SILTECH

Silube®
Silicone Emulsifiers

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Silube® – Silicone Emulsifiers

Despite the fact emulsions are found in almost every category of cosmetic product, the preparation of stable, cosmetically elegant emulsions remains one of the most daunting tasks undertaken by the cosmetic chemist. The inclusion of coated pigments, sunscreen actives, fragrances, humectants and other actives tend to complicate the process even more.

To address this problem, Siltech has developed a patented new innovative kit of emulsifiers that will take some of the stress out of formulating. These molecules are composed of three parts; (1) an alkyl soluble part; (2) a water-soluble part and (3) a silicone soluble part. Choosing the right ratio of the three parts is critical in creating a stable emulsion. As the required HLB of your formulation changes with selection of oil or oils, the HLB of your emulsifier will change along with it.

Polymeric emulsifiers are not one product but a mixture of related polymers called oligomers. A major problem with polymeric products can be phase separation, most commonly observed in cold weather. This is due to the fact that when the number of each type of group in the emulsifier is low, there are molecules that lack those groups entirely. Separation will cause tremendous difficulty in production especially if you are using part drums of emulsifier, where the entire drum may not be homogeneous from top to bottom. Depending upon which phase or phases actually get into a batch, the HLB of the emulsifier can vary widely, resulting in unstable and unpredictable emulsions. In order to eliminate this problem Siltech has made a polymer that does not separate upon chilling. The mixtures of our molecules are still based on an oligomer distribution but they all have at least a one value for each of the three portions. This keeps our product stable even in cold temperatures keeping the product uniform and allowing the formulator to confidentially know what the HLB value of the emulsifier when it is used.

Formulator Friendly® Silicones

Emulsion Theory

Emulsions are systems composed of two (or more) immiscible materials (usually liquids) in which one material (the dispersed/internal phase) is suspended or dispersed throughout another material (the continuous/external phase) in separate droplets. All emulsions are inherently unstable (with the exception of spontaneously forming micro emulsions). All we can do is delay the day when the instability will arrive.

Emulsification is a process that allows for the preparation of a **metastable single phase** of **two insoluble materials**. The preparation of cosmetically acceptable emulsions is a very challenging and often frustrating undertaking. The metastable nature of the two insoluble materials is critical to understanding the nature and performance of emulsions. The metastable nature of the emulsion, and the requirement that the emulsion be cosmetically appealing, offer unique challenges to the formulator. The challenge is two fold; to delay the onset of separation and to provide a cosmetically elegant product.

There are fundamentally two types of emulsions, the more common oil in water and the water in oil (or invert emulsion). The type of emulsifier used will to a great extent determine the type of emulsion that is formed with a specific oil and water combination.

Emulsion Terms

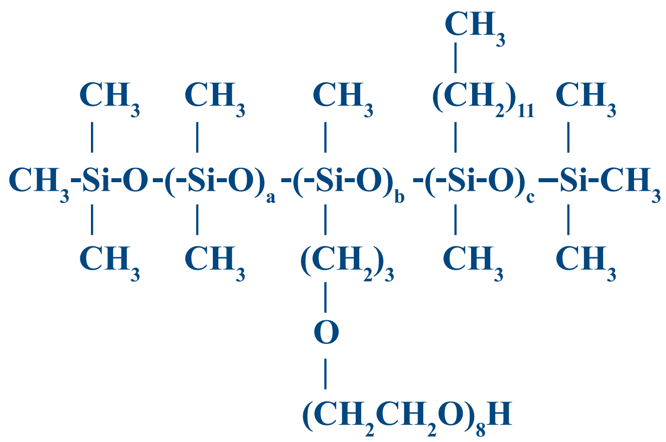
Continuous phase - The continuous phase is also called the external phase. While it is true in many emulsions that the continuous phase is the larger of the two phases as far as weight percentage is concerned it does not have to be the larger. The general rule is that if you can dilute an emulsion with water without splitting it is a water continues emulsion, or an O/W emulsion.

Discontinuous phase - The discontinuous phase is the phase that is dispersed into the continuous phase. Again, it may be the predominant percentage by weight material, but does not have to be so.

Polymeric Emulsifiers

The Silube J-208 series is made up of four patented emulsifiers* all having the INCI name Lauryl PEG-8 Dimethicone. The difference among them is the percentage alkyl, silicone and PEG. These differences make surfactants with different 3D HLB values.

The structure of the compounds is as follows:



The composition of the products are disclosed in Table 1. The series of products have been designed to have different solubility in a variety of solvents (Table 2). We have adopted the 3D HLB system in describing the molecules, since we feel that it is much more descriptive than the standard HLB. 3D HLB, a concept developed by Siltech scientists, was explained in two articles which are available upon request.

*U.S. Patent 7,279,503 others pending.

Emulsifier Composition

Siltech has developed a series of emulsifiers ranging in HLB from 3.2 to 9.6. This range of emulsifiers allows for the emulsification of a wide range of oils. The composition are as follows:

	%		3D HLB	
Product	**EO**	**Alkyl**	**x % EO/5**	**y % alkyl/5**
Silube® J208-212	48	6	9.6	1.2
Silube® J208-412	39	13	7.8	2.6
Silube® J208-612	28	22	5.6	4.4
Silube® J208-812	16	32	3.2	6.4

Emulsion Formulation

The first set of experiments are conducted using all four emulsifiers, and allow the formulator not only the ability to evaluate emulsion stability, but also cosmetic aesthetics. The formulation is;

Material	%
Water	47.25
Oil	47.25
Emulsifier	5.00
Salt	0.50

Procedure:

1. Place emulsifier or emulsifier blend into the oil phase.
2. Mix well, noting clarity.
3. Add salt to water phase.
4. Heat both phases to 50°C.
5. Add water phase to oil phase and using mixer mix for 120 seconds.
6. Note appearance.

The above process is repeated with emulsifier blends depending upon the results of the first emulsion.

Sheer Mixer – Laboratory Evaluation

Product Evaluation

Typical results are shown below. Two of the formulations are emulsions, and the others are not. Silube -208-412 results in an oil in water emulsion and Silube J208-812 produces a water in oil emulsion.

Emulsion of Silwax B-116 (Cetyl Dimethicone)

Time = 3 hours

J-208-212 J-208-412 J-208-612 J-208-812

Time = 24 hours

J-208-412 J-208-612 J-208-812

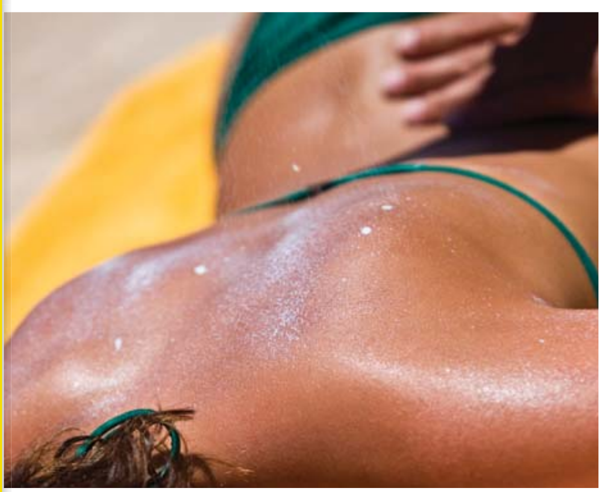
Emulsion Equipment

Generally the making of emulsions includes not only the proper selection of a discontinuous phase, the proper selection of a continuous phase and an emulsifier, it will also include a number of additives like salt and processing aides, and includes high energy processing to provide small particle size. As previously stated, the smaller the particle size the more stable the emulsion. There are a number of high energy pieces of equipment that include;

Homogenizer

Homogenization is a mechanical treatment to lower particle size of the discontinuous phase brought about by passing the emulsion under high pressure through a tiny orifice, which results in a decrease in the average diameter and an increase in number and surface area, of the oil globules. The net result, from a practical view, is a much reduced tendency for separation. Three factors contribute to this enhanced stability: a decrease in the mean diameter of the globules (a factor in Stokes Law), a decrease in the size distribution of the globules (causing the speed of rise to be similar for the majority of globules such that they don't tend to cluster during creaming), and an increase in density of the globules (bringing them closer to the continuous phase).

Auguste Gaulin's patent in 1899 consisted of a 3 piston pump in which product was forced through one or more hair like tubes under pressure. It was discovered that the size of fat globules produced were 500 to 600 times smaller than tubes. The homogenizer consists of a 3 cylinder positive piston pump (operates similar to car engine) and homogenizing valve. The pump is turned by an electric motor through connecting rods and a crankshaft.



Colloid Mill

A colloid mill does its work by hydraulic shear, bringing to bear a tremendous amount of energy on a small portion of material in the form of a thin film. This action overcomes the strong polar forces which bind together small clumps of solids or which hold together drops of liquid. A colloid mill will not break down hard crystalline particles by fracturing them across the crystal planes as an impact type mill would do. It will, however, reduce these particles down to their ultimate crystal size by breaking up the agglomerates into which they form.

In the case of emulsions, the same principle holds. As the particles of the dispersed phase of the emulsion get smaller and smaller it requires progressively more energy to overcome the surface tension holding them together. Enormous hydraulic shear is needed to do the job and a colloid mill is an ideal means of accomplishing it.

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