

Sulfate free personal cleaners based on alpha olefin sulfonates

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Alpha olefin sulfonates provide a cost / performance alternative to formulators who want to develop sulfate free formulas for personal cleansers like liquid hand soap, hair shampoo, body wash, or pet shampoos. Alpha olefin sulfonates such as Pilot Chemical's Calsoft AOS-40, are high foaming anionic surfactants and can replace sodium and ammonium lauryl / laureth sulfates in many personal cleaning formulas. The trick to this substitution is to learn how to build the viscosity of formulas based on AOS. In this paper we will take a look at various sulfate free formulas that are high foaming and high viscosity and are suitable as starting formulas for personal cleansing products such as liquid hand soaps, shampoos and body washes as well as pet shampoos. Formula #1 listed below, illustrates a simple liquid hand soap formula.

Following abbreviations are used for the product type in subsequent formulas listed throughout this paper.

HS	Liquid hand soap
SH	Hair shampoo
BW	Body wash
PS	Pet shampoo

Note: Pilot products used in the formulations throughout this paper are:

Calsoft [®] AOS	Sodium C ₁₄₋₁₆ alpha olefin sulfonate
Calamide [®] C	Cocamide DEA
Calamide [®] MC	Cocamide MEA
Calamide [®] F	Oleamide DEA
Caltaine [®] C-35	Cocamidopropyl betaine

Note: All viscosities are measured using Brookfield DV-1 + viscometer. The spindle and speed were selected to give the % torque reading 50 – 80

AOS-Cocamide DEA-Sodium Chloride

HS

Formula # 1

<u>Ingredient</u>	<u>% w/w</u>
Water	Q.S to 100%
Calsoft® AOS-40	30.0
Calamide® C	4.0
Sodium Chloride	4.0
Citric Acid	to pH 5.5
Preservatives, perfume & dye	Q.S

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and at the end, after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Appearance:	Clear viscous liquid
pH	5.5
Viscosity	3150 cp.

In this formula Ammonium chloride gives higher viscosity as compared to sodium chloride. Formula # 1 when repeated with ammonium chloride instead of sodium chloride gave a viscosity of 5700 cp.

Cocamidopropyl betaine has several desired properties for use in personal cleansing products. It is mild, enhances the foam quantity as well as the stability and also helps build the viscosity of the system. Following formulas will illustrate these benefits of cocamidopropyl betaine like Caltaine C-35 from Pilot Chemicals.

AOS-Cocamide DEA-Cocamidopropyl betaine-Sodium Chloride

<u>Ingredient</u>	<u>Formula #</u>	<u>HS</u> 2	<u>SH</u> 3	<u>BW</u> 4
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Calamide® C		4.0	4.0	4.0
Caltaine® C-35		3.0	5.0	10.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity		6000 cp.	9200	19,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Still higher foam and higher viscosity formulas suitable starting point for shampoos and body washes can be developed by increasing the amount of AOS from 25.0 % to 30.0%. Some examples are listed below.

<u>Ingredient</u>	<u>Formula #</u>	<u>HS</u> <u>5</u>	<u>SH</u> <u>6</u>	<u>BW</u> <u>7</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0
Calamide® C		4.0	4.0	4.0
Caltaine® C-35		3.0	5.0	10.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		8,000	14,000	28,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Some other high viscosity formulas using the same ingredients as in formulas 2-4 are as follows.

<u>Ingredient</u>	<u>Formula #</u>	<u>BW</u> <u>8</u>	<u>SH</u> <u>9</u>	<u>BW</u> <u>10</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	30.0	30.0
Calamide® C		3.0	2.0	3.0
Caltaine® C-35		10.0	10	10.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		25,000	13,000	26,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Using ammonium chloride as the salt thickener instead of sodium chloride gave some interesting results as listed below.

AOS-Cocamide DEA-Cocamidopropyl betaine-Ammonium Chloride

<u>Ingredient</u>	<u>Formula #</u>	<u>PS</u> <u>11</u>	<u>PS</u> <u>12</u>	<u>PS</u> <u>13</u>
		(Compare these to formulas 5, 6 & 7)		
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Calamide® C		4.0	4.0	4.0
Caltaine® C-35		3.0	5.0	10.0
Ammonium chloride		4.0	4.0	4.0

Citric acid	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye	Q.S	Q.S	Q.S
Viscosity cp.	7500	9300	5900

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Use of ammonium chloride in place of sodium chloride gives lower viscosities in comparable formulas. This is because compared to sodium chloride based formulas ammonium chloride based formulas will need less amide / salt combination to get maximum viscosity. 4% ammonium chloride and 4% amide will take the system beyond the peak, to the other side of the viscosity / salt curve. The optimized formulas for viscosity using ammonium chloride/cocamide DEA are as follows.

<u>Ingredient</u>	<u>Formula #</u>	<i>BW</i>	<i>SH</i>	<i>SH</i>
		14	15	16
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Calamide® C		2.0	3.0	3.0
Caltaine® C-35		10.0	10.0	5.0
Ammonium chloride		4.0	3.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		31,000	23,000	12,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Increasing the amount of AOS to 30% from 25% and repeating formulas 11, 12 & 13 gives the following results.

<u>Ingredient</u>	<u>Formula #</u>	<i>SH</i>	<i>SH</i>	<i>SH</i>
		17	18	19
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0
Calamide® C		4.0	4.0	4.0
Caltaine® C-35		3.0	5.0	10.0
Ammonium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		11,400	13,500	14,520

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Ammonium chloride reaches the peak viscosity at a lower concentration compared to sodium chloride when used in same formulas, based on AOS. Another factor is the amount of amide

present in the system. Higher amounts of amide will require less ammonium chloride for the peak viscosity. Any further ammonium chloride will take the system to the other side of the viscosity curve and thus actually decrease the viscosity. Formulas listed below represent higher viscosities, achievable by adjusting the amount of amide and / or ammonium chloride.

<u>Ingredient</u>	<u>Formula #</u>	BW 20	BW 21	BW 22
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	30.0	30.0
Calamide® C		2.0	2.0	3.0
Caltaine® C-35		10.0	10.0	10.0
Ammonium chloride		4.0	4.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		31,000	39,000	28,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

All the above listed formulas were made with cocamide DEA. Now we will look into formulating similar formulas using cocamide MEA. These formulas are not only sulfate free but also DEA free. There are pros and cons of using an MEA amide in AOS based formulas. Generally speaking, less cocamide MEA is required to build the same viscosity of an AOS or AOS/betaine based formula as compared to cocamide DEA. On the other hand cocamide MEA is a solid material and is supplied as flakes etc. Therefore heat is required to make a batch when using cocamide MEA. Some examples are as follows.

Sulfate and DEA free - formula # 23 through 50

AOS-Cocamide MEA-Sodium Chloride

<u>Ingredient</u>	<u>Formula #</u>	SH 23	HS 24	PS 25	SH 26
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	30.0	30.0
Calamide® MC		3.0	4.0	3.0	4.0
Sodium chloride		4.0	4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		13,700	3100	8,800	14,500

Procedure: Add water and AOS-40. Mix and heat to 70° C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30°C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

With cocamide MEA, less ammonium chloride is needed compared to sodium chloride to build similar viscosity in an AOS based formula. Examples are listed below

AOS-Cocamide MEA-Ammonium Chloride

<u>Ingredient</u>	<u>Formula #</u>	<u>SH</u> <u>27</u>	<u>SH</u> <u>28</u>	<u>SH</u> <u>29</u>	<u>SH</u> <u>30</u>
		Compare these to formula 23, 24, 25 & 26)			
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	30.0	30.0
Calamide® MC		3.0	4.0	3.0	4.0
Ammonium chloride		3.0	2.0	3.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		11,500	13,000	13,500	9,400

Procedure: Add water and AOS-40. Mix and heat to 70° C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30°C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

Adding cocamidopropyl betaine to the AOS/Cocamide MEA based formulas improves the viscosity further. Betaines like Caltaine C-35 provide soft creamy lather and mildness to the formula. Some examples are listed below.

AOS-Cocamide MEA-Cocamidopropyl betaine-Sodium Chloride

<u>Ingredient</u>	<u>Formula #</u>	<u>HS</u> <u>31</u>	<u>PS</u> <u>32</u>	<u>BW</u> <u>33</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® MC		2.0	2.0	2.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		3200	11,500	52,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70° C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30°C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

<u>Ingredient</u>	<u>Formula #</u>	<u>BW</u> <u>34</u>	<u>BW</u> <u>35</u>	<u>BW</u> <u>36</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Caltaine® C-35		10.0	5.0	10.0
Calamide® MC		3.0	4.0	4.0
Sodium chloride		3.0	2.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		45,000	19,500	48,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70° C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch

cools down to 30⁰C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

Increasing the amount of AOS to 30% from 25% will increase the foam; it did increase the viscosity in some cases in others it did not. Examples are listed below.

<u>Ingredient</u>	<u>Formula #</u>	<u>HS</u> <u>37</u>	<u>PS</u> <u>38</u>	<u>BW</u> <u>39</u>
(Compare to formula 31, 32 & 33)				
Water		to 100%	to 100%	to 100%
Calsoft [®] AOS-40		30.0	30.0	30.0
Caltaine[®] C-35		3.0	5.0	10.0
Calamide [®] MC		2.0	2.0	2.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		4,000	8,600	50,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70⁰ C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30⁰C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

<u>Ingredient</u>	<u>Formula #</u>	<u>BW</u> <u>40</u>	<u>BW</u> <u>41</u>	<u>BW</u> <u>42</u>
Water		to 100%	to 100%	to 100%
Calsoft [®] AOS-40		30.0	30.0	30.0
Caltaine [®] C-35		10.0	5.0	10.0
Calamide [®] MC		3.0	4.0	4.0
Sodium chloride		3.0	2.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		45,000	19,500	51,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70⁰ C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30⁰C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

Once again using ammonium chloride instead of sodium chloride gives higher viscosities in general, particularly with low amounts of betaine. In some 30% AOS formulas sodium chloride did better than ammonium chloride for viscosity building. Examples are listed below.

AOS-Cocamide MEA-Cocamidopropyl betaine-Ammonium Chloride

<u>Ingredient</u>	<u>Formula #</u>	<u>SH</u> <u>43</u>	<u>BW</u> <u>44</u>	<u>SH</u> <u>45</u>	<u>BW</u> <u>46</u>
(Compare to formula 37, 38 & 39)					
Water		to 100%	to 100%	to 100%	to 100%

Calsoft® AOS-40	25.0	25.0	25.0	25.0
Caltaine® C-35	3.0	5.0	10.0	10.0
Calamide® MC	2.0	2.0	2.0	3.0
Ammonium chloride	4.0	4.0	4.0	2.0
Citric acid	to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye	Q.S	Q.S	Q.S	Q.S
Viscosity cp.	22,000	35,500	27,000	69,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70⁰ C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30⁰C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

Formulas made with 30% Calsoft AOS-40 and thickened with ammonium chloride are listed below.

<u>Ingredient</u>	<u>Formula #</u>	BW 47	BW 48	BW 49	BW 50
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0	30.0
Caltaine® C-35		10.0	5.0	10.0	10.0
Calamide® MC		3.0	4.0	4.0	2.0
Ammonium chloride		3.0	2.0	2.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		30,000	29,000	33,000	44,000

Procedure: Add water and AOS-40 and Caltaine C-35. Mix and heat to 70⁰ C. Add Calamide MC and salt. Start cooling and add the rest of the ingredients after the batch cools down to 30⁰C with constant mixing. Mix well after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps and /or particles.

We have used cocamide DEA and Cocamide MEA as foam booster, foam stabilizer and viscosity builder in the above listed formulas. Now we will look into developing similar formulas using Pilot's Calamide F, a modified oleic diethanolamide. Oleic being a C-18 chain, Calamide F (modified oleic diethanolamide) tend to build higher viscosities as compared to Calamide C (Coconut diethanolamide). Some examples are as follows.

We first started 25% AOS. Adding 3 or 4% Calamide F built excellent viscosities with salt. The examples are listed in formulas 45, 46, 47 & 48.

AOS-Oleamide DEA-Sodium Chloride/Ammonium Chloride

<u>Ingredient</u>	<u>Formula #</u>	PS 51	PS 52	PS 53	PS 54
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	30.0	30.0
Calamide® F		3.0	4.0	4.0	4.0
Sodium chloride		4.0	2.0	3.0	4.0

Citric acid	to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye	Q.S	Q.S	Q.S	Q.S
Viscosity cp.	9400	10,000	13,300	16,500

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

The final viscosity of the formula depends on the amounts of anionic surfactant, amide and the salt. If the amount of AOS is increased to 30% in above listed formulas the viscosity can go up or down depending on the final ratios of the three ingredients mentioned above. Examples are listed in formulas 55 & 56, 57 & 58

<u>Ingredient</u>	<u>Formula #</u>	HS 55	SH 56	SH 57	SH 58
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0	30.0
Calamide® F		4.0	4.0	3.0	4.0
Sodium chloride		3.0	4.0	----	----
Ammonium chloride		---	---	4.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		8,300	22,800	20,000	22,300

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

AOS-Oleamide DEA-Cocamidopropyl betaine- Sodium Chloride

Adding cocamidopropyl betaine (Caltaine C-35) again improves the lather quality and quantity, mildness and builds higher viscosity. Examples are listed below.

<u>Ingredient</u>	<u>Formula #</u>	HS 63	PS 64	BW 65	BW 66
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0	25.0
Caltaine® C-35		3.0	5.0	10.0	10.0
Calamide® F		2.0	2.0	2.0	3.0
Sodium chloride		4.0	4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		2,400	7,800	51,000	65,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Some other formulas made with Calamide F that show high viscosities are as follows

<u>Ingredient</u>	<u>Formula #</u>	BW 67	BW 68	BW 69	BW 70
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0	25.0
Caltaine® C-35		3.0	10.0	3.0	10.0
Calamide® F		3.0	3.0	4.0	4.0
Sodium chloride		4.0	3.0	3.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		25,000	72,000	51,000	141,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

We have seen that increasing the amount of AOS from 25% to 30% as a general rule increases the viscosity if every other ingredient in the formulas based on cocamide DEA, was kept constant (see formulas 2,3&4 in comparison to formulas 5,6 & 7). With Calamide F and cocamidopropyl betaine the situation is different. Here an increase in the amount of AOS from 25% to 30% generally decreases the viscosity. Although the increased amount of AOS will improve the lather and the viscosity is not that low either, so some of these formulas can still give good starting point for formulating sulfate free shampoos and body washes (Formulas 71, 72 & 73).

<u>Ingredient</u>	<u>Formula #</u>	HS 71	PS 72	BW 73
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® F		2.0	2.0	2.0
Sodium chloride		4.0	4.0	4.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		1,600	6,300	34,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

AOS-Oleamide DEA-Cocamidopropyl betaine- Ammonium Chloride

Next, we made formulas with ammonium chloride instead of sodium chloride. These formulas are based on AOS, Calamide F and cocamidopropyl betaine just like formulas 63 through 73). Ammonium chloride in general as we have seen with cocamide DEA and cocamide MEA formulas, build higher viscosity than sodium chloride. Examples are as follows.

<u>Ingredient</u>	<u>Formula #</u>	BW 74	BW 75	BW 76	BW 77
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0	25.0

Caltaine® C-35	3.0	5.0	10.0	10.0
Calamide® F	2.0	2.0	2.0	2.0
Ammonium chloride	4.0	4.0	4.0	3.0
Citric acid	to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye	Q.S	Q.S	Q.S	Q.S
Viscosity cp.	22,000	51,000	66,000	84,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Other high viscosity formulas are listed below (Formula # 78 through 83)

<u>Ingredient</u>	<u>Formula #</u>	<i>BW</i> <u>78</u>	<i>BW</i> <u>79</u>	<i>BW</i> <u>80</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® F		3.0	3.0	3.0
Ammonium chloride		3.0	3.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		35,000	40,000	86,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

<u>Ingredient</u>	<u>Formula #</u>	<i>BW</i> <u>81</u>	<i>BW</i> <u>82</u>	<i>BW</i> <u>83</u>
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		25.0	25.0	25.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® F		4.0	4.0	4.0
Ammonium chloride		2.0	2.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		40,000	60,000	99,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Just as we have seen in sodium chloride thickened formula (71, 72 & 73) an increase in the amount of AOS from 25% to 30% generally decreases the viscosity. Although the increased amount of AOS will improve the lather and the viscosity is not that low either, so some of these formulas can still give good starting point for formulating sulfate free shampoos and body washes (Formulas 84, 85, 86 & 87).

PS PS BW SH

Ingredient	Formula #	84	85	86	87
Water		to 100%	to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0	30.0
Caltaine® C-35		3.0	5.0	10.0	10.0
Calamide® F		2.0	2.0	2.0	2.0
Ammonium chloride		4.0	4.0	4.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S	Q.S
Viscosity cp.		11,000	24,000	65,000	38,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Ingredient	Formula #	PS 88	HS 89	BW 90
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® F		3.0	3.0	3.0
Ammonium chloride		3.0	3.0	3.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		19,000	32,000	70,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Ingredient	Formula #	SH 91	SH 92	BW 93
Water		to 100%	to 100%	to 100%
Calsoft® AOS-40		30.0	30.0	30.0
Caltaine® C-35		3.0	5.0	10.0
Calamide® F		4.0	4.0	4.0
Ammonium chloride		2.0	2.0	2.0
Citric acid		to pH 5.5	to pH 5.5	to pH 5.5
Preservatives, perfume & dye		Q.S	Q.S	Q.S
Viscosity cp.		19,000	27,000	85,000

Procedure: Add all ingredients in the order listed with constant mixing. Mix well after each ingredient has been added and then at the end after all ingredients have been added until a clear, smooth, homogenous batch is obtained that is free of lumps or particles.

Conclusion:

By using AOS, a wide variety of sulfate free personal cleansers and pet cleansers are possible. AOS formulas can provide both sulfate and DEA free product, by incorporating cocamide MEA for foam stability and viscosity building characteristics. The addition of cocamidopropyl betaine will enhance the mildness, foaming, creamy lather and the viscosity.

All the formulas listed in this article are simple base formulas to be fine tuned and finished according to the specific product requirements. For example, by incorporating glycerin,

ethoxylated lanolin or other emollients into a liquid hand soap formula, the humectant effects and skin moisture characteristics will improve. Vitamins, proteins, botanicals and other additives can be used to the body wash formulas. Quaternized polymers, fatty quats or silicone derivatives can provide conditioning characteristics in shampoo formulas. Products can see some aromatherapy benefits by incorporating essential oils into a formula. Ethoxylated sorbitan esters, amphoteric, sulfosuccinates can also be added to provide mildness and lower skin and eye irritation formulas.

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