



PEG-8 Dimethicone a High HLB Silicone Surfactant

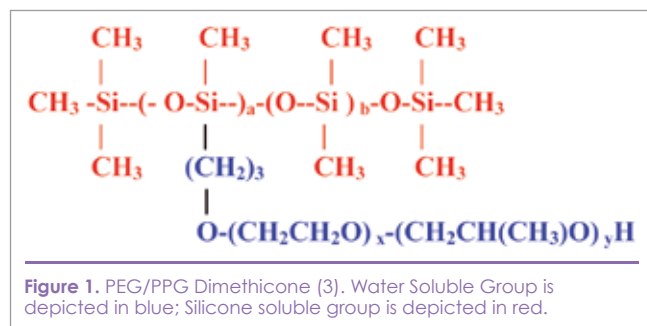
KEYWORDS: Emulsifier, PEG8 dimethicone, oil in water, regular emulsion, microscopic evaluation, HLB, 3DHLB, skincare, sun care.

ABSTRACT

Sometimes the best possibility for developing new technology is to look more closely at products that we currently have knowledge of and ask how can we modify these existing products to make new products that have better performance. This type of evaluation often requires we look at a class of compounds and compounds of that are homologues. A homologue is a compound belonging to a series of compounds differing from each other only in the number of repeating units contained therein (1). So, if you look at Figure 1, homologues would differ only in the number of a, b, x and y units.

The silicone polymers we examined in this paper are referred to as PEG 8 Dimethicone, specifically one with a high HLB. The formulator must realize that although PEG/PPG dimethicone is a better description than dimethicone copolyols, one cannot ascertain the basic functional properties from the INCI name. This is because there are variations in structure that profoundly affect solubility, surface tension, emulsification, foam and many others. As should become clear, we know a lot about a few compounds in the wide range of possible product, but must learn more about different structural variables within this class.

The polymers examined in this paper have the structure shown in Figure 1 (2).



Much has been written on this class of compounds over the year, however there remains much to discover. What has been agreed upon up until now is;

The success of silicone emulsifiers is related to their special character, which differs in many respects from that of low molecular weight organics and polymeric emulsifiers (4):

- High flexibility of the silicone backbone with even very long chains being able to achieve optimal orientation at interfaces in a relatively short time.
- Behavior of silicones has hydrophobic as well as oleophobic character.
- Ease of synthesis and great versatility for tailoring their properties.

Silicone polymers comprising a non-ionic hydrophilic group and a hydrophobic poly(dimethyl siloxane) chain have been studied for their emulsifying properties in detail (3). The molecular architecture of these polymers can be tailored to suit specific applications. In most cases, the hydrophilic moiety of choice has been poly (oxyethylene) (EO groups) because of its good water solubility and ease of synthesis with a wide range of molecular weights. The hydrophilicity/hydrophobicity of these polymers can be controlled by varying the chain length of EO groups, partial or complete substitution of EO with poly(oxypropylene) (PO groups), or by varying the degree of modification in the case of grafted polymers.

The lack of predictability of the function of these molecules have led to the development of a concept called "3 dimensional HLB". This approach was first developed by Anthony O'Lenick (5). This empirical system is an extension of the HLB concept, and it is so named because it includes contributions from the three components related to portions of the molecule that are soluble in either silicone, oil or water. This 3D HLB system is like the conventional HLB scale except that it is represented on triangular coordinates instead of a linear (2-component) HLB scale. One of the boundary lines of this triangle system represents the conventional HLB system. The three parameters of 3D HLB system can be calculated as follows:

$$X1/420 M_H = M Y1/420 M_L = M Z1/420 X Y$$

where,

X represents coordinate of water-loving portion

Y represents coordinate of oil-loving portion (6)

Our evaluation also included compounds in which the terminal hydroxyl is modified to have a methyl cap. This alteration changes the polarity of the molecule, decreasing it. In this study, we wanted to determine the differences between methyl capped $-(CH_2CH_2O)_8CH_3$ and hydroxyl terminated product $-(CH_2CH_2O)_8H$. We have designated the materials as PEG 8 dimethicone and PEG 8 dimethicone Me for the hydroxyl capped and methyl capped respectively.

O/W SKIN CARE LOTION FORMULATION

Because of the high HLB (i.e. high percentage of EO) Peg 8 Dimethicone and PEG 8 dimethicone MC were evaluated as a primary emulsifier to make O/W emulsion. O/W emulsion systems are used in facial, hand, body, hair, baby products on the market. The unique sensory effects of this type of system are readily perceived by customers and make these products well suited for daily wear to protect and care for the skin and hair.

Ingredients	FC342.1 w/PEG 8 Dimethicone	FC342.2 w/PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	54.85	54.85
Pemulen TR2	0.05	0.05
TEA	0.10	0.10
Part B		
Peg 8 Dimethicone	5.00	0
Peg 8 Dimethicone-MC	0	5.00
Jajoba Oil	40	40
Total	100.00	100.00

Table 1. O/W Skin Care Lotion Formula.

Procedure: Disperse Pemulen TR2 in water until uniform and heat up to 75~80 °C. Combine Part B and mix well, heat up to 75~80 °C. Add Part B into Part A while agitating quickly to obtain a homogeneous mixture; continue to mix for 5 minutes. Cool batch down to room temperature. High shear at 2000 rpm in 5 minutes.

Analysis Skin Care Lotion

Both formulations were described as very soft skin feel, lacking

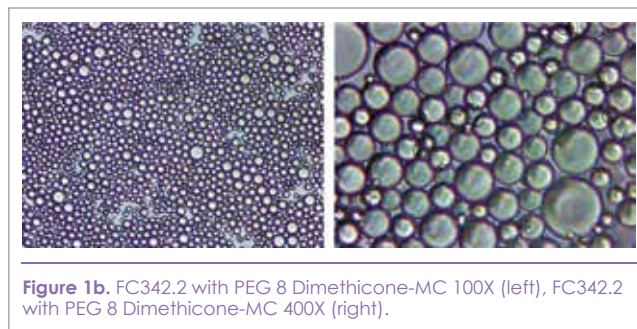
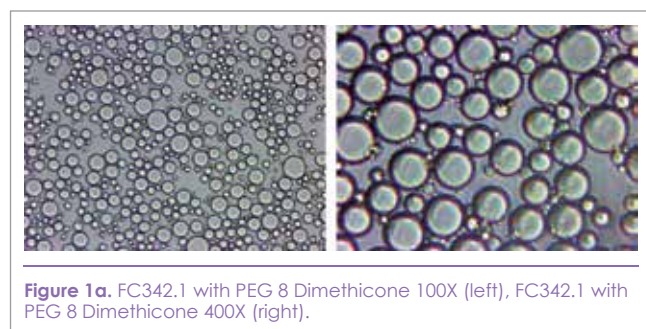
Analysis	FC342.1 w/PEG 8 Dimethicone	FC342.2 w/PEG 8 Dimethicone-MC
Viscosity (cps)*	600	900
pH	6.95	7.00
Appearance	White Cream	White Cream
Stability @RT/45°C	Good/Good	Good/Good
Feel (1-10, 10 the best)	9.3	9.3
Compatibility	Good	Good

Table 2.
*Viscosity was tested by using Brookfield, LVT, #4 spindle, and 60 rpm at 25°C. The followings are the same.

the normal stickiness seen in such emulsions. Due to both samples have very low viscosity (< 1000 rpm), which suggests their use in sun screen spray formulations.

Microscopic Study of O/W Skin Care Lotions

Method: Barska AY11374-Digital Microscope was used to take pictures of emulsion particles of the products. The images were taken at 100X and 400 X magnifications at multiple spots on each microscopy glass slide. Pictures were processed by using Adobe Photoshop 7.0. Full scale of the image is 400 um and 100 um for 100X magnification and 400X magnification respectively.



The particle size (average around 10 μm) and size distribution are very close for both emulsions, with a slight advantage going to the methyl capped product.

O/W FACE CARE CREAM FORMULATION

The next series of products used PEG 8 Dimethicone and PEG 8 Dimethicone-MC as primary emulsifiers in a simple face care cream.

Ingredients	FC354A PEG 8 Dimethicone	FC354B PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	65.10	65.10
Pemulen TR2	0.30	0.30
DL-Panthenol	0.10	0.10
Glycerin	5.00	5.00
Tea	0.30	0.30
Part B		
Peg 8 Dimethicone	5.00	0
Peg 8 Dimethicone-MC	0	5.00
Ethyl methicone	2.00	2.00
MQ Resin	2.00	2.00
Cetyl Alcohol	1.50	1.50
Behenyl Alcohol	1.00	1.00
Argan Oil	2.00	2.00
Moringa Oil	2.00	2.00
Coco Butter	2.00	2.00
Shea Butter	2.00	2.00
Mongo Butter	1.55	1.55
Squalane	1.00	1.00
Phenonip	0.60	0.60
Part C		
Aloe Vera Extract	5.00	5.00
Wheat Protein	0.50	0.50
Preservative, Fragrance	q.s.	q.s.
Total	100.00	100.00

Table 3. O/W Face Care Cream Formulation.

Procedure: Disperse Pemulen TR2 in water until uniform and add the rest ingredients of Part A and heat up to 80 °C. Combine Part B and mix well, heat up to 80 °C. Add Part B into Part A while agitating quickly to obtain a homogeneous mixture; continue to mix for 5 minutes. Cool batch down to room temperature. High shear batch with homogenizer at 20,000 rpm in 1 minute.

Analysis of O/W Face Care Cream

Analysis	FC354A PEG 8 Dimethicone	FC354B PEG 8 Dimethicone-MC
Viscosity (cps)	18,000	13,500
pH	6.50	6.50
Appearance	White Cream	White Cream
Stability @RT/45°C	Good/Not good	Good /good
Feel (1-10, 10 the best)	9.3	9.3
Compatibility	Good	Good

Table 4. Very soft moisture skin feel for both creams.

Microscopic Study of O/W Face Care Cream

Method is the same as the above.

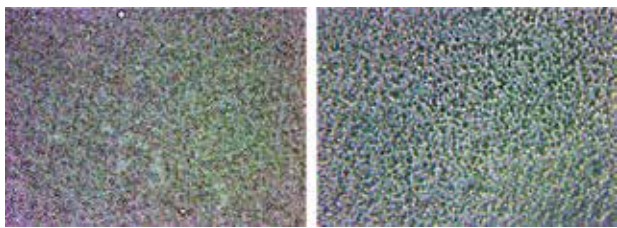


Figure 2a. FC354A with PEG 8 Dimethicone 100X (left), FC354A with PEG 8 Dimethicone 400X (right).

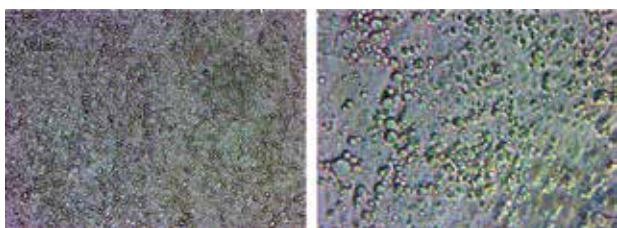


Figure 2b. FC354B with PEG 8 Dimethicone-MC 100X (left), FC354B with PEG 8 Dimethicone-MC 400X (right).

The average particle size of FC354A with PEG 8 Dimethicone (less than 2 µm) is much smaller than that of FC354B with Peg 8 Dimethicone-MC, and the particle distribution of the emulsion with Peg 8 Dimethicone is very narrow.

O/W SUN CARE CREAM FORMULATION

Formula of O/W Sun Care Cream

Procedure: Disperse Pemulen TR-2 in water until uniform and

Ingredients	FS421A PEG 8 Dimethicone	FS421B PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	46.50	46.50
Pemulen TR-2	0.25	0.25
Na ₂ EDTA	0.100	0.100
Part B		
Peg 8 Dimethicone	5.00	0
Peg 8 Dimethicone-MC	0	5.00
Neo Heliopan OS	5.00	5.00
Neo Heliopan 303	10.00	10.00
Neo Heliopan HMS	15.00	15.00
Neo Heliopan 357	3.00	3.00
Neo Heliopan BB	6.00	6.00
Neo Heliopan AV	7.50	7.50
Part C		
Sodium Hydroxide 10% aq	0.60	0.60
SymOcide	1.00	1.00
Total	100.00	100.00

Table 5. Formula of O/W Sun Care Cream.

add Na₂EDTA and heat up to 75~80 °C. Combine Part B and mix well, heat up to 75~80 °C. Add Part B into Part A while agitating quickly to obtain a homogeneous mixture; continue to mix for 5 minutes. Cool batch down to room temperature. This is high SPF 50+ sun care product.

Analysis of Sun Care Cream

Analysis	FS421A w/PEG 8 Dimethicone	FS421B w/PEG 8 Dimethicone-MC
Viscosity (cps)	10,000	10,500
pH	7.10	7.08
Appearance	White Cream	White Cream
Stability @RT/45°C	Good/good	Good/good
Feel (1-10, 10 the best)	9.3	9.3
Compatibility	Good	Good

Table 6. Analysis of Sun Care Cream

Both formulations have a very soft moisture skin feel for both sun care creams.

Microscopic Study of Sun Care Cream

Method is the same as the above.

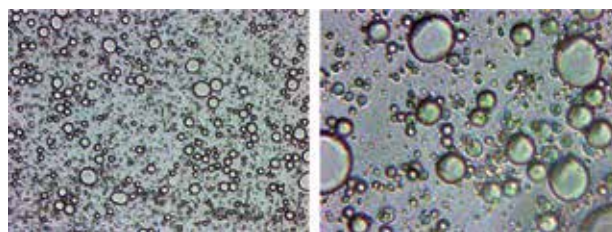


Figure 3a. FS421A with PEG 8 Dimethicone 100X (left), FS421A with PEG 8 Dimethicone 400X (right).

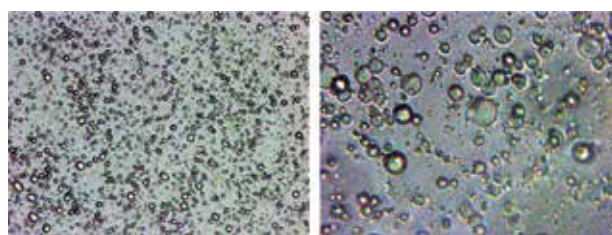


Figure 3b. FS421B with PEG 8 Dimethicone-MC 100X (left), FS421B with PEG 8 Dimethicone-MC 400X (right).

The average sizes for both sunscreens are close but the size distribution of FS421B is better than that of FS421A, this means Peg 8 Dimethicone-MC is little bit better than Peg 8 Dimethicone in terms of skin feel and stability of the sun screen.

O/W BB CREAM (MAKE-UP/SUNSCREEN)

Ingredients	FM110A PEG 8 Dimethicone	FM110B with PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	54.50	54.50
Ultrez 30	0.20	0.20
Propane Diol	5.00	5.00
Unipure White LC981 SGP	8.04	8.04
Unipure Yellow LC182 SGP	1.71	1.71
Unipure Red LC381 SGP	0.60	0.60
Unipure Black LC989 SGP	0.15	0.15
Part B		
Peg 8 Dimethicone	5.00	0
Peg 8 Dimethicone-MC	0	5.00
Part C		
Pelemol 899	3.00	3.00
Isohexadecane	2.00	2.00
D5	5.00	5.00
Isopropyl Myristate	2.30	2.30
Escalol 557	7.50	7.50
Cetyl Alcohol	1.80	1.80
Part C		
TEA	0.10	0.10
Part D		
Nylone-12	2.50	2.50
Total	100.00	100.00

Table 7. Formula of O/W BB Cream (Make-up/Sunscreen) Formulation.

Procedure: Disperse Carbomer in water until fully hydrated and add propane diol and pigments. Blend well then add emulsifier, mix well, then heat up to 75~80 °C. Combine Part B and mix well, heat up to 75~80 °C. Add Part B into Part A while agitating quickly to obtain a homogeneous mixture; continue

to mix for 5 minutes. Cool batch down to room temperature. Add Part C into batch under mixing.

Analysis of O/W BB Cream (Make-up/Sunscreen)

Analysis	FM110A with PEG 8 Dimethicone	FM110B with PEG 8 Dimethicone-MC
Viscosity (cps)	12,000	13,000
pH	7.05	7.10
Appearance	Ivory Makeup	Ivory Makeup
Stability @RT/45°C	Good/good	Good/good
Feel (1-10, 10 the best)	9.30	9.30
Compatibility	Good	Good

Table 8. Very soft moisture skin feel for both BB creams.

CONDITIONING

Hair Conditioner

Formulation of Hair Conditioner with Peg 8 Dimethicone/PEG 8 Dimethicone-MC

Ingredients	FH155A w/PEG 8 Dimethicone	FH155B w/PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	80.90	80.90
Hydroxyl Ethyl Cellulose	0.80	0.80
Mackernium 261	0.30	0.30
Glycerin	3.00	3.00
Na ₂ EDTA	0.10	0.10
Part B		
Peg 8 Dimethicone	3.00	0
Peg 8 Dimethicone-MC	0	3.00
Ethyl methicone	0.50	0.50
Moringa Oil	3.00	3.00
Meadowfoam Seed Oil	2.00	2.00
Raspberry Seed Oil	1.80	1.80
Cetyl Alcohol	1.00	1.00
Stearyl Alcohol	1.20	1.20
EGDS	1.00	1.00
Part C		
Aloe Vera Extract	5.00	5.00
Wheat Protein	0.40	0.40
Citric Acid (aq)	q.s.	q.s.
Preservative, Fragrance	q.s.	q.s.
Total	100.00	100.00

Table 9. Formulation of Hair Conditioner with Peg 8 Dimethicone/PEG 8 Dimethicone-MC.

Procedure: Into a cleaned and sanitized stainless steel tank equipped with a propeller mixer, disperse cellulose and Mackernium 261 one by one in D.I. water, and mix well until fully hydrated. Then heat up to 80 °C. In a separate clean and sanitized vessel, add all the ingredients of Part B, and heat up to 75 ~ 80 °C under mixing. Add Part B into Part A slowly and continue stirring. Keep the temperature at around 80 °C for 5 minutes and cool down to room temperature. Add the rest of ingredients of Part C one by one and mix until uniform. Adjust pH to 4.5 ~ 5.5 by using q.s. citric acid.

Analysis of Hair Conditioner with PEG 8 Dimethicone/PEG 8 Dimethicone-MC

Analysis	FB205.1 with PEG 8 Dimethicone	FB205.2 with PEG 8 Dimethicone-MC
Viscosity (cps)	8,500	9,600
pH	4.50	4.50
Appearance	White Cream	White Cream
Stability @RT/45 °C	Good/good	Good/good
Feel (1-10, 10 the best)	9.30	9.30
Compatibility	Good	Good

Table 10. Very soft lubricious moisture skin feel for both hair conditioners.

Body Wash

Formulation of Body Wash with Peg 8 Dimethicone and PEG 8 Dimethicone-MC

Ingredients	FB205.1 with PEG 8 Dimethicone	FB205.2 with PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	45.50	45.50
Guar Hydroxypropyltrimonium Chloride	0.50	0.50
Na ₂ EDTA	0.10	0.10
Sodium Laureth-2 Sulfate	16.00	16.00
Cocamidopropyl Betaine	16.00	16.00
Genapol TSM	5.00	5.00
Disodium Cocoamphodiacetate	1.00	1.00
Coco Glucoside	2.00	2.00
PEG 8 Dimethicone	1.00	0
PEG 8 Dimethicone-MC	0	1.00
Jobba Oil	0.10	0.10
Wheat Protein	0.50	0.50
Nipaguard DMDMH	0.30	0.30
Part B		
D.I. Water	11.00	11.00
Carbopol Aqua SF-1 Polymer	1.00	1.00
TEA	0.10	0.10
Part C		
Citric Acid (40% aq)	q.s.	q.s.
Sodium Chloride	1.00	1.00
Crothix Liquid	q.s.	q.s.
Fragrance	q.s.	q.s.
Total	100.00	100.00

Table 11. Formulation of Body Wash with Peg 8 Dimethicone and PEG 8 Dimethicone-MC.

Procedure: Disperse guar in water until it is thickened up. Add the rest of Part A one by one under mixing. Mix SF-1 and water in Part B, then add TEA mix until clear. Add Part B into Part A and mix slowly while minimizing air incorporation. Adjust pH by using Citric acid in the range of 4.5 to 5.5; and using NaCl and Crothix to adjust the viscosity 6,000 to 9,000 cps.

Analysis of Body Wash with Peg 8 Dimethicone and PEG 8

Analysis	FB205.1 with PEG 8 Dimethicone	FB205.2 with PEG 8 Dimethicone-MC
Viscosity (cps)	7,000	7,100
pH	6.45	6.50
Appearance	White Cream	White Cream
Stability @RT/45 °C	Good/good	Good/good
Feel (1-10, 10 the best)	9.30	9.30
Compatibility	Good	Good

Table 12. Very soft lubricious moisture skin feel for both body washes.

Dimethicone-MC

Foam Performance Evaluation of Body Washes with Peg 8 Dimethicone/PEG 8 Dimethicone-MC

Method: All products were evaluated with the same procedure. A 1000 mL cylinder with 10 mL increments was used. All samples and distilled water was prepared at 25 °C. 1.00 gram of test material was used and 100 mL distilled water was added to dissolve the test material in a 250 mL beaker. After the test material was totally dissolved, the solution transferred into the cylinder. An outlet of air pump was placed on the bottom of the cylinder to generate the bubbles. Record the foam height within 20 seconds for each test materials, each material was evaluated 3 times and their averages were documented.

The scale for Foam Height is 1000 mL is outstanding and 100 mL is very poor. The type of foam was also noted whether it is tight or loose. Bubbles were generated by electronic air pump.

Sample (Bubble for 20 sec)	Initial Reading (Average, mL)	Two Minute Reading (Average, mL)	Five Minute Reading (Average, mL)
Peg 8 Dimethicone	715	705	695
Peg 8 Dimethicone-MC	710	700	690
FH193.1 w/PEG 8 Dimethicone	720	710	695
FH193.2 w/PEG 8 Dimethicone-MC	715	700	690

Table 13. Foam Performance of Body Wash with Peg 8 Dimethicone and PEG 8 Dimethicone-MC. All foams are tight uniform.

FORMULATION OF BABY WIPE

Formulation of Baby Wipe with Peg 8 Dimethicone and PEG 8 Dimethicone-MC

Ingredients	FBW002A With PEG 8 Dimethicone	FBW002B With PEG 8 Dimethicone-MC
Part A	W/W%	W/W%
D.I. Water	98.40	98.40
Hydroxyl Ethyl Cellulose	0.20	0.20
Peg 8 Dimethicone	1.00	0
Peg 8 Dimethicone-MC	0	1.00
Fragrance	q.s.	q.s.
Total	100.00	100.00

Table 14. Formulation of Baby Wipe with Peg 8 Dimethicone and PEG 8 Dimethicone-MC.

Procedure: Disperse hydroxyl ethyl cellulose in water, heat up to 70°C until it is clear, allow the polymer to fully wet, then cool down batch to RT, add the rest of ingredients one after another mix until uniform.

Analysis of Baby Wipe

Analysis	FBW002A With PEG 8 Dimethicone	FBW002B With PEG 8 Dimethicone-MC
Viscosity (cps)	50	50
pH	7.00	6.98
Appearance	Clear liquid	Clear liquid
Stability @RT/45 °C	Good/good	Good/good
Feel (1-10, 10 the best)	9.30	9.30
Compatibility	Good	Good

Table 15. Analysis of Baby Wipe. Very soft smooth feel for both baby wipes.

Surface Tension of Peg 8 Dimethicone, PEG 8 Dimethicone-MC and Baby Wipe

Surface Tension (mN/m)	Peg 8 Dimethicone	Peg 8 Dimethicone-MC	FBW002A With PEG 8 Dimethicone	FBW002B With PEG 8 Dimethicone-MC
Mean Value	31.862	30.971	31.190	30.945
Standard Deviation	0.449	0.295	0.330	0.287

Table 16. Surface Tension of Peg 8 Dimethicone, PEG 8 Dimethicone-MC and Baby Wipes.

The baby wipe with Peg 8 Dimethicone and Peg 8 Dimethicone-MC are very close in terms of skin feel, performance and appearance. Both render baby wipe very

soft skin feel. It is interesting to note that the surface tension of the products are in the 30 dyne/cm range, meaning the formulation has the surface tension of a fatty surfactant not the surface tension of a silicone surfactant.

COMPATIBILITY WITH PERSONAL CARE INGREDIENTS

Peg 8 Dimethicone and PEG 8 Dimethicone-MC the solvent at 5% wt.

Solvent	Material (5%)	Peg 8 Dimethicone	Peg 8 Dimethicone-MC
Highly polar	Water*	Soluble	Soluble
Non-polar Hydrocarbons	Mineral oil	Insoluble	Insoluble
	Isododecane	Insoluble	Insoluble
	Isoparaffin	Insoluble	Insoluble
Esters	C8-10 Triglycerides	Insoluble	Insoluble
	Isopropyl Myristate	Insoluble	Insoluble
	Trioctyldodecyl Citrate	Soluble	Soluble
	C ₁₂₋₁₅ alkyl benzoate	Insoluble	Insoluble
Ethers	PPG-14 Butyl Ether	dispersible	Dispersible
	Dicaprylyl ether	Insoluble	Insoluble
Silicones	Cyclopentasiloxane	Insoluble	Insoluble
	Dimethicone	Insoluble	Insoluble
	Phenyl Trimethicone	Dispersible	Dispersible
	Trimethylsilyloxysilicate	Dispersible	Dispersible
Natural Oils	Olive oil	Dispersible	Dispersible
	Sunflower oil	Dispersible	Dispersible
	Castor oil	Dispersible	Dispersible
Alcohols	Octyldodecanol	Dispersible	Dispersible
	Isopropanol	Soluble	Soluble
	Ethanol	Soluble	Soluble
Glycols	Glycerin	Soluble	Soluble
	Propylene Glycol	Soluble	Soluble
	Butylene Glycol	Soluble	Soluble
	Hexylene Glycol	Soluble	Soluble

Table 17. Peg 8 Dimethicone and PEG 8 Dimethicone-MC the solvent at 5% wt.

*It was found that Peg 8 Dimethicone is highly water soluble, even at 50%, it is still crystal clear, but Peg 8 Dimethicone-MC is hazy when the concentration is 50%.

The compatibility of Peg 8 Dimethicone and PEG 8 Dimethicone-MC with most personal care ingredients are good especially for polar solvent (soluble or dispersible) except with some of ingredients such as non-polar organic and silicone solvents (insoluble). The best solvent for PEG 8 Dimethicone and PEG 8 Dimethicone-MC are water, alcohols and glycols.

SUMMARY OF THE APPLICATION IN PERSONAL CARE

Peg 8 Dimethicone and Peg 8 Dimethicone-MC

Finished product and functionality	Peg 8 Dimethicone	Peg 8 Dimethicone-MC
O/W skin care emulsion, emulsifier	v	v
O/W hair care emulsion, emulsifier	v	v
O/W BB Cream, emulsifier	v	v
O/W sunscreen, emulsifier	v	v
Shampoo, conditioning	v	v
Body wash, conditioning	v	v
Baby wipe, conditioning	v	v

Table 18. Peg 8 Dimethicone and Peg 8 Dimethicone-MC. *x: not applicable; v: applicable

CONCLUSION

PEG 8 Dimethicone and Peg 8 Dimethicone-MC have excellent properties and unique sensory profile as the followings:

1. In general, Peg 8 Dimethicone and PEG 8 Dimethicone-MC both can be used as O/W emulsifier to make Oil-in-Water personal care products like face care, body care, and hair care creams/lotions/and make-ups, the differences between Peg 8 Dimethicone and PEG 8.
2. There were small differences between the methyl capped product and the hydroxyl capped product in formulation, but a clear difference was not evident.

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ABOUT THE AUTHOR

Tony O'Lenick is President of Siltech LLC. Tony has published six books, numerous articles and has over 300 patents. He received the 1996 Samuel Rosen Award, the 1997 Innovative Use of Fatty Acids Award and the 1996 Partnership to The Personal Care. Tony was President of the U.S. SCC in 2015 and is currently Education Chair of IFSCC.



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