VEEGUM® / VAN GEL®

From the earth...

a natural ingredient for cosmetics, pharmaceuticals and household products

Contents

VEEGUM VAN GEL

VEEGUM and VAN GEL are natural smectite clays that have been water-washed to optimize purity and performance. Smectite clay* is valued for its ability to swell in water and to impart useful rheological properties to aqueous compositions. VEEGUM and VAN GEL have been the formulator's choice for more than fifty years to stabilize suspensions, perfect emulsions and optimize flow properties.

VEEGUM products are mainly offered for pharmaceutical and cosmetic applications, although they are widely used in other areas as well. VAN GEL products are offered for industrial applications. All grades of VEEGUM and VAN GEL undergo the same water-washing process and meet the same standard of clay purity. Pharmaceutical and cosmetic grades of VEEGUM are also controlled for arsenic, lead and bacteria content to ensure compliance with industry standards. Several grades of VEEGUM and VAN GEL are available, with rheological, chemical and colloidal properties tailored through careful smectite ore selection.

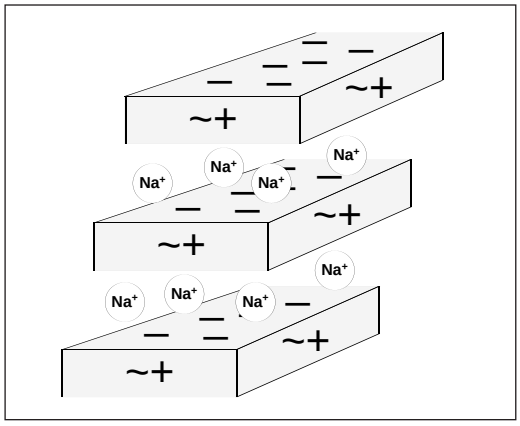
R.T. Vanderbilt Company's diversified smectite clay reserves in the U.S. southwest are the foundation of VEEGUM's and VAN GEL's reputation for uniformity and quality. This secure resource base also enables the continuing development of new grades in response to customer needs.

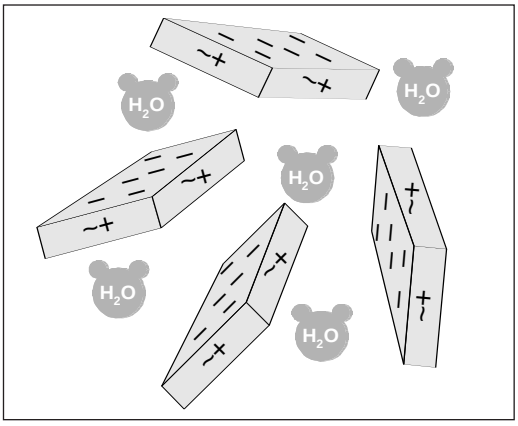
HOW THEY WORK

The value of high purity smectites like VEEGUM or VAN GEL as stabilizing and rheological agents is due to their colloidal structure in water. Each smectite particle is composed of thousands of submicroscopic platelets stacked in sandwich fashion with a layer of water between each. The faces of these platelets carry a negative charge, while edges have a slightly positive charge. The net negative charge of the platelet is mostly balanced by sodium ions, although other inorganic cations are present in minor amounts. These charge-balancing ions are associated with platelet faces and are termed "exchangeable" since they can be readily substituted by other cations.

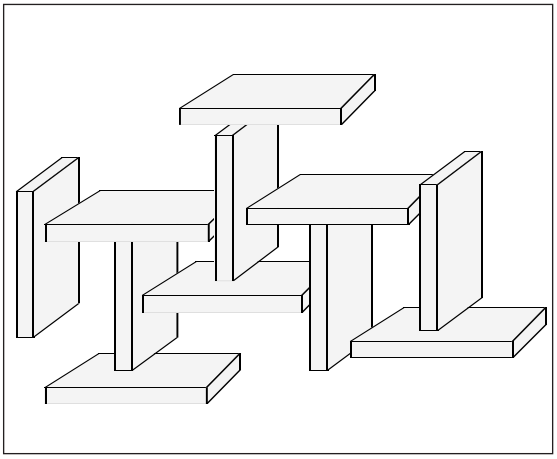
Hydration - When the smectite is mixed with water, the latter penetrates the area between the platelets, forcing them further apart. As this happens, the exchangeable ions begin to diffuse away from the platelet faces. Further penetration of water between the platelets then proceeds in an osmotic process, until they are completely separated.

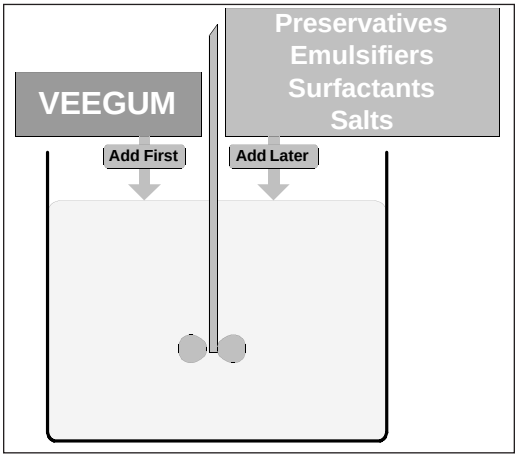
**Also known as bentonite*





For most smectites, the speed with which platelet separation occurs is directly related to the amount of energy introduced during hydration. Both mechanical and thermal energy will accelerate hydration: high shear mixing or the use of warm water will reduce hydration time. The presence of dissolved substances in the water will prolong hydration time by inhibiting the osmotic swelling essential to platelet separation.



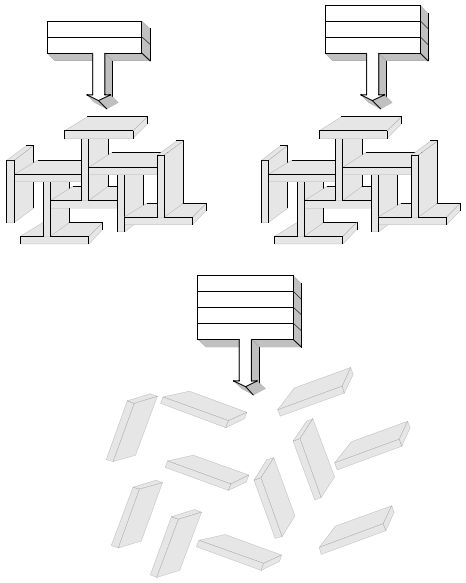


RHEOLOGICAL PROPERTIES

Rheology - Once the smectite is hydrated (i.e., the platelets are separated) the weakly positive platelet edges are attracted to the negatively charged platelet faces. The resulting three dimensional structure (often referred to as the “house of cards”) builds rapidly at first, giving a quick increase in viscosity. As time passes, the remaining free platelets take a longer time to find an available site in the structure, so viscosity increases at a progressively slower rate. Conversely, when a given shear is applied, most of the structure is disrupted quickly, with subsequent breakdown becoming more gradual. Smectite dispersions are therefore thixotropic: undisturbed they increase in viscosity over time, and under a constant shear rate they decrease in viscosity over time. Smectite dispersions are also pseudoplastic, because increasing shear rates (an increase in structure breakdown) result in decreasing viscosities.

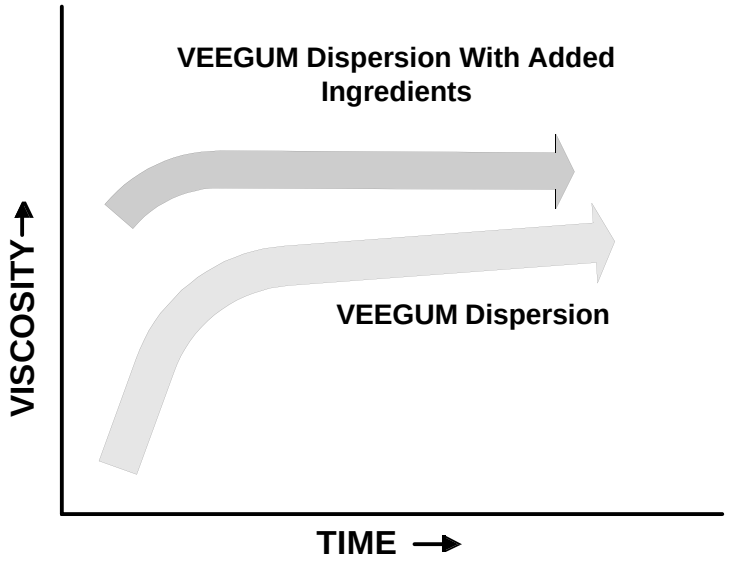
Yield Value - The colloidal structure also provides the smectite’s most useful property - yield value. This is a measure of the resistance of the structure to breakdown. A certain minimum force, the yield value, must be applied to start disrupting the structure. Solids, oils and gases are trapped and segregated by the structure. They must exert a force greater than the yield value to be able to move through the liquid. This means that the greater the yield value, the more stable the suspension, emulsion or foam.

A unique and valuable feature of VEEGUM and VAN GEL is their ability to impart yield value at low viscosity. Stabilization of the dispersed phase is possible even in thin, fluid systems where flowability is important. Most common organic thickeners possess little or no yield value and can stabilize suspensions, emulsions or foams only at high viscosity.



Rheology Modifiers - Formulators are more concerned with the behavior of VEEGUM and VAN GEL in the presence of other ingredients, rather than that in water alone. Most water soluble components will modify the rheological properties of smectite clay, usually beneficially. Salts, surfactants and water-miscible solvents will increase the smectite's viscosity and yield value contribution and decrease thixotropy, but still enable a shear-thinning composition.

Excess water solubles will destabilize the smectite's colloidal structure. This may appear as a relatively stable thick gel or as flocculated masses with syneresis. The stability of the smectite dispersion in the presence of electrolytes is strongly dependent upon cation valence. Monovalent cations have the weakest flocculating effect and are the most compatible with VEEGUM and VAN GEL. Divalent cations have a stronger flocculating effect, and trivalent cations the strongest. The influence of water-soluble ingredients on VEEGUM and VAN GEL is controlled by proper grade selection. VEEGUM K and VAN GEL ES, for example, are highly tolerant of electrolytes.



FORMULATION BENEFITS

VEEGUM and VAN GEL are valued by formulators for their ability to:

Stabilize Emulsions - One of the most useful features of VEEGUM and VAN GEL is their ability to stabilize oil-in-water (O/W) emulsions at low concentrations. The smectite colloidal structure effectively keeps the internal phase droplets suspended and separated. Since smectite viscosity is not affected by heat, VEEGUM and VAN GEL reduce the tendency of emulsions to thin out and break at elevated temperatures. Small amounts (about 1%) will stabilize emulsions containing anionic or nonionic surfactants with a wide variety of oils, fats, and waxes.

In addition, VEEGUM has been found to be an effective water-in-oil (W/O) emulsion stabilizer, increasing internal phase viscosity to inhibit coalescence. Some migration of the smectite may also occur, which strengthens the interfacial water/oil film. VEEGUM has been used in the formulation of fluid W/O emulsions that are otherwise difficult to stabilize.

Stabilize Suspensions - Like its emulsion stabilizing properties, the colloidal structure of VEEGUM and VAN GEL provides excellent suspension of fine particles in aqueous systems. Its high yield value enables the successful suspension of even high density minerals, salts and organics.

VEEGUMs and VAN GELs have many advantages as suspending agents. They:

- Prevent hard packing of the suspended material.
- Control bleeding. Suspensions that tend to settle are easily redispersed.
- Ensure products of uniform dosage: pharmaceutical suspensions and pesticide concentrates, among others.
- Achieve maximum suspension without losing pourability.
- Do not form gelatinous, irreversible gels, as do many organic gums.
- Offer better suspension efficiency than do organic gums at equal viscosity; they are especially useful at low viscosities.

Modify Rheology - Shear-thinning products with controlled thixotropy can be formulated. Rich creams spread smoothly. Cleaners spray easily, coat evenly, and cling to vertical surfaces. Suspensions freely pump and pour without losing stability.

Enhance Skin Feel - VEEGUM contributes spreadability and cosmetic elegance to topical products. It is used to formulate tack-free topical products because of the insoluble, platy nature of its aqueous dispersions. It is also used to reduce or eliminate the tacky, gummy or stringy nature of organic gums and polymers.

Modify Organic Thickeners - In addition to their tactile benefits, VEEGUM and VAN GEL are often used with organic thickeners to exploit the best characteristics of each. The smectites contribute to synergistic viscosity and yield value, while the gums' and polymers' protective colloidal action improves the clay's stability in the

presence of electrolytes, surfactants, and other water-solubles. Recommendations for the use of VEEGUM and VAN GEL with organic thickeners are detailed in the section on Synergy With Organic Polymers and Gums.

Perform at High and Low pH - VEEGUM and VAN GEL are routinely used in products spanning the pH 2 to pH 13 range. These include AHA emulsions, antiperspirants, internal analgesic suspensions, chlorine bleach scrubs and caustic oven cleaners. Certain grades are particularly effective at pH extremes, where their pH stability is further extended by protective colloids such as xanthan gum.

Function with Most Additives - As anionic clays, VEEGUM and VAN GEL are compatible with most anionics and nonionics; they are incompatible with most cationics. Their dispersions can be combined with water-miscible solvents: up to 20% alcohol, 50% glycerin and 30% propylene glycol and polyethylene glycols.

Resist Degradation - Because they are minerals, VEEGUM and VAN GEL are not decomposed by bacteria, heat or excess mechanical shear. They are insoluble in solvents and water, and can be used at pH values encompassing nearly all household and industrial cleaners.

Act as Binders and Disintegrants - VEEGUM and VAN GEL are used as nonmigratory binders in tablets, sticks, and pressed cakes. They do not migrate to the product surface during drying, thereby ensuring uniformity and the desired level of hardness, rub-off, and color value. They also function as low-bulk disintegrants in pharmaceutical and industrial tablets, particularly in massive tablets where the active ingredient makes up the major weight and bulk of the composition.

GRADES OF VEEGUM AND VAN GEL

Pharmaceutical and Cosmetic Grades

Nine grades of VEEGUM are available to the cosmetics and pharmaceutical industries. Four of these (VEEGUM, VEEGUM F, VEEGUM HV and VEEGUM K) conform to the USP/NF monograph for Magnesium Aluminum Silicate. One grade (VEEGUM HS) conforms to the USP/NF monograph for Purified Bentonite. As monograph products, they are differentiated by dispersion viscosity and aluminum to magnesium ratio. They also conform to standards for arsenic, lead, moisture content, acid demand, microbiology, color, and x-ray diffraction identification. These five grades, and the four others listed below, are also used in household, institutional, agricultural, and industrial formulations, where they provide similar benefits.

The Aluminum Magnesium Silicate monographs in the British Pharmacopoeia, European Pharmacopoeia and Japanese Pharmaceutical Excipients are generally applicable to VEEGUM. These monographs vary somewhat from the USP/NF monograph and are less detailed. VEEGUM products are not routinely tested using BP, EP or JPE test methods, but generally meet these monograph requirements.

Pharmaceutical & Cosmetic Grades

Grade	Viscosity Range	Description
VEEGUM	225-600 cps 5% Dispersion	VEEGUM is the most useful, economical grade for a wide range of applications: pharmaceutical, cosmetic, personal care, veterinary, agricultural, household and industrial products. Typical use levels are between 0.5% and 3.0%*. USP/NF M.A.S.** Type IA. INCI Name: M.A.S.
VEEGUM F	150-400 cps 5% Dispersion	VEEGUM F, a micronized powder, is indicated for use where a dry material is required. It is used primarily in pressed powders and in direct compression tablets.Typical use levels are between 1% and 5%*. USP/NF M.A.S. Type IB. INCI Name: M.A.S.
VEEGUM HV	800-2200 cps 5% Dispersion	VEEGUM HV is indicated for use where high viscosity at low solids is desired. Excellent emulsion and suspension stabilization is obtained at low use levels. It is used primarily in cosmetics (e.g. pigment suspension in mascaras and eyeshadow creams) and pharmaceuticals.Typical use levels are between 0.5% and 3%*. USP/NF M.A.S. Type IC. INCI Name: M.A.S.
VEEGUM HS	40-200 cps 5% Dispersion	VEEGUM HS was developed for maximum electrolyte stability and minimum acid demand. In cosmetics it is the preferred grade for hair and face masks. Typical use levels are between 1% and 3%*. USP/NF PurifiedBentonite. INCI Name: M.A.S.
VEEGUM K	100-300 cps 5% Dispersion	VEEGUM K is used in pharmaceutical oral suspensions at acid pH and in hair care formulas containing conditioning ingredients. It has low acid demand and high acid and electrolyte compatibility. It is used to provide good suspension at low viscosity. Typical use levels are between 0.5% and 3%*. USP/NF M.A.S. Type IIA. INCI Name: M.A.S.
VEEGUM PRO	300-550 cps 1.5% Dispersion	VEEGUM PRO is chemically modified and has the highest thickening efficiency of the cosmetic grades. It is widely used in sunscreen emulsions, dandruff shampoos, skin cleansers and liquid soaps with abrasives. Typical use levels are between 0.5% and 2%*. INCI Name: Tromethamine Magnesium Aluminum Silicate.
VEEGUM D	100-300 cps 5% Dispersion	VEEGUM D was designed for rapid hydration in water, even at high concentrations. It is used in dentrifice pastes and gels, and is generally suitable for stabilizing suspensions and emulsions. Typical use levels are between 1% and 3%*. INCI Name: M.A.S.
VEEGUM *Ultra*	225-425 cps 5% Dispersion	VEEGUM *Ultra* is a unique acidic smectite clay. It produces dispersions in the 4.2 to 5.2 pH range, making it particularly suitable for topicals. It is especially easy to hydrate, taking no more than 15 minutes in most cases. It is whiter and brighter than other clays and this carries over to the finished formula. Typical use levels are between 0.5% and 2%*. INCI Name: M.A.S.
VEEGUM Plus	400-900 cps 3% Dispersion	VEEGUM Plus is a blend of purified smectite clay and CMC. It is easy to hydrate, has superior thickening efficiency, suspension power and whiteness. Typical use levels are between 0.5% and 3%*. INCI Name: M.A.S. (and) Cellulose Gum.

*Actual concentration will depend on thickening and stabilization requirements and on other formula ingredients.
**M.A.S. = Magnesium Aluminum Silicate

Household and Industrial Grades

The industrial grades of VEEGUM and VAN GEL offer clay purity and uniformity equal to that of the cosmetic and pharmaceutical grade VEEGUM products. For this reason, they are widely used in household and industrial cleaners, agricultural pesticide concentrates, abrasive suspensions, ceramic glazes and bodies, coatings, polishes, and industrial specialties. The industrial grades are used to provide suspension power, emulsion stabilization, and tailored rheology even at pH extremes and in the presence of strong oxidizing agents.

Industrial Grades

Grade	Viscosity Range	Description
VAN GEL B	300-900 cps 4% Dispersion	VAN GEL B is recommended for general industrial applications in the pH 2 to pH 13 range. It is used in agricultural pesticide suspension and emulsion concentrates, and in household and institutional liquid cleaners, polishes, oven and grill cleaners and aqueous paint strippers. Typical use levels are between 0.5% and 3%*. Technical name: M.A.S.**
VAN GEL C	150-350 cps 6% Dispersion	VAN GEL C is designed for use in highly alkaline systems such as oven cleaners. Typical use levels are between 2% and 5%*. Technical name: M.A.S.
VAN GEL ES	40-200 cps 5% Dispersion	VAN GEL ES is the suspension and thickening agent for products with high levels of electrolytes and surfactants. It is recommended for both acid and alkaline type cleaners as well as liquid detergents. Typical use levels are between 0.5% and 4%*. Technical name: M.A.S.
VAN GEL O	70-350 cps 6% Dispersion	VAN GEL O was developed for use with strong oxidizing agents. It is used in alkaline cleaners with hypochlorite to provide suspension stability, thickening and vertical surface cling. Typical use levels are between 2% and 4%*. Technical name: M.A.S.
VEEGUM T	250-800 cps 4% Dispersion	VEEGUM T - technical grade - offers high thickening and suspension efficiency, particularly in highly alkaline products. Typical use levels are between 0.5% and 2%*. Technical name: M.A.S.

*Actual concentration will depend on thickening and stabilization requirements and on other formula ingredients.

**M.A.S. = Magnesium Aluminum Silicate

PREPARATION OF DISPERSIONS

VEEGUM and VAN GEL products must be properly dispersed in water and hydrated to provide the desired performance properties.

Any materials present in the water when VEEGUM or VAN GEL is added, including preservatives, chelating agents or other minor additives, will interfere with hydration and inhibit the formation of the desired colloidal structure.

Dry smectite particles are actually multiple layers of individual platelets separated by a single layer of water. The extent to which these particles are delaminated into individual clay platelets is referred to as the degree of hydration. The greater the degree of hydration, the stronger the colloidal structure, and the greater the viscosity and yield value of the dispersion.

The degree of hydration is directly proportional to the amount of energy used to disperse the product, and therefore increases in proportion to the following factors:

- Mixing Time
- Mixing Intensity
- Water Temperature

As the following table demonstrates, increasing the mixing intensity or water temperature considerably reduces the amount of mixing time necessary to achieve proper hydration.

Any modification of mixer intensity (e.g., speed, propeller to vessel ratio) or water temperature will affect the degree of hydration and the hydration time. Whichever mixing conditions are used, it is very important that they be consistently controlled to achieve reproducible results in the laboratory, during scale-up and in production.

Because of its unique nature, VEEGUM *Ultra* is an exception. It is relatively unaffected by changes in hydration parameters. Adequate hydration of this product will be achieved in most cases in no more than 15 minutes. Increasing mixing intensity, mixing time or water temperature will not significantly affect VEEGUM *Ultra*'s degree of hydration.

The following table provides guidelines for the minimum amounts of time suggested for the hydration of VEEGUM and VAN GEL. They are based on laboratory scale preparations: 1 kg batches using distilled, deionized water at specification concentrations under practical formulating conditions. Actual hydration times in the laboratory or in production will depend on the particular combination of batch size, mixer shear, and water temperature used.

In the laboratory or during production, the key to VEEGUM's and VAN GEL's consistent performance is consistent conditions of hydration. Changes in hydration time, mixer shear, vessel size or water temperature will change results.

Minimum Suggested Hydration Times	Normal Hydrating Grades	Quick Hydrating Grades	Ultra Hydrating Grade
	VEEGUM VEEGUM F VEEGUM K VEEGUM HV VEEGUM PRO VEEGUM T VAN GEL B VAN GEL C	VEEGUM HS VEEGUM D VEEGUM Plus VAN GEL O VAN GEL ES	VEEGUM *Ultra*
Propeller Mixer:			
800 rpm, 25°C water	120 Minutes	30 Minutes	15 Minutes
800 rpm, 75°C water	45 Minutes	20 Minutes	10 Minutes
Homogenizer:			
3000 rpm, 25°C water	30 Minutes	20 Minutes	10 Minutes
3000 rpm, 75°C water	15 Minutes	10 Minutes	10 Minutes

SYNERGY WITH ORGANIC GUMS AND POLYMERS

VEEGUM and VAN GEL products are often used synergistically with organic thickeners. The viscosity or stability of formulations containing such mixtures will be greater than the viscosity or stability of the same formulation made with the individual components of the mixture. These combinations allow the formulator to fine-tune viscosity, yield value, and flow properties beyond what is possible with either the clay or organic thickener alone.

For example, VAN GEL B and xanthan gum combinations are widely used to stabilize flowable, concentrated (up to 70% solids) agricultural pesticide suspensions. VEEGUM is frequently used with nonionic cellulosic thickeners to provide a balance of suspension stability and smooth flow properties in dandruff shampoos. VEEGUM and carboxymethylcellulose are often combined in liquid makeups.

Other advantages of combining VEEGUM or VAN GEL with an organic thickener are:

- The combination may be more economical than the use of either component alone.
- VEEGUM and VAN GEL can impart yield value to systems thickened with high efficiency organic polymers or gums.
- Because the colloidal structure of VEEGUM and VAN GEL is not sensitive to heat, it can compensate for the loss of viscosity at elevated temperatures common to many organic thickeners.
- VEEGUM and VAN GEL can reduce the tacky, gummy or stringy nature of organic thickener solutions.

The table below provides suggested weight-to-weight ratios of VEEGUM and VAN GEL products that will produce beneficial synergistic effects, and indicates the appropriate procedure to introduce the two ingredients into the formulation:

Suggested Starting Ratios*

Organic Thickener	Weight to Weight Ratio Range of VEEGUM or VAN GEL to Organic Thickener	Recommended Mixing Procedure
Polyacrylates		
Polyacrylates	5:1 to 1:1	A
Carbomers	10:1 to 1:1	A,B
Cellulosics		
Sodium Carboxymethylcellulose	10:1 to 1:1	C
Hydroxyethyl Cellulose	1:1	A,D
Hydroxypropyl Cellulose	1:1	A,D
Hydroxypropylmethylcellulose	1:1	A,D
Methylcellulose	1:1	A,D
Natural Gums		
Xanthan Gum	10:1 to 1:1	C
Sodium Carageenan	10:1 to 1:1	C
Sodium Alginate	2:1 to 1:1	C
Hydroxypropyl Guar	1:1	A
Gum Arabic (Acacia)	4:1 to 2:1	C
Gum Tragacanth	9:1 to 2:1	C

* For initial evaluations. Ratios are based on rheological studies in water alone. Preferable or optimum ratios may be different in formulated products.

RECOMMENDED MIXING PROCEDURES

A Divide the available water and prepare the hydrated VEEGUM dispersion and the organic thickener solution separately. Slowly add the thickener solution to the VEEGUM dispersion with good agitation. Mix until uniform before adding other formula ingredients.

B Add the acid pH VEEGUM *Ultra* and carbomer simultaneously or as a dry blend to the available water. Hydrate thoroughly before adding other formula ingredients. The carbomer can be neutralized at any convenient point after hydration.

C Add the VEEGUM and organic thickener simultaneously or as a dry blend to the available water. Hydrate thoroughly before adding other formula ingredients.

D For nonionic cellulosics that are insoluble in hot water: hydrate the VEEGUM in hot water. Add the gum to the hot VEEGUM dispersion with good agitation. Cool the dispersion with continued agitation until the gum is completely dissolved.

HEALTH AND SAFETY

VEEGUM and VAN GEL are naturally occurring mineral products. Because they are natural products processed only by physical means (water-washing and drying), they are automatically listed (under Smectite, CAS Registry Number 12199-37-0 or Hectorite, CAS Registry Number 12173-47-6) in major chemical inventories such as the United States' TSCA Inventory, Canada's Domestic Substances List (DSL), and the European Inventory of Existing Chemical Substances (EINECS). The INCI name for these products is Magnesium Aluminum Silicate.

VEEGUM PRO, a chemically modified smectite, is listed in the United States' TSCA Inventory, the Canadian Domestic Substances List, the EINECS Inventory and the Korean MOHS Inventory under CAS Registry Number 68511-77-3; its INCI name is Tromethamine Magnesium Aluminum Silicate.

VEEGUM (except VEEGUM PRO) is not chemically irritating to the skin or eyes. In a 90 day feeding study in rats, VEEGUM was administered at a dose level of 10% of the diet; no adverse effects were observed. Because of its remarkably low toxicity, VEEGUM enjoys a long history of safe use in a variety of cosmetic, pharmaceutical and food contact applications.

Additional information concerning the health and safety of these materials may be found in the individual Material Safety Data Sheets.

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