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PEER REVIEWED

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Silicone additives
for antiperspirants based upon alum

Abstract Recently there have been a number of new approaches to improving personal care formulations. Our recommended approach to formulation development is Minimally Disruptive Technology (MDT). Small additions of silicone compounds to formulation (less than 5% by weight) can result in major alterations of aesthetics. This article will address additives that can be placed into formulations of this type to improve aesthetics.

ANTIPERSPIRANT / DEODORANT

One of the first topics that needs to be addressed is the concept of an alum based antiperspirant. The definition of terms that are used in the market of products used in the control of perspiration and the odor that it can cause is the first item that needs to be addressed. A very good discussion is provided reference (1).
The terms "antiperspirant" and "deodorant" are often used interchangeably but they do in fact refer to different products. Antiperspirants control sweat and body odor in two ways: firstly by preventing sweat reaching the skin surface and secondly by eliminating the bacteria that causes body odor via antimicrobial ingredients. Deodorants differ from antiperspirants as they only contain antimicrobial agents to prevent body odor; they do not control the flow of sweat. Both antiperspirants and deodorants often contain fragrances to help mask the smell of body odor.
When an antiperspirant is applied to the skin surface, its active ingredients – usually aluminum salts – dissolve in the sweat or moisture on the skin surface of the armpit. The dissolved substance forms a gel, which creates a small temporary "plug" near the top of the sweat gland, significantly reducing the amount of sweat that is secreted to the skin surface. Bathing and washing will remove the antiperspirant gel. Re-application of antiperspirants can be beneficial to help reduce sweating and keep fresh throughout the day (Figure 1). Antiperspirants reduce underarm sweating but they do not impact on the natural ability of the body to control its temperature (thermoregulation).
There are differences in the way the products are regulated in the United States and in Europe. In the United States antiperspirants are classified as drugs. They need to contain a monograph level of an active approved for use in antiperspirants. For this reason a product for use in the United States that contains alum and no active is not an antiperspirant, they are generally marketed as deodorants. Deodorant generally either have a fragrance that covers the odor encountered in perspiring, or contain an antimicrobial that controls the microbes that are responsible for the odor.

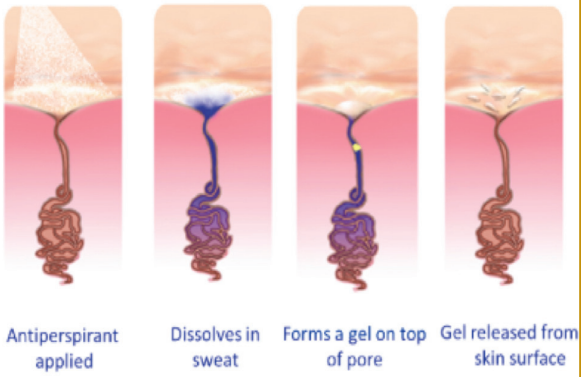

Figure 1. Mechanism of action of antiperspirants (1).

ALUM

Alum is the hydrated potassium aluminum sulfate (potassium alum) with the formula $KAl(SO_4)_2 \cdot 12H_2O$. Styptic pencils containing potassium aluminum sulfate are used as astringents to prevent bleeding from small shaving cuts. Alum occurs in nature.

Active Ingredients	Regulatory Citation
• Aluminum Chloride	• 350.10(a)
• Aluminum Chlorohydrate	• 350.10(b)
• Aluminum Chlorohydrex Polyethylene Glycol	• 350.10(c)
• Aluminum Chlorohydrex propylene glycol	• 350.10(d)
• Aluminum Dichlorohydrate	• 350.10(e)
• Aluminum Dichlorohydrex Polyethylene Glycol	• 350.10(f)
• Aluminum Dichlorohydrex Propylene Glycol	• 350.10(g)
• Aluminum Sesquichlorohydrate	• 350.10(h)
• Aluminum Sesquichlorohydrate Poylethylene Glycol	• 350.10(i)
• Aluminum Sesquichlorohydrate Propylene Glycol	• 350.10(j)
• Aluminum Zirconium Octachlorohydrate	• 350.10(k)
• Aluminum Zirconium Octachlorohydrex Gly	• 350.10(l)
• Aluminum Zirconium Pentachlorohydrate	• 350.10(m)
• Aluminum Zirconium Pentachlorohydrex Gly	• 350.10(n)
• Aluminum Zirconium Tetrachlorohydrate	• 350.10(o)
• Aluminum Zirconium Tetrachlorohydrex Gly	• 350.10(p)
• Aluminum Zirconium Trichlorohydrate	• 350.10(q)
• Aluminum Zirconium Trichlorohydrex Gly	• 350.10(r)

Table 1. Active Ingredients United States FDA (2)

Figure 2. Alum, hydrated potassium aluminum sulfate $(SO_4)_2 \cdot 12H_2O$ (3).

Products that contain alum act more like antiperspirants than deodorants in that they are not fragrances nor are they antimicrobial. They work by blocking sweat. Independently of the classification afforded products in different countries, a formulations using alum have been developed and will continue to be available.

PROCEDURE

In a vessel, combine ingredients of Part A. Heat and mix well to uniformity under impeller. Keep temperature at 75°C, slowly add Part B under agitation until clear. Keep temperature at 75 ~ 80°C. In another container, combine Part C and heat up to 80°C under mixing, add Part D, make sure solids are melted and the solution is clear. Add Part C+D into Part A+B under mixing, keep temperature at 75 ~ 80°C for 5 minutes, then Cool batch to 60°C, add Part E one by one under mixing. Pour batch into stick mould at 55~60°C, it takes at least one hour to form the stick after cooling down to room temperature.

Ingredients	Control
Part A	
D.I. Water	55.50
Glycerine	9.00
Part B	
Potassium Alum	9.00
Part C	
PPG-15 Stearyl Ether	11.00
Steareth-21	6.00
Steareth-2	5.00
Cyclopentasiloxane	3.00
Dimethicone	1.00
BHT	0.10
Phenoxyethanol	0.40
Part D	
Talc	3.00
Fragrance	q.s.
Total	**100.00**

Table 2. Formulation for Alum Containing Antiperspirant

This product is designed to be applied from a roll on bottle.

*Scale used is 1 to 10, 10 being the best, applied for compatibility and spreadbility.

Cream	Appearance	Compatibility*	Stability (at 42°C)	Spread-ability	Viscosity @25C, 12 rpm
Control	Off-white Cream	Good	Stable	9.0	13,000

*Scale used is 1 to 10, 10 being the best, applied for compatibility and spreadbility.

Table 3. Analysis of Control Product

ADDITIVES

1. **Silicone Quaternaries**

The silicone quaternary compounds that were evaluated have the structure shown in Table 4. The difference is the ratio of water-soluble quaternary compound (red) to oil soluble quaternary group (blue). This class of compounds are polymeric cationic emulsifiers that have very appealing skin aesthetics

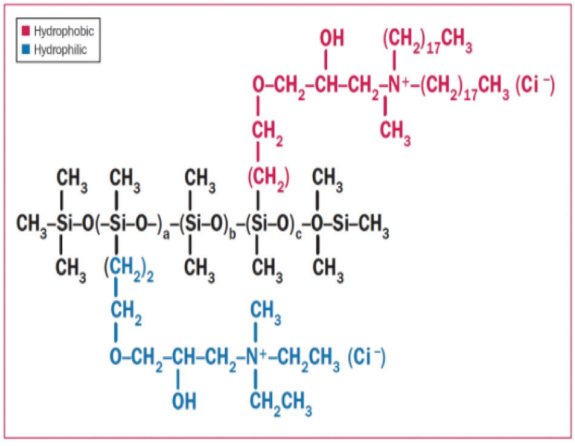

Table 4. Silicone Quaternary Compounds

The ratio of oil soluble / water soluble and silicone soluble groups is shown in Table 5.

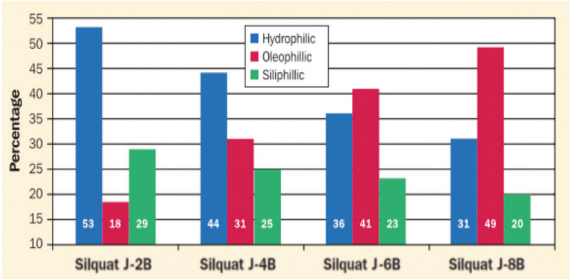

Table 5. Composition of silicone Quats

Silquat J-2B is Formula A

Silquat J-8B is used in Formula B.

2. Alkyl Elastomer
This polymer is Cetyldimethicone / dimethicone crosspolymer. Silube CR-1 is used in Formula C.

3. MQ Resins
This polymer is trimethylsiloxysilicate. Silmer Q-25 is used in Formula D.

4. Silicone Emulsifiers
The silicone emulsifier evaluated here was SilubeJ208-2I. It is a PEG/PPG 8/8 dimethicone. Silube J208-2I is used in Formula E.

5. Silicone Wetting Agent
The silicone wetting evaluated was PEG8 dimethicone. Silsurf A-008 is used in Formula F.

FORMULATIONS

Ingredients	Control	A	B	C	D	E	F
Part A							
D.I. Water	55.50	55.50	55.50	55.50	55.50	55.50	55.50
Glycerine	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Silsurf A008	**0**	**0**	**0**	**0**	**0**	**0**	**1.00**
Part B							
Potassium Alum	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Part C							
PPG-15 Stearyl Ether	11.00	**8.00**	**8.00**	11.00	11.00	**8.00**	11.00
Steareth-21	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Steareth-2	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Cyclopenta-siloxane	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dimethicone	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BHT	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Phenoxyethanol	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Silquat J2-2B	**0**	**3.00**	**0**	**0**	**0**	**0**	**0**
Silquat J2-8B	**0**	**0**	**3.00**	**0**	**0**	**0**	**0**
Silube CR-1	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**
Silmer Q25	**0**	**0**	**0**	**0**	**1.00**	**0**	**0**
Silube J208-2I	**0**	**0**	**0**	**0**	**0**	**3.00**	**0**
Silsurf A008	**0**	**0**	**0**	**0**	**0**	**0**	**1.00**
Part D							
Talc	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Fragrance	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.
Total	**100.00**	**100.00**	**100.00**	**101.00**	**101.00**	**100.00**	**101.00**

ANALYSIS

Cream	Appearance	Compatibility*	Stability (at 42°C)	Spread-ability	Viscosity @25C, 12 rpm
Control	Off-white Cream	Good	Stable	9.0	13,000
Formula A w/Silquat J2-2B	Off-white Cream	Good	Stable	9.3	10,500**
Formula B w/Silquat J2-8B	Off-white Cream	Good	Stable	9.3	10,500
Formula C w/Silube CR-1	Off-white Cream	Good	Stable	9.3	13,000
Formula D w/Silmer Q25	Off-white Cream	Good	Stable	9.3	13,500
Formula E w/Silube J208-2I	Off-white Cream	Good	Stable	9.3	9,000
Formula F w/Silsurf A008	Off-white Cream	Good	Stable	9.3	12,500

CONCLUSIONS

Each of the additives had an impact on the aesthetics of the product.

- **Formula B** -Silquat J2- Formula C 2B/8B both provide improved stability of the emulsion, and also provides the skin conditioning and powdery feel. Silquat J2-2B/8B and Silube J208-2I can partially replace PPG-15 Stearyl Ether to reduce the viscosity therefore increase the spreadbility of the stick.
- **Formula C** - Silube CR-1 reduces the surface tension of the oil phase and improves the spreadbility of the cream resulting in s thinner more elegant feel.
- **Formula D** - Silmer Q25 used in this formula softens the cream softness, and provides a dry feel.
- **Formula E** - Silube J208-2I improves emulsion stability texture of the cream, in addition, it can improve the lubricity of the cream.
- **Formula F** - Silsurf A008 can decrease the surface tension of water significantly, therefore improve the skin feel and aesthetics.

REFERENCES AND NOTES

1. http://www.antiperspirantsinfo.com/en/antiperspirants-and-deodorants/
2. http://www.fdahelp.us/fda_otc/antiperspirant.html
3. http://www.herb-magic.com/alum-chunk.html