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Developing minimally disruptive formulations

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. We have therefore called this approach Minimally Disruptive Formulation. This article will show the concept in a moisturising product.

One of the most apparent transformations that have occurred in the last 30 years in the personal care industry is the fact that the product development cycle has compressed tremendously. In the 1980s short time developments were 18 months. Today the market wants new products in what appears to be 18 days. This accelerated development takes place in an environment that has increased regulation and stability that needs to be addressed and has to be done with fewer people. This change has forced personal care companies to re-think how they do research and development and to redefine the function of the R&D organisation.

Recently technology has been defined as either disruptive or sustaining in an attempt to better manage it. The concept of disruptive technology was coined by Clayton M. Christensen in the book *The Innovator's Dilemma*.[1] Disruptive technologies surprise the market by generating a substantial improvement over existing technology.[2] A disruptive technology is one that displaces an established technology and shakes up the industry or a groundbreaking product that creates a completely new industry.[2] While highly desirable, it is more expensive and risky to rely upon substantial market-changing developments to keep a company growing. Sustaining technology is extremely important to a business and can have a more direct effect upon a company's successful introduction of new products. Table 1 shows some differences between disruptive and sustaining technology.[3]

We have begun using a concept we refer to as minimally disruptive formulation (MDF) as an effective approach to product development. 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.

The fact is that silicone polymers, properly chosen at a concentration of 10% or less, will provide to the formulation a lowering of surface tension, an alteration of feel, an altering of cushion and play time, a change in gloss, and a perception to a customer the product is different from the formulations to which the additive has not been made. This makes silicone polymers quite valuable at low concentrations in formulation to make 'new products'. I have often said that if a personal care product is compared to a gourmet meal, silicone additives will be the spice, not the meat or potatoes.[4] 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. This approach will allow the formulator to make small but major modifications to formulations in a very efficient way by modifying well known formulations to provide new products with different aesthetics.

Additions of a properly chosen organo-functional silicone can be made to the oil phase (alkyl silicones), water phase (PEG/PPG dimethicone) or the silicone

Table 1: Differences between disruptive and sustaining formulating.[3]

Disruptive	Sustaining
Newer markets	Current markets
Typically starts at the lower end of the customer segment	Primarily for milking the cash cows, so to speak
Transformational business model	Sustaining current business model

Table 2: Initial formulation.

Phase	Ingredients	% Weight
A	Water	67.50
	Propylene Glycol	5.00
	Allantoin	0.20
	Triethanolamine	1.00
B	Stearic Acid	10.00
	PEG-2 Stearate	2.00
	Isopropyl Myristate	3.50
	Dimethicone (50 Cst)	6.00
	Mineral Oil	3.00
	Lanolin Oil	1.00
	Methyl Paraben	0.15
	Propyl Paraben	0.15
C	Fragrance	0.50

Procedure: In a clean and sanitised container, combine phase A and heat up to 90°C, mix well. In a separate clean and sanitised container equipped with a propeller mixer, combine phase B and heat up to 90°C, mix well. Add phase B into phase A at 90°C slowly. Agitation around 650 rpm (incorporation time for a batch of 200 g is 6 minutes). Then gently increase mixing rate with the batch becoming thicker. Cool batch down to 65°C, add fragrance under mixing, then continue to cool down to room temperature under mixing.

phase (dimethicone), there are many possibilities. The reason for the addition needs to be evaluated. Adding a silicone to the oil phase can result in improved wetting and spreadbility, which in turn alters cushion and play time. The surface tension reduction can be reduced from 32 dynes/cm to 25 dynes/cm. This dramatic change will alter cushion, play time and ultimate aesthetics. Addition of a silicone that is soluble in the aqueous phase will reduce the surface tension of the water phase and also alter aesthetics. Finally, addition of a silicone soluble material other than dimethicone can provide water resistance, barrier properties and alter the skin-feel providing a dry powdery feel. All in all there are many possibilities.

Case study

Starting product is a greaseless, stainless water-based moisturiser with a light fresh fragrance. It is an everyday multipurpose moisturising lotion that contains rich moisturising ingredients that perform to soften dry, chapped skin.

FC 343A Control

FC 343B

Skin-feel evaluation

The differences in aesthetics were evaluated by panel and the experimental products were compared to the control (FC343A). The formulations, when applied to the skin, produced different consumer attributes.

- Formulation FC343B provided a powdery feel when rubbed into the skin. The formulation cream gave the best skin-feel and was described soft, silky, slippery and powdery, while the control was somewhat greasy.
- Formulation FC343B was much easier to apply, reducing both cushion and play time. The consumer commented the cream was easier to apply and appeared less hydrophobic than the control (FC343A).
- FC343C was silky and provided a ‘bright appearance’ to the skin when dry.
- FC343D, the cream has a very soft feel on the skin with a shortened play time.

Light microscopy

The formulations were evaluated using Barska AY11374-Digital Microscope which was used to take pictures of o/w emulsion drops. Pictures were processed (1X) by using Adobe Photoshop 7.0. Full scale of the image is 100 μm.

- In Formulation FC 343B, the addition of trimethyltrisiloxysilicate resulted in a reduction of the average size of the emulsion particles and narrowed the distribution.
- In Formulation FC 343C, the addition of polydecane and cetyldimethicone / dimethicone crosspolymer resulted in the decrease of the average size of the emulsion particles and a narrowing of the distribution is narrower compared with the control, but not as pronounced in FC343B.
- In Formulation FC 343D, the addition of cetyl/hexacosyl dimethicone resulted in little change from the control.
- In Formulation 343E, the addition of ethyl methicone resulted in a reduction of the average size of the emulsion particles and narrowed the distribution.

Table 3: Formulation variations.

Reference		FC343A	FC343B	FC343C	FC343D	FC343E
Phase	Ingredients	% Weight				
A	Water	67.50	67.50	67.50	67.50	67.50
	Propylene Glycol	5.00	5.00	5.00	5.00	5.00
	Allantoin	0.20	0.20	0.20	0.20	0.20
	Triethanolamine	1.00	1.00	1.00	1.00	1.00
B	Stearic Acid	10.00	10.00	10.00	10.00	10.00
	PEG-2 Stearate	2.00	2.00	2.00	2.00	2.00
	Isopropyl Myristate	3.50	3.50	3.50	3.50	3.50
	Dimethicone (50 Cst)	6.00	3.00	3.00	3.00	3.00
	Trimethylsiloxysilicate	-	3.00	–	–	–
	Polydecane and cetyldimethicone/ dimethicone crosspolymer	–	–	3.00	–	–
	Cetyl/Hexacosyl Dimethicone	–	–	–	3.00	–
	Ethyl Methicone	–	–	–	–	3.00
C	Fragrance	0.50	0.50	0.50	0.50	0.50
	Mineral Oil	3.00	3.00	3.00	3.00	3.00
	Lanolin Oil	1.00	1.00	1.00	1.00	1.00
	Methyl Paraben	0.15	0.15	0.15	0.15	0.15
	Propyl Paraben	0.15	0.15	0.15	0.15	0.15

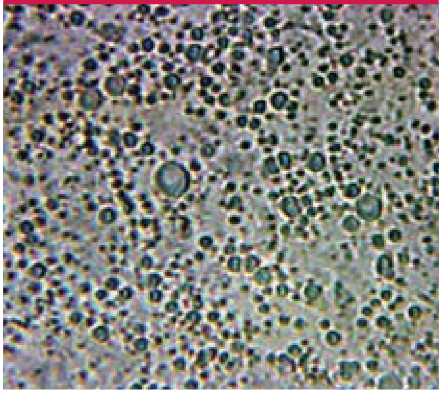
Table 4: Formulation properties.

Reference	Additive	Viscosity*	pH	Appearance	Stability 45˚C/6 weeks	Feel (1-10)
FC343A	None	3033	7.3	White cream	Pass	9.0
FC343B	1	2005	7.3	White cream	Pass	9.5
FC343C	2	2543	7.3	White cream	Pass	9.3
FC343D	3	3601	7.3	White cream	Pass	9.2
FC343E	4	2091	7.3	White cream	Pass	9.3

*Rotational viscosity tested using Brookfield DV-II Rheometer V3.3 RV, Spindle CP51, 6 rpm

FC 343C

FC 343D



FC 343E

Conclusion

The different additives were successful in altering the feel and appearance of the formulation, providing a difference the consumer could readily note. The change was one of 3% of the total formulation, meaning the formulation was 97% identical.

The changes were made rapidly, changing only one ingredient at a time. The processing technology was not changed nor was the quality control specifications. This approach offers a number of formulations differing in consumer aesthetics with minimal disruption to the formulation.

We recommend this approach to our customers looking for new product aesthetics with minimal formulation disruption. PC

References

1 Christensen CM. *The Innovator's Dilemma*. Harvard Business School Press, 1995 [ISBN 0-87584-585-1].
2 http://whatis.techtarget.com/definition/disruptive-technology
3 http://techbizcurry.wordpress.com/2014/05/30/disruptive-vs-sustaining-innovations
4 http://tinyurl.com/kc4k5af

Table 5: Additive references.

Trade name	Formula	INCI Name
Silmer Q-25	FC343B	Trimethylsiloxysilicate
Silube CR-1	FC343C	Polydecane and cetyldimethicone/dimethicone crosspolymer
Silwax J221M	FC343D	Cetyl/hexacosyl dimethicone
Silwax D02	FC343E	Ethyl Methicone