# Sensory changes by minimally disruptive technology

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**Abstract**

Silicone polymers have the unique ability to lower the surface tension of organic oils and thereby present a different aesthetic effect in cosmetic formulations. This allows silicone polymers to be added at less than 10% concentration and often less than 5% concentration and provide a different customer experience than achieved by standard silicones. Since the formulation is 90%+ identical to the starting formulation, the time and work needed to evaluate change is minimised. Likewise, the toxicology of the formulation, the need for many raw materials and the cost change is minimised.

In 2015 we have started using a concept we refer to as minimally disruptive formulation (MDF) as an effective approach to product development.[1] This approach depends upon the ability of personal care formulators to provide products that have consumer perceptible differences that meet a market need. Since product aesthetics are a key attribute of personal care products, the ability to alter product aesthetics to provide a different consumer perception with minimal change to the formulation is a very cost effective way to develop new products.

This article will show the concept in a moisturiser that will be transformed into a cationic moisturiser. As silicone polymers continue to rise in price, using low levels of these materials added to a formulation is the best approach to get the benefit of silicone at a cost effective level.

The fact is a silicone polymer, properly chosen at a concentration of 10% or less, will provide to the formulation (1) a lowering of surface tension, (2) an alteration of feel at the interface, (3) an altering of cushion and playtime, (4) changing gloss and (5) a perception to a customer the product is different from the formulation to which the additive has not been made.[2] This makes silicone polymers quite valuable at low concentrations on formulation to make 'new products'.

The formulation of cosmetic products is both an art and a science. The science of most of the individual items in a complex formulation is generally well understood. The general concepts of formulation as far as what materials go into a specific type of product formulation are open to greater creativity. The formulator can combine many different types of ingredients into that and once combined have very different properties than any raw material alone. Generally, in other types of chemistries than the blend, the formulation chemist is required to strictly regard the reacting raw materials and observe the stoichiometric ratio. Formulations that are blends are different, despite the fact there are numerous interactions between the ingredients in a personal care blended product they all interact with each other, the solvent and the skin or hair to which they are applied. An added area that needs to be considered is the formulation must have the required aesthetics both as applied and after drying. I have seen many formulations that make outstanding emulsion stability. They may even have a great feel when applied, but they need to have a great initial feel after the solvent is gone and over the time they are on the skin or hair, finally they must wash off well and provide an acceptable aesthetic after wash.

These requirements make the formulation of a product that provides outstanding performance in all these different ways, a work of art. This in part is why we recommend Minimally Disruptive Formulation (MDF). If you can successfully jump the hurdles of providing a product that meets all requirements, it would be a real waste to start a new platform from scratch. The tested formulation is tried and true, is cost effective, is toxicity tested, and has a history. Making small, minimally disruptive changes is the optimum approach to formulation modification. Low concentrations of surface active ingredients will provide many different sensory feels and amaze the consumer that these are not vastly different.

## Surface tension modification

"If a personal care product is compared to a gourmet meal, silicone additives will be the spice, not the meat or potatoes."[2] This means that small amounts of silicone polymer added to great formulas will bring out desired properties to a consumer, that will amaze and delight.[3] This approach will allow the formulator to make SMALL but MAJOR modifications to formulators in a very efficient way by modifying well known

**Table 1: Formulation for Moisturiser**

| Phase | FC367 | FC367A | FC367B | FC367C | FC367D |
|---|---|---|---|---|---|
| A | | | | | |
| Water | 73.60 | 73.60 | 73.60 | 73.60 | 73.60 |
| C10-30 Alkyl acrylates crosspolymer | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Glycerine | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Xanthan Gum | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| $Na_2EDTA$ | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| B | | | | | |
| Cetyl Alcohol | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Coconut Oil | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Isododecane | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Ethylhexyl Palmitate | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Caprylic/capric Triglycerides | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| PEG-100 Stearate | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 |
| GMS | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Cetearyl Methicone | 1.17 | 1.17 | 1.17 | 1.17 | 1.17 |
| Shea Butter | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Ethyl Methicone | 0 | 1 | 0 | 0 | 0 |
| Polysilicone 11 | 0 | 0 | 1 | | 0 |
| PEG-8 Distearmonium Chloride PG-Dimethicone | 0 | 0 | 0 | 1 | 0 |
| Trimethylsiloxysilicate | | | | | |
| Sweet Almond Oil | 0 | 0 | 0 | 0 | 1 |
| DMDM Hydantoin | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |
| Silica | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| C | | | | | |
| Mica | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| TEA | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| Tocopherol | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Retinal Palmitate | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| VE Acetate | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| **Total** | 100 | 100 | 100 | 100 | 100 |

**Procedure:**
1. Into a cleaned and sanitized stainless container equipped with a propeller mixer, disperse hydroxyl hexyl cellulose in water until fully hydrated. Add the rest of ingredients of Part A one by one, mix until homogeneous. Then heat up to 75 ~ 80°C. 2. In a separate clean and sanitized vessel, add all the ingredients of Part B, and heat up to 75 ~ 80 °C, mix well until uniform. 3. Add Part B into Part A slowly and continue stirring. 4. Keep the temperature at 75 ~ 80°C for 5 minutes and cool down until 45°C, then add Part C one by one slowly and continue stirring and cool down to room temperature. 5. Homogenize the batch for 1 minutes at 2,000 rpm

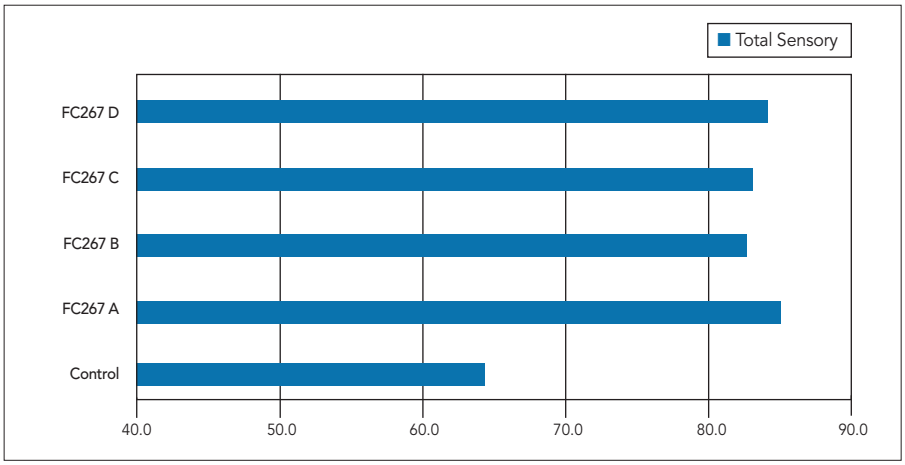


**Figure 1:** Sensory modification by silicone addition.

formulations to provide new products with different aesthetics.

## Importance of proper sensory

Steve Herman pointed out in 2008 that sensory is key to commercial cusses for cosmetic products. He stated:[4]

"It is necessary to formulate a product for pleasing sensory attributes and to confirm the results with meaningful tests. Emollient properties and rheology are obviously important formulation parameters for skin application. Some results can be obtained with instruments, but expert panels and consumer testing can be crucial to determining the market requirements for commercial success."

The initial factor that was shown to influence sensory is the emollient oil phase. This dependence of feel on marketability is the reason there are so many esters and triglycerides sold in our industry. Herman continues:

Esters form the largest family of emollient oils, and they have some predictable properties. As chain length increases, they become less irritating, have a heavier feel, and are harder to emulsify. An increase in branching raises the dry feel and lowers the viscosity. Unsaturation increases skin penetration and makes emulsification more difficult. Hydroxyl groups make them more water-soluble and easier to emulsify.[4]

Dr Wiechers' work resulted in the amazing conclusion that the predominant contributor to variance in skin feel could be attributed to the emulsifier selection. Contribution to skin feel attributed to the emulsifier was pegged at 74%, whereas emollient selection showed to control 12% of the total variance. Large portions of the emulsifier skin feel control was seen in the important appearance, pick-up, and rub-out phases.[6]

We now propose that other surface active materials like oil soluble silicone polymers also have a dramatic effect on sensorial properties. We also believe that this is accomplished by the same mechanism Dr Wiechers observed, namely partition at the interface of the silicone polymer, altering feel. The formulations shown here and the effect of additives to sensory, shows that modifications to formulations using minimally disruptive formulation techniques will result in new aesthetics in old formulations.

## Moisturiser

Objective: To modify the control formulation to make it feel softer, drier, and provide a silky clean feel to the skin to which it was applied by adding oil soluble silicone polymers.

Table 1 (opposite) provides the formulations evaluated.

**Table 2: Analysis of Moisturiser**

| Property | FC367 Control | FC367A ethyl methicone | FC367B Polysilicone 11 | FC367C PEG-8 Distearmonium Chloride PG-Dimethicone | FC367D Trisiloxy silicate |
|---|---|---|---|---|---|
| Viscosity (cps)* | 47,000 | 40,000 | 44,000 | 45,000 | 410,000 |
| pH | 6.23 | 6.19 | 6.26 | 6.20 | 6.20 |
| Appearance | White Cream | White Cream | White Cream | White Cream | WhiteCream |
| Stability RT/ 45C Stable/ | stable Stable/ | stable Stable/ | stable Stable/ | stable Stable/ | stable Stable/ |
| Feel | Good | Great | Great | Good | Great |
| Compatibility | Good | Good | Good | Good | Good |
| Conclusion | Good | Good | Good | Not Good | High Viscosity |

**Brookfield Synchro-Lectric Viscometer LVF7 Spindle #4, 6 rpm, at 25 °C*

**Table 3: Sensory Evaluation**

| Sensory Parameters* | FC367 | FC367A | FC367B | FC367C | FC367D |
|---|---|---|---|---|---|
| Before Absorption: | | | | | |
| Wetness | 7 | 8.3 | 8 | 8 | 8 |
| spreadability | 8.2 | 9 | 9 | 9 | 9 |
| no tackiness | 7 | 8.5 | 8.5 | 8.5 | 8.5 |
| absorbency | 5 | 8 | 7.5 | 7.5 | 8 |
| After Absorption: | | | | | |
| gloss | 5 | 7.5 | 7.5 | 7 | 7.5 |
| film residue | 6 | 7.5 | 7.0 | 7.5 | 7.5 |
| no greasiness | 8 | 9.2 | 9.2 | 9.2 | 9.2 |
| silkiness | 5 | 9.0 | 8.5 | 8.6 | 8.8 |
| no tackiness | 6 | 9.0 | 8.5 | 8.5 | 8.8 |
| softness | 6.5 | 9.0 | 9.0 | 9.2 | 8.8 |
| **Total** | **64.5** | **85.0** | **82.7** | **83.0** | **8.41** |

**1 ~ 10, 10 is the best*

### Analysis of moisturiser

Table 2 (see page 55) provides the analytical data of the formulations made according to the formulations shown in Table 1.

### Sensory evaluation of moisturiser

Table 3 (See page 55) shows the results of the sensory evaluation of the formulations shown in Table 1.

## Formulation evaluation summary

The various surface active silicone polymers did alter the sensory of the formulation at 1% by weight added to the oil phase. The sensory score on the basic formulation was increased from 64.5 to 84.1. This information is presented in Figure 1.

When 1% ethyl methicone was added to the base formulation it provided a silky and brightened the skin, when compared to the control.

When 1% polysilicone 11 is added to the base formulation provided a dry soft powdery skin feel.

When PEG-8 distearmonium chloride PG-dimethicone was added to the base formulation, the formulation provided increased softness and a powdery skin feel, but due to the fact it has a cationic charge, the emulsion is not compatible with the thickener anionic thickener and is not recommended

The trimethoxysiloxysilicate likewise provided a significant increase in viscosity and for this reason is not recommended for this project.

Since the objective is to provide both softer, dry, silky feel, a combination of ethyl methicone and polysilicone 11 is recommended at a level of 0.5% each, to achieve the desired effect.

## Re-formulation

On occasion the concept of minimally disruptive formulation becomes more complicated and can be extended to more than one additive that contributes more than one functional property. We decided to try to make a cationic emulsion replacing the non-ionic emulsifier. Cationic emulsions are highly desirable since they often have both a unique feel and are highly

**Table 4: Moisturiser with cationic silicone emulsifier**

| Ingredient | FC368 |
|---|---|
| Part A | |
| Water | 70.50 |
| Hydroxyl Hexyl Cellulose | 0.90 |
| Glycerine | 5.00 |
| Na2EDTA | 0.10 |
| Part B | |
| Cetyl Alcohol | 2.00 |
| Coconut Oil | 5.00 |
| Isododecane | 4.00 |
| Ethylhexyl Palmitate | 2.00 |
| Caprylic/capric Triglycerides | 1.70 |
| PEG-100 Stearate | 0 |
| GMS | 0 |
| Cetearyl Methicone | 1.17 |
| Shea Butter | 0.50 |
| PEG-8 Distearmonium Chloride PG-Dimethicone | 3.00 |
| Ethyl Methicone | 0.50 |
| Polysilicone 11 | 0.50 |
| Sweet Almond Oil | 0.60 |
| Silica | 0.50 |
| Part C | |
| Mica | 0.50 |
| Tocopherol | 0.05 |
| Retinal Palmitate | 0.05 |
| VE Acetate | 0.10 |
| **Total** | **100** |

**Procedure:**

1. Into a cleaned and sanitized stainless container equipped with a propeller mixer, disperse hydroxyl hexyl cellulose in water until fully hydrated. Add the rest of ingredients of Part A one by one, mix until homogeneous. Then heat up to 75 ~ 80 °C.
2. In a separate clean and sanitized vessel, add all the ingredients of Part B, and heat up to 75 ~ 80 °C, and blend well until uniform.
3. Add Part B into Part A slowly and continue stirring.
4. Keep the temperature at 75 ~ 80 °C for 5 minutes and cool down until 45 °C, then add Part C one by one slowly and continue stirring and cool down to room temperature.
5. Homogenize the batch for 1 minutes at 20,000 rpm

**Table 5: Analysis of moisturiser**

| Property | FC368 |
|---|---|
| Viscosity (cps)* | 10,000 |
| pH | 6.23 |
| Appearance | White Cream |
| Stability RT/45C | Stable/stable |
| Feel | Very Good |
| Compatibility | Good |
| Conclusion | Very Good |

**Brookfield Synchro-Lectric Viscometer LVF Spindle #4, 12 rpm, at 25 °C*

substantive to skin. This is due to the fact that the skin has a net negative charge because of the oxidised sulfur containing amino acids. In this case we replaced the non-ionic. The formulation is shown in Table 4.

Table 5 shows the analytical data on formulation FC368. This formulation also contained the additives found to be effective in the non-ionic formulation to make a truly multifunctional product.

### Sensory feel

Table 6 shows the sensory evaluation of all the formulations tested. The sensory evaluation for all formulations is presented in graphic form in Figure 2.

## Conclusion

Alkyl silicones can be oil soluble, and that these silicones alter the oil air or oil water interface, lowering surface tension and forming self-assembling units has been known for many years.[8,9]

The fact that not just oils, but emulsifiers can alter sensory properties of cosmetic products has likewise been known for many years.[5,6]

Alkyl silicones added to oils in which they are soluble and will form gels when cooled has also been known since 2007.[10]

It is now understood that other surface active polymers notably alkyl silicones are able to alter sensory properties of oils, just like emulsifiers (Wiechers) and oil selection (Herman).

The addition of a variety of raw materials at low concentrations will potentially have a large effect upon the aesthetics of the finished formulation. These changes are achieved by altering the physical properties of the surface. The differences are many times not immediately predictable since there are many interactions between raw materials in the non-modified formulation that will change when a surface-active additive is included in the formulation. Viscosity, rheology, surface tension, wetting and solubility all can change with the minimally disruptive approach. The formulator is encouraged to try different additives to the oil phase, water phase or both to understand the effect of an ingredient added in low concentrations to the final product. It will not only provide outstanding formulations; it will be able to be done more rapidly as the effect of additives becomes better known.

**Table 6: Sensory Feel Evaluation of FC 367 Series and FC368**

| Sensory Parameters* | FC367 | FC367A | FC367B | FC367C | FC367D | FC368 |
|---|---|---|---|---|---|---|
| Before Absorption: | | | | | | |
| wetness | 7 | 8.3 | 8 | 8 | 8 | 9 |
| spreadability | 8.5 | 9 | 9 | 9 | 9 | 9.5 |
| no tackiness | 7 | 8.5 | 8.5 | 8.5 | 8.5 | 9.2 |
| absorbency | 5 | 8 | 7.5 | 7.5 | 8 | 9.3 |
| After Absorption: | | | | | | |
| gloss | 5 | 7.5 | 7.5 | 7 | 7.5 | 8 |
| film residue | 6 | 7.5 | 7.0 | 7.5 | 7.5 | 8.5 |
| no greasiness | 8.5 | 9.2 | 9.2 | 9.2 | 9.2 | 9.5 |
| silkiness | 5 | 9.0 | 8.5 | 8.6 | 8.8 | 9.3 |
| no tackiness | 6 | 9.0 | 8.5 | 8.5 | 8.8 | 9.2 |
| softness | 6.5 | 9.0 | 9.0 | 9.2 | 8.8 | 9.5 |
| Total | 64.5 | 85.0 | 82.7 | 83.0 | 84.1 | 91 |

**1 ~ 10, 10 is the best*

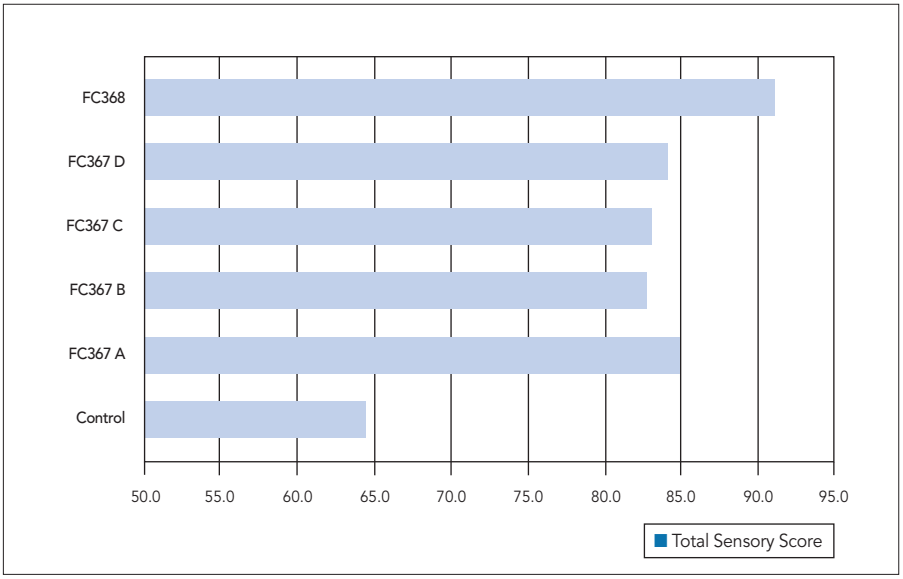


**Figure 2:** Sensory modification (all formulations).

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