

Sulfate-Free Personal Cleaners

By Shoaib Arif

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Sulfate-Free Personal Cleansers

More marketers are trying to develop mild cleaners that are free of sulfates. This article explains how to do it.

By Shoaib Arif
Pilot Chemical Co.
Cincinnati, OH



THERE ARE many different formulas to cleanse hair and skin, but there are only a few price points. The three categories that classify sulfate-free formulas for personal cleansing products such as hair shampoo, body wash, liquid hand soap and facial cleanser are:

- Economy formulas based on alpha olefin sulfonates;
- Medium grade formulas based on

sulfosuccinate, betaine and/or amine oxide and

- Premium formulas based on higher priced specialty surfactants.

Economy Formula

Economy sulfate-free formulations can use sodium C₁₄₋₁₆ alpha olefin sulfonates as a primary surfactant. It is a low cost, high foaming anionic surfactant. These formulations can also incorporate alkanolamides and betaines as a secondary surfactant to provide mildness, foam stability and viscosity-building characteristics.

A simple and economic starting formula for a plain shampoo can be as follows.

Formula 1: Shampoo

Ingredients	% Wt
Water	q.s. to 100
Sodium alpha olefin sulfonate	30.0
Cocamide DEA	4.0
Sodium chloride	4.0
Preservative, perfume and dye	q.s.
Citric acid	to pH 5.5
Viscosity: 3200 cp.	

Cocamidopropyl betaine can improve the mildness and also the viscosity of the product. A desirable viscosity in the range of 7000 cp to 28,000 cp can be achieved by adding various amounts of betaine to this shampoo formula, while reducing the corresponding amount of water to keep the formula as 100%. An addition of 3% betaine to the formula will increase the viscosity to about 7000 cp., 5% betaine will take the viscosity to 14,000 and 10% will raise it to about 28,000 cp.

Formula 1 uses sodium chloride to increase viscosity. Ammonium chloride tends to build higher viscosities in most AOS based formulas than sodium chloride. The pH of the product must be lower than 7.0 in order to minimize the chances of ammonia release. Whereas 4% sodium chloride used in the shampoo formula with 10% additional betaine will give a viscosity of 28,000 cp., 4% ammonium chloride added in place of 4% sodium chloride will boost the viscosity to about 40,000 cp.

Let us also compare the viscosity building performance of the three commonly used alkanolamides, namely

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cocamide DEA, oleamide DEA and cocamide MEA. In the shampoo formula with 10% betaine, the viscosity is 28,000. If we replace the cocamide DEA with cocamide MEA the viscosity will jump to about 52,000 whereas oleamide DEA will take the viscosity all the way up to 68,000 cp.

Medium Grade Formulas

Sulfosuccinates, betaines and amine oxides are somewhat lower cost materials among the specialty surfactants used in sulfate-free personal cleansing formulas. These are also comparatively mild surfactants with good foaming and viscosity-building properties. Their

ers are available to build the viscosity of a personal cleanser formula based on sulfosuccinate, betaine and/or amine oxide. To compare the viscosity-building performance of various thickeners we have put together the following sulfate-free formula.

Formula 2: Shampoo Without Viscosity Builders

Ingredients	% Wt
Disodium laureth sulfosuccinate	30.0
Cocamidopropyl betaine	10.0
Lauramine oxide	10.0
Sodium chloride	4.0
Preservative, perfume and dye	q.s.
Water	to 100%

To improve the minimal viscosity of formula 2, the following thickening chemistries were evaluated. The performance evaluation of these viscosity builders utilized a 4% (as is) addition rate to formula 2. Table 1 illustrates the viscosity building results of these thickeners.

A viscosity of 5000-12,000 cp. is achievable using the thickening systems shown above. The combination of HMPC and PEG-150DS gives the highest viscosity, is amide and DEA free and may be the most economical thickening system except for oleamide DEA. The high degree of ethoxylation in these thickening systems may also cut down the irritation of the formula and increase mildness. The thickeners listed above, in particular the last four, will also help provide the body, creamy and soft lather and pleasant after feel.

Additional thickeners were also utilized to build viscosity of formula 2. The viscosity responses are in Table 2.

Be sure to choose the right surfactants and the appropriate thickener system which complement each other.

Premium Grade Formulas

Premium grade sulfate-free personal cleansers utilize specialty surfactants, most of which are naturally derived, biodegradable and mild. The surfactants used in premium grade are comparatively higher cost materials than the ones in economy or premium grade formulas. Table 3 depicts a wide variety of formulas and viscosities. Another set of formulas based on mild, biodegradable surfactants with rich, creamy lather and soft after feel are listed in Table 4, showing the viscosity building properties of various thickeners.

The final two formulas (Table 5) use ultra mild surfactants as additives to provide mild and eco-friendly products that are sulfate- and amide-free.

In conclusion, the main objective in formulating sulfate-free personal and pet cleansers is to choose the right surfactants and the appropriate thickener system which complement each other and provide an optimum cost/performance effective formulation. ●

Be sure to use comparatively higher active surfactant loads when formulating with non-sulfated surfactants.

foaming capabilities do not match that of the high foaming alkyl sulfates or alkyl ether sulfates like sodium/ammonium lauryl and lauryl ether sulfates. However, that is why one must use comparatively higher total active surfactant load when formulating with the previously mentioned non-sulfated surfactants. A wide variety of thicken-

About the Author



Shoaib Arif is the applications and technical service manager, home and personal care products, at Pilot Chemical Co., Cincinnati, OH. Previously, he was technology manager at Degussa Goldschmidt, Hopewell, VA. He has also worked in surfactant applications for home and personal care products at Noveon, Witco and Olin Chemicals. He has more

than 30 years of experience in the home and personal care applications. For most of his career, Mr. Arif has been involved in the development of new and innovative formulations and applications for raw materials, particularly surfactants. He has authored many articles for technical magazines and journals and holds several patents.

Table 1: Viscosity Building Attributes of Thickeners

Viscosity builder	% used	Viscosity cp.
Oleamide DEA	4.0	5,500
PEG-150 polyglyceryl-tristearate (and) PEG-6 capric/caprylic glycerides	24.0	8,000
PEG-150 pentaerithrityl tetrastearate (and) PEG-6 capric/caprylic glycerides	4.0	11,400
Hydroxypropyl methylcellulose	1.0	12,200
PEG-150 distearate	0.5	

Table 2: Viscosity Building Attributes of Thickeners

Viscosity builder	% used	Viscosity cp.
Laureth-3	4.0	5,000
Acrylates copolymer	6.7	18,000
Acrylates/steareth-20 Methacrylate copolymer	6.7	34,000
PEG-120 ethyl glucose dioleate	2.0 w/ 2% salt	22,000
PEG-150 distearate	2.0 w/ 2% salt	28,000

Table 3: Premium Grade Shampoo Formulas

Formula	A	B	C
Ingredients	% Wt.		
Water	————— to 100% —————		
Disodium laureth sulfosuccinate	30.0	30.0	30.0
Cocamidopropyl betaine	10.0	10.0	10.0
Sodium cocoamphoacetate	10.0	—	—
Sodium cocoyl sarcosinate	—	10.0	—
Coco glucoside	—	—	10.0
Oleamide DEA	4.0	—	—
Sodium chloride	4.0	—	—
PEG-150 pentaerithrityl tetrastearate (and) capric/caprylic glycerides acrylates/steareth-20 methacrylate	—	4.0	—
Copolymer, preservative, dye, perfume	—	—	6.7
Preservative, perfume & dye	q.s.	q.s.	q.s.
Viscosity cp.	5,000	15,000	35,000

Table 4: Shampoos with Rich, Creamy Lather

Formula	D	E	F
Ingredients	% Wt.		
Water	————— to 100% —————		
Disodium laureth sulfosuccinate	30.0	30.0	30.0
Cocamidopropyl betaine	10.0	10.0	10.0
PEG-80 sorbitan laurate	4.0	—	—
Sodium cocoyl sarcosinate	—	3.5	—
Sodium methyl cocoyl taurate	—	—	10.0
Oleamide DEA	—	4.0	4.0
Sodium chloride	4.0	4.0	4.0
PEG-150 distearate	2.0	—	—
Preservative, perfume & dye	q.s.	q.s.	q.s.
Viscosity cp.	22,000	20,000	8,000

Table 5: Mild, Eco-Friendly Shampoo Formulas

Formula	G	H
Ingredients	% Wt.	
Water	————— to 100% —————	
Disodium laureth sulfosuccinate	30.0	30.0
Cocamidopropyl betaine	10.0	10.0
Potassium cocoyl glycinate	10.0	—
Sodium alkylpolyglucose tartrate	—	10.0
Steareth-20 methacrylate	6.7	6.7
Preservative, perfume & dye	q.s.	q.s.
Viscosity cp.	16,000	37,000

Sulfate Free Shampoo

INGREDIENTS:	% WT.
Water	to 100%
Calinate® LE	30.0
Calinate® C-35	10.0
Caloxamine® LO	10.0
Calamide® O	4.0
Sodium chloride	3.0
Preservatives, perfume & dye	Q.S
Citric Acid	to pH 6.5

PROCEDURE:

Add all ingredients in the order listed with constant mixing. Mix well after each ingredients has been added and then at the End after all ingredients have been added until the batch is clear, Smooth, homogenous and free of lumps and particles.

SPECIFICATIONS:

Viscosity: 3,000 cps

Sulfate and Amide Free Body Wash

INGREDIENTS:	% WT.
Water	to 100%
Calinate® LE	30.0
Caltaine® C-35	10.0
Caloxamine® LO	10.0
Genopal DAT (Clariant)	4.0
Sodium chloride	3.0
Preservatives, perfume & dye	Q.S
Citric Acid / Sodium hydroxide 10% aqueous	to pH 6.5

PROCEDURE:

Add all ingredients in the order listed with constant mixing. Mix well after each ingredients has been added and then at the End after all ingredients have been added until the batch is clear, Smooth, homogenous and free of lumps and particles.

SPECIFICATIONS:

Viscosity: 6,000 cps

Sulfate Free Mild Shampoo

INGREDIENTS:	% WT.
Water	to 100%
Calinate® LE	30.0
Caltaine® C-35	10.0
Mackam HP-32 (McIntyre)	10.0
Calamide® O	4.0
Sodium chloride	3.0
Preservatives, perfume & dye	Q.S
Citric Acid /Sodium hydroxide 10% aqueous	to pH 6.5

PROCEDURE:

Add all ingredients in the order listed with constant mixing. Mix well after each ingredients has been added and then at the End after all ingredients have been added until the batch is clear, Smooth, homogenous and free of lumps and particles.

SPECIFICATIONS:

Viscosity: 5,000 cps

Sulfate and Amide Free Baby Wash


INGREDIENTS:	% WT.
Water	to 100%
Calinate® LE	30.0
Aculyn 22	6.7
Caltaine® C-35	10.0
Amilite CGK-12 (Ajinomoto)	10.0
Preservatives, perfume & dye	Q.S
Citric Acid /Sodium hydroxide 10% aqueous	to pH 6.5

PROCEDURE:

Add all ingredients in the order listed with constant mixing. Mix well after each ingredients has been added and then at the End after all ingredients have been added until the batch is clear, Smooth, homogenous and free of lumps and particles.

SPECIFICATIONS:

Viscosity: 15,000 cps



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