrate the benefits of using these long chain products.

1. Introduction

Broadly used to describe a wide range of multi-charged molecules, “amphoteric” surfactants are often simply zwitterionic or have some capacity of carrying multiple charged functional groups. This property makes them tremendously useful in the formulation of a wide range of cleansers, especially gels, but their charge characteristics also make them useful for other applications as well. They are well known for their ability to form mixed micelles with anionic surfactants, substantially lowering the irritation potential of those surfactants while greatly improving foam and viscosity building properties. Formulators are most familiar with the coconut-derived products, such as Cocamidopropyl Betaine, Cocamidopropyl Hydroxysultaine, Disodium Cocoamphoacetate (a true amphoteric), and the like. While the coconut derived products are excellent foaming products on their own and are often used alone for this property, analogous products derived from soybean and other oils high in stearic, oleic, and linoleic acids do not demonstrate this same property and have been largely ignored. As formulators move away from many traditional tertiary surfactants, especially those containing secondary amines and ethoxylates, it is increasingly important that alternative chemistries be considered for similar benefits.

2. Materials

All surfactants used in this evaluation were supplied by Colonial Chemical, Inc, South Pittsburg, TN. The amphoteric products of interest are

- Cocamide MIPA – a standard tertiary surfactant
- Oleamidopropyl Betaine – based on high oleic oils
- Cannabisamidopropyl Hydroxysultaine – based on hemp seed oil
- Cetyl Betaine – based on coconut and palm-derived tertiary amines
- Sodium Stearoamphoacetate – based on palm-derived fatty acid
- Soyamidopropylamine Oxide – based on soybean oil
- Stearamine Oxide – based on coconut-derived tertiary amines
- Sodium GrapeSeed Amidopropyl PG-Dimonium Chloride Phosphate – based on grapeseed oil

3. Methodology

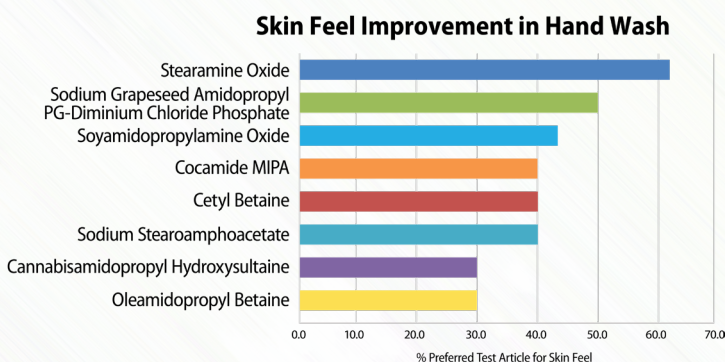
A. Hand Wash Skin Feel Perception

Longer chain amphoteric surfactants are expected to provide some sensory benefit in a cleanser due to their partial or complete cationic (positive) charge at skin-compatible pH of 5-6. The cationic charge should drive some added substantivity of the amphoteric surfactant to the skin’s anionic (negative) charge. The impact on in-wash and dried skin feel of the long chain amphoteric surfactants was compared.

A standardized base surfactant formulation consisting of Sodium C14-16 Olefin Sulfonate and Cocamidopropyl Hydroxysultaine was evaluated in combination with the tertiary additives listed previously according to the following formulation:

Ingredient	% Solids
Water	qs to 100.00
Sodium C14-16 Olefin Sulfonate	8.00
Cocamidopropyl Hydroxysultaine	2.00
Tertiary surfactant	1.50
Citric Acid 50%	qs to pH 6.0

A panel of 9 naïve and 1 expert individuals (3 female, 7 male ages 25-35) participated in a triangle test, with two samples containing a control wash without additive and one containing the wash with the long chain surfactant or standard tertiary surfactant (which is generally considered to be effective for the benefit indicated). Panels were asked to notice any difference in feel on the skin in wash or after their hands dried and to select the wash they felt performed best. The percentage of individuals who selected the wash with the additive is indicated in the following chart.

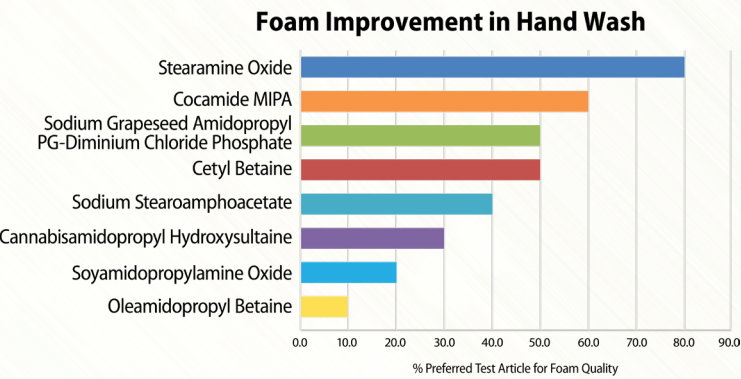


B. Hand Wash Later Perception

In part one of this study the authors demonstrated modest improvements in foam height and texture using an instrumental dynamic foam analysis. They again sought to see if any of those differences could be noticed in a real-world wash setting.

For this evaluation, test solutions of the same formulations of Part A were evaluated by a second panel of 10 naïve individuals (4 female, 6 male ages 25-45). The same triangle design was employed, with two samples containing a control wash without additive and one containing the wash with the long chain

surfactant or standard tertiary surfactant (which is generally considered to be effective for the benefit indicated). Again, the panelists were asked to select which product they felt gave the creamiest lather feel. The percentage of individuals who selected the wash with the additive is indicated in the chart below.



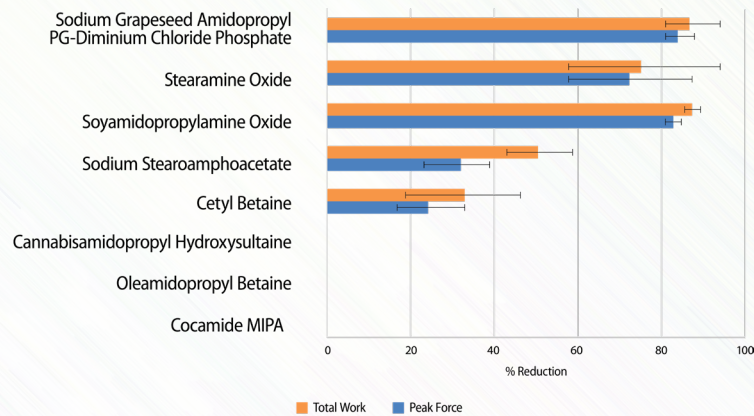
C. Hair Comb Force Reduction

By the same mechanism described for the skin substantivity, long chain amphoteric surfactants are expected to have some impact on the combing properties of hair.

Measurements were performed on wet tresses to obtain the peak force to comb the hair, which is often associated with detangling, as well as the force as a function of distance along the tress (total work).

Studies were conducted on 6"/2g virgin brown single bleached hair tresses (International Hair Importers & Products, Inc.) using a Diastron fibra.one fitted with comb accessory.

Baseline measurements were conducted on tresses washed in tap water with 0.4g of a 14% active SLES solution adjusted to pH 5.0 for one minute then rinsed 30 seconds. Following the baseline measurements, the same tresses were treated with the test solution and the combing method was then repeated, similar to the baseline test. Combing tests were repeated 10 times. The peak force and total work were calculated within the fibra.one software and the averages are presented here.



4. Conclusions

While amphoteric surfactants are well known and frequently used, their application is typically limited to foam stabilization and irritation mitigation of primary anionic surfactants using the coconut derived varieties. The usefulness of long chain amphoteric surfactants has now been demonstrated.

For the evaluation of skin feel, the ability of naïve participants to differentiate the products was somewhat limited. While the data for the expert was not removed or analyzed separately, that individual was able to discern an improvement in all test articles compared to the control with no additive. This indicated that while expert formulators may easily notice these differences, the importance of testing a naïve panel was strongly demonstrated. Among the full panel, Stearamine Oxide performed very well. The phosphobetaine Sodium Grapeseed Amidopropyl PG-Dimonium Chloride Phosphate was mixed in its perception and others failed to provide a noticeable improvement for the majority of individuals.

For the foam liking, Stearamine Oxide again performed very well. Since there was no overlap in participants between the foam and feel perception tests, it's very clear that Stearamine Oxide provides a substantial and noticeable benefit. The benchmark Cocamide MIPA also performed well, with the phosphobetaine and Cetyl Betaine additives appealing to half of the respondents.

In the comb analysis, we saw the largest spread of effects among all the testing we conducted. Results fell into three buckets: high, medium, and low performers. The high performing products included the phosphobetaine and the amine oxides. The phosphobetaine performs very well thanks to its multiple alkyl chains. Interestingly, the same product failed to produce a significant benefit to skin feel in the wash test, highlighting the importance of formulation design in optimizing benefits. The amine oxides gain a fairly strong positive charge even under the mildly acidic conditions of the test and perform well. For the Stearamine Oxide, a greater than typical variance was observed in the results. This may be related to the lower water solubility of that product. In the mid-tier group we see the amphoacetate and alkyl betaine performed moderately well, with the amphoacetate (a true amphoteric) performing better, which is anticipated by the structure. Finally, three products failed to produce any effect at all. One of those, the Cocamide MIPA is predicted by its structure, but the low impact of the amidopropyl betaine and amidopropyl hydroxysultaine is surprising.

Long chain amphoteric surfactants have again demonstrated themselves to be useful additives. The authors previously demonstrated these ingredients' large impact on viscosity generation in gel cleansers and to a lesser extent improved irritation potential and foam stabilization. These new data demonstrate that consumer-perceivable benefits for foam feel, skin feel, and in hair care can be realized by some of these products as well, though the impact may be more variable for these endpoints. For all benefits, careful formulation design is needed to fully realize them.



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