

**Enhanced
Performance**
Through Applied
Innovation



Personal
Care

ELEMENTIS

A global specialty chemicals company

HOW TO SELECT A BENTONE GEL

Properties and Applications





Introduction

Elementis' BENTONE GEL® additive portfolio provides multi-benefit rheology solutions suitable for a wide variety of cosmetic systems, including natural and D5-free products. Whether formulating for color cosmetics or skin care, BENTONE GEL® additives provide the cosmetic chemist with many functional and aesthetic benefits and is based on vegan and naturally derived clay.

What is a BENTONE GEL®?

Hectorite clays are hydrophilic in nature and only suitable for thickening the water phase in formulations. In oils these clays do not disperse. To facilitate the use of this network building material in the oil phase of a system, the clays are reacted with various quaternary ammonium compounds, which cover the hydrophilic surface structure of the clay with organophilic (hydrophobic) material. This new "organoclay" tricks the solvent or oil into accepting the hydrophilic clay. In the organoclay powder format, there is an attraction between the platelets, which creates layers of clay, sandwiched between layers of the quaternary compound. The long chain quaternaries lie down across the surface of the clay. A chemical activator, e.g. propylene carbonate, ethanol or triethyl citrate, attaches to the platelet surface, displacing the loose end of the long chain quaternaries lying on the surface. This loose end of the quaternary is then pushed away from the platelet surface, and mutual attraction between the platelets is lessened. The hydroxyl groups on the edges of the clay platelet are then available to form hydrogen bonds and create the BENTONE GEL® network, as shown in Figure 1.

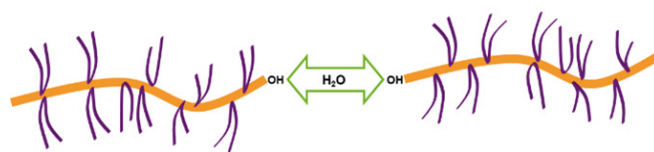





Figure 1. Hydrogen bonding in BENTONE GEL®

Creating this organoclay dispersion can be a very time consuming and difficult to reproduce step in the process, which if not done correctly, can result in batch-to-batch variation, and problems of increasing or decreasing viscosity overtime. For this reason, we offer a range of BENTONE GEL® products in various oils and solvents to accommodate all formulating needs.

Usage

There are many advantages of adding BENTONE GEL® to a formulation. At just 1% it can already start to thicken the oil phase of a water in oil emulsion, while improving emulsion stability. Suspension of actives and pigments can be achieved at 3-10%. Lower concentrations are needed in an emulsion and higher concentrations are beneficial in an anhydrous system. Thermostable viscosity control can be seen in water in oil emulsions at concentrations as low as 1-5%, whereas in an anhydrous product like a lipstick, it can be useful to add 10% BENTONE GEL® to ensure an even distribution of pigments during cool down. BENTONE GEL® additionally provides an even and balanced application onto the skin.



BENTONE GEL® Concentrations		
	Suspension	3-10%
	Thickening	1-15%
	Thermostable Viscosity Control*	1-25%

BENTONE GEL® dispersions offer unique rheological performance in both single oil systems and the oil phase of an emulsion. They create a network, that looks like a honeycomb, or is often referred to as a house of cards. This helps to stabilize and suspend actives, pigments and droplets and provide shear thinning flow for improved application, as shown in Figure 2.

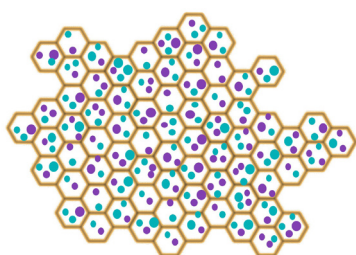


Figure 2. Ideal representation of network formed by BENTONE GEL® for stabilizing actives and particles

This BENTONE GEL® network is built up via hydrogen bonding, which are very weak bonds, so the structure will be fully formed when the product is in the container. When shear is applied the platelets align flat on the skin, giving a beautiful application. Once the shear has been removed, the structure does not bounce back straight away, like with pseudoplastic products. It needs a little time to rebuild its structure, allowing the product to move evenly over the skin, for a uniform distribution of actives. This thixotropic flow is shown in Figure 3.

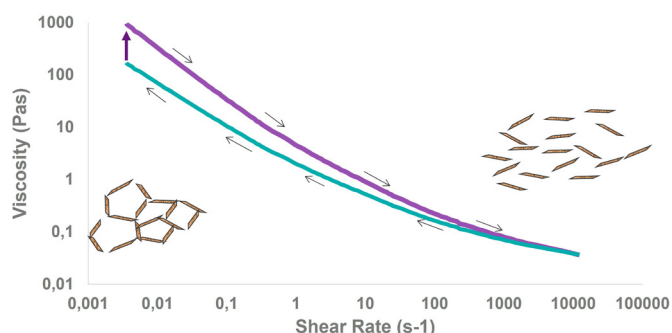


Figure 3. Thixotropic flow created by BENTONE GEL®

Selecting the right BENTONE GEL®

A good starting point for selecting the most appropriate BENTONE GEL® is to choose one which is based on a solvent that is already in the formulation. Normally a formulation will contain various oils, so there could be several BENTONE GEL® options, but generally the BENTONE GEL® can be picked that represents the highest concentration of oil in the system. This will



give the most efficient results. The solvent or oil in the BENTONE GEL® will affect the formula's oil phase almost like a pure oil regarding skin feel, shine and richness. These characteristics can be controlled by selecting a suitable BENTONE GEL®.

Focus on Product Type

The BENTONE GEL® range offers suitable products for many applications but not every BENTONE GEL® will fit perfectly for every product. For example BENTONE GEL® CAO V is great for gloss enhancing in lip formulas, but it will be much too sticky and heavy for a facial product. BENTONE GEL® TN V fits perfectly into sun care concepts but there are better alternatives for lipsticks or foundations.



Focus on Texture

Acting as oil phase thickeners, BENTONE GEL® can impact the texture of a product differently, depending on the BENTONE GEL® composition and the base formulation.

Due to the shear thinning flow behavior, BENTONE GEL® gives very pleasant application properties to formulations. Unlike other stabilizers such as waxes or consistency enhancers, BENTONE GEL® will not affect the richness of the formula or make it heavier or harder to apply.

BENTONE GEL® can be used in any kind of application, from light lotions to rich creams to solid sticks.

The efficacy of a BENTONE GEL® regarding viscosity development will always depend on the base formulation.

To give an example how different the BENTONE GEL® products behave in one system, a comparative test was carried out. Different BENTONE GEL® products were incorporated at 10% in the oil phase of a water-in-silicone foundation, Formula 1 with results in Figure 4 and a water-in-oil emulsion, Formula 2 with results in Figure 5.

Phase	Ingredient	Supplier	%w/w
A	Undecane (and) Tridecane (Cetiol Ultimate)	BASF	16.50
	BENTONE GEL®	Elementis	10.00
	Dimethicone (and) Dimethicone Crosspolymer (Dowsil 9041 Silicone Elastomer Blend)	Dow	5.00
	Cetyl PEG/PPG-10/1 Dimethicone (Abil EM 180)	Evonik	2.00
B	Titanium Dioxide (and) Dimethicone (and) PEG/PPG-18/18 Dimethicone (and) Triethoxycaprylsilane (and) Tocopheryl Acetate (FAND65USI)	Kobo	6.50
	CI 77492 (and) Cyclopentasiloxane (and) PEG/PPG 18/18 Dimethicone (and) Triethoxycaprylsilane (and) Tocopheryl Acetate (FAS50EYSI-E)	Kobo	1.00
	CI 77491 (and) Cyclopentasiloxane (and) PEG/PPG 18/18 Dimethicone (and) Triethoxycaprylsilane (and) Tocopheryl Acetate (FAS50EYSI-E)	Kobo	0.30
	CI 77499 (and) Cyclopentasiloxane (and) PEG/PPG 18/18 Dimethicone (and) Triethoxycaprylsilane (and) Tocopheryl Acetate (FAS60EBI-E)	Kobo	0.20
C	Deionized Water		55.00
	Propylene Glycol		2.00
	Phenoxyethanol (and) Ethylhexylglycerin (Euxyl PE9010)	Schuelke Mayr	1.00
	Sodium Chloride		0.50

Formula 1. Water-in-silicone foundation

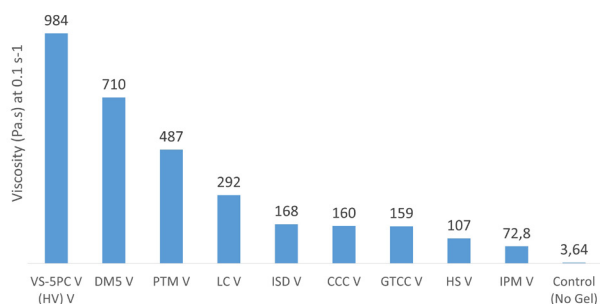


Figure 4. Comparison of different BENTONE® GEL products in Formula 1

All BENTONE GEL® products helped to stabilize the systems and improved pigment suspension in the foundation, whereas samples without BENTONE GEL® showed instability.

Formula 1 is using only silicone in the oil phase, hence BENTONE GEL® VS-5PC V HV and BENTONE GEL® DM5 V show the best viscosity in this system as expected, as they are both based on silicone. If this formulation was based on Isododecane, the best performance is expected from BENTONE GEL® ISD V.

Phase	Ingredient	Supplier	% w/w
A	BENTONE GEL®	Elementis	10.0
	Caprylic/Capric Triglyceride (Palmester 3595)	KLK Oleo	9.0
	Dimethicone (KF-96L-2cs)	Shin Etsu	9.0
	Cetyl PEG/PPG-10/1 Dimethicone (Abil EM 90)	Evonik	2.0
B	Deionized Water		66.5
	Propylene Glycol		2.0
	Phenoxyethanol (and) Ethylhexylglycerin (Euxyl PE9010)	Schuelke & Mayr	1.0
	Sodium Chloride		0.5

Formula 2. Water-in-oil Emulsion

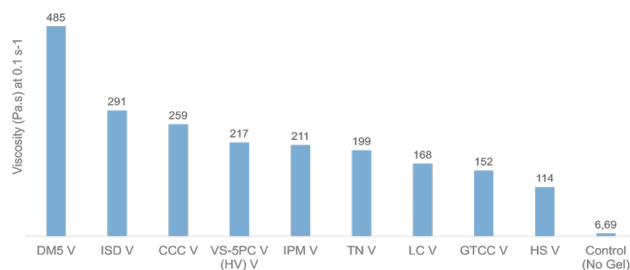


Figure 5. Comparison of different BENTONE GEL® products in Formula 2

Formula 2 and Figure 5 show a water-in-oil emulsion, with a silicone emulsifier, but also a natural oil in the main phase. This demonstrates different thickening efficiencies of the BENTONE GEL® products. So it cannot be said that one gives superior thickening over another. It is truly dependent on the formulation and the other ingredients.

Focus on Concept

The selection of the BENTONE GEL® can also depend strongly on the product philosophy. For some customers, synthetically derived base solvents like Cyclopentasiloxane (D5), Dimethicone or Mineral oils are not for debate, as they are looking for high natural index based raw materials to meet their concept. The same applies for “clean” claims.

The BENTONE GEL® range offers many products based on natural oils and solvents that have a high natural index.



Focus on Skin Feel

Although the main feel of a formulation can be manipulated by the remaining ingredients, the solvents and the shear thinning flow given by the BENTONE GEL® range have benefits for the final touch and feel of the formulation. The richness of a BENTONE GEL® depends on the base solvent and can vary strongly within the BENTONE GEL® range. See Figure 6 for a comparison example for a small range of products.



Figure 6. Comparison of feel of different BENTONE GEL® products

As mentioned, the feel can be altered by adjusting other parameters of the formula (like using mattifying powders or less greasy oils), but as the oil phase often limits the formulation freedom, it makes sense to find a BENTONE GEL® that fits these expectations.

Focus on Finish

In Color Cosmetics the finish of a product is a crucial factor. It is also interesting for skincare to achieve a matte or dewy glow. BENTONE GEL® can have a significant effect on the final performance of a product. The solvent in the BENTONE GEL® can affect the final visual appearance of a formulation significantly. BENTONE GEL® products cover the whole spectrum from matte, satin, to glossy finishes, see Figure 7.



Figure 7. Comparison of the finish achieved with different BENTONE GEL® products

In addition, BENTONE GEL® improves the suspension of pigments, resulting in an even and smooth film on skin.

Additional Benefits

Tests showed that the addition of BENTONE GEL® to a formula can increase the SPF. The underlying theory is that the clay network supports a proper distribution of particles (like titanium dioxide or zinc oxide) and actives (like sunscreen actives), resulting in a uniform film on skin. In addition, the thixotropic behavior of formulas containing BENTONE GEL® allows the formation of a thicker layer after application, giving a better protection.

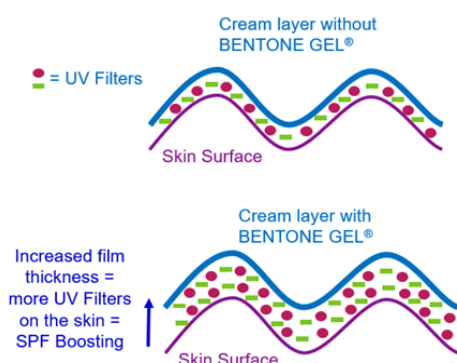


Figure 8. Film thickness with BENTONE GEL®

One important factor in sunscreens and in decorative cosmetics is also the water resistance, which can be improved by using BENTONE GEL® products. The clay has a potential to increase the film integrity and help improve the water resistance. This combined with the natural water resistance of the solvent or oil in the system boosts the water resistance of the final formulation. The contact angle is a method that can be used to predict water resistance. The BENTONE GEL®, or oil, is applied in an even layer to a glass slide and a droplet of water was placed on top. The angle of the water droplet was then measured, as shown in Figure 9, with the results of different BENTONE GEL® products shown in Figure 10.

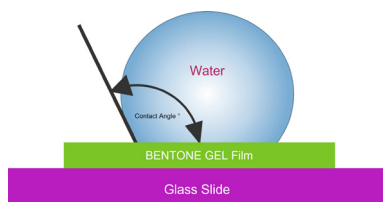


Figure 9. Illustration of the contact angle measurement

	Ø Contact Angle	
	Pure Solvent	As BENTONE GEL®
Dimethicone (BENTONE GEL® DM5 V)	47.67°	98.75°
Isododecane (BENTONE GEL® ISD V)	65.77°	95.43°
Cyclopentasiloxane (BENTONE GEL® VS-5 PC V (HV))	69.23°	91.38°
Isopropyl Myristate (BENTONE GEL® IPM V)	66.37°	84.42°
C12-15 Alkyl Benzoate (BENTONE GEL® TN V)	46.14°	80.97°
Caprylic/Capric Triglyceride (BENTONE GEL® GTCC V)	42.87°	75.05°

Figure 10. Comparison of contact angle of water on some BENTONE GEL® products

Figure 10 shows the water contact angle values for the pure solvents and the version as a BENTONE GEL®. The addition of the organoclay always increases the natural contact angle of the oil. This means that it is expected to achieve improved water resistance when using a BENTONE GEL® in comparison to the oil alone.

Conclusion

Selecting the right BENTONE GEL® depends on several factors. Most importantly is the compatibility with the system. Sensorial effects, appearance and finish are other important factors that influence the choice.

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