



Silicone Anionic / Silicone Cationic Complex Silicone Quaternium 20

Abstract The interactions can result in thickening, foam enhancement, aesthetics improvement and other desirable factors, however the interactions can cause instability, splitting, foam degradation and even loss of preservative functioning.

The ability to capitalize on interactions is not only of interest to the formulator; it is of interest to the raw material supplier as well. This article reviews the formation of silicone anionic and silicone cationic complexes and their functionality in formulation.

KEYWORDS: *Silicone Complexes, Coacervate, Soft complexes, hard complexes, silicone quaternium 20, formulation interaction, anionic / cationic interactions, shampoo, body wash, foam, aesthetics.*

In a previous article on interaction between anionic and cationic surfactants, it is stated: "The interaction between ingredients in a formulation is almost always the most important factor in determining the properties of the formulation (1)." The interaction between anionic and cationic surfactants are clearly one of the interactions that can be used to improve functional of a formulation. However, the ability to capitalize upon the interaction between anionic and cationic surfactants has been extended to anionic and cationic polymers and has been extended from formulators to raw material suppliers. This review article will address the development.

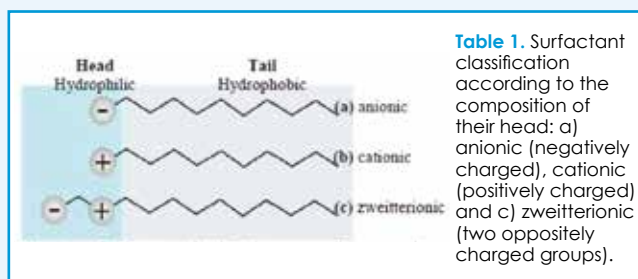
FORMULATOR TIP

The formulator should view old assumptions with a healthy degree of skepticism, understanding that assumptions sometimes, but rarely, are universally true; often contain an element of truth to them; and rarely are just wrong.

HARD AND SOFT COMPLEXES

Surfactant molecules interact with the solvent molecules around them. In order for a surfactant to be soluble in water,

the surfactant molecules need to hydrogen bond with the water molecules. Ionic surfactants containing a charge, will be either positive or negative (Table 1).



Charges can increase the ability of forming hydrogen bonds with water molecules, however when mixing ionic surfactants, it is important to consider the interactions of not only surfactant / water but also surfactant / surfactant interactions. When there is a mixture of positive and negative surfactants, the positive and negative charges on the surfactants can interact with one another. If the positive / negative interaction is strong (greater than the interaction of surfactant / water), the two surfactant molecules will prefer to interact with each other and not with the surrounding water molecules. This creates "shielding" of the charges from the water molecules and the surfactant can lose solubility in water. This is seen in Hard Complexes (HC) (3), the turbidity of the solution is a result in the positive / negative interaction being stronger than the surfactant / water interactions (hydrogen bonds). As the solubility decreases, the particles start to scatter light leading to turbidity. The turbidity is clearly

FORMULATOR TIP

An excellent article written by Robert Lochhead et al entitled *Deposition from Conditioning Shampoo: Optimizing Coacervate Formation* is recommended reading for all formulators interested in coacervate technology (7).

Procedure

1. Into a clean sanitized steel container equipped with a propeller mixer, add water in phase B.
2. Add SLES-2 and betaine in phase B and heat to 70-75C, slowly, adding cocamide MEA and EGDS. Mix slowly minimizing introduction of air. Mix until uniform then cool to room temperature.
3. In another clean sanitized steel container add the rest of the ingredients in phase A one by one while mixing and minimizing air entrainment.
4. Add phase B slowly into Phase A. Mix well until uniform.
5. Premix Silicone Quaternium 20 and Octyldodecyl citrate crosspolymer then add to premixed phase A and B.
6. Add the remaining Phase C under good agitation.
7. Add ingredients in Phase D, one by one. Adjust pH using citric acid to 5.5-6.5 and adjust viscosity to 6,000 to 12,000 cps by addition of salt. Add fragrance.

2 in 1 Shampoo Coacervate		
A	Ingredient	% Wt
	Water	22.00
	Acrylates Copolymer	2.50
	Triethanolamine	0.20
	Disodium EDTA	0.10
	Sodium Laureth 2 Sulfate	27.50
	Cocamido betaine	6.00
B		
	Water	18.00
	Sodium Laureth Sulfate	5.50
	Cocamido betaine	4.00
	Cocamid DEA	1.20
	Ethylene glycol distearate	3.00
C		
	Silicone Quaternium 20	1.00
	Octyldodecyl citrate crosspolymer	1.00
	Wheat Protein	0.50
	Cannabis Sativa Seed Oil	1.00
	DMDM Hydantoin	0.50
D		
	Decyl Glucoside	3.00
	Sodium Cocamphodiacetate	3.00
	Citric	Qs
	Sodium Chloride	Qs
	Fragrance	Qs
	Total	100.00

Table 7. Shampoo Formulation FH183D.

WET COMB

All products were evaluated on 10 inch Virgin Brown Hair. Two x 2 gram swatches were used for each test material, all from the same lot. All swatches were wet with water at 25oC and 1 gram of test material for each swatch. Swatches were washed and then rinsed for one minute per swatch. Wet comb evaluation was then performed. Hair was not blow dried, rather they were air dried.

Evaluation scale 1 -5. (1 worst – 5 best) Table 8 shows the results.

A well-known baby shampoo was also evaluated.

	Wet Comb	Rinse off	Clean Feel	Shine	Residual Feel
Water only	1.0	3.0	2.0	2.0	2.0
Baby Shampoo	2.0	3.0	3.0	2.0	2.0
FGH183D	4.5	4.5	4.5	3.0	3.0

Table 8. Wet Comb Analysis.

Table 9 shows the results for dry comb analysis.

	Dry Comb	Dry Feel	Clean Feel	Shine	Manageability	Fly Away	Residual Feel	Static
Water only	3.0	3.0	2.0	1.0	1.0	1.0	1.0	2.0
Baby Shampoo	3.0	3.5	3.0	1.0	2.0	2.0	1.0	2.0
FGH183D	4.5	3.5	4.0	4.0	4.0	4.0	4.0	4.0

Table 9. Dry Comb Analysis.

FORMULATOR TIP

Always look at new ways to combine old ingredients to solve formulation problems and to introduce new formulation aesthetics. These should include differing ratios of ingredients, different orders of addition, and different combinations. Remember, the interactions that are observed in our formulations are complex and not necessarily well understood.

CONCLUSIONS

1. Silicone Quaternium 20 is an outstanding additive to a variety of shampoo systems. When added to baby shampoo at a level of between 0.5 and 0.75% by weight the shampoo exhibits outstanding conditioning effects without sacrificing the sting free, and eye irritation claims. In short, the product is transformed into a family shampoo.
2. Silicone Quaternium 20 is an outstand product for heavy full hair, especially Asian, African American and Latino hair. It provides softness, combability and shine to the hair.
3. Silicone Quaternium 20 is non-irritating the eyes, unlike many fatty quats.
4. Silicone Quaternium can be used in body wash applications where it provides a very pleasant aesthetic to the skin.
5. Finally, Silicone Quaternium 20 can be used to make coacervate delivery systems.

REFERENCES AND NOTES

1. O'Lenick, Tony , H&PC Today - Household and Personal Care Today, vol. 11(4) July/August 2016 p,10-12
2. <https://fouling-on-solar-panels.wikispaces.com/Solutions+Surfactants>
3. O'Lenick, Tony HPC Today - Household and Personal Care Today, vol. 11(3) May/June 2016 p 37-40
4. O'Lenick, Tony Cosmetics and Toiletries , Vol. 120 No. 11 November 2005 p. 63-64.
5. The term "coacervate" refers to spherical aggregates of colloidal droplets held together by hydrophobic forces. Coacervate droplets can measure from 1 to 100 micrometres across, while their soluble precursors, are typically on the order of less than 200 nm (6).
6. <https://en.wikipedia.org/wiki/Coacervate>
7. Lochhead, Robert, Huisings Lisa and Waller Tara. Cosmetics and Toiletries Vol. 121, No. 3/March 2006.

About the author

TONY O'LENICK
Siltech L.L.C., Lawrenceville, USA

Tony O'Lenick is President of Siltech LLC. Tony has published six books, numerous articles and has over 300 patents. He received the 1996 Samuel Rosen Award, the 1997 Innovative Use of Fatty Acids Award and the 1996 Partnership to The Personal Care. Tony was President of the U.S. SCC in 2015 and is currently Education Chair of IFSCC.



Care
Creations™

ALL ABOUT TOMORROW

Joining forces for better sustainability

Achieving greater sustainability is complex – all stakeholders in the value chain can contribute in different ways. Whatever approach you take, BASF's Care Creations™ can support you. For example, with ingredients that are sustainably sourced, conserve resources or help avoid negative environmental or social impact.



Ingredients from RSPO certified sustainable palm kernel oil – another Care Creations™ solution inspired by life.

carecreations.basf.com

 **BASF**

We create chemistry