VEEGUM® / VAN GEL®
Magnesium Aluminum Silicate
Magnesium Aluminum Silicate

The Story
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Please visit our web site at www.vanderbiltminerals.com to obtain the following Vanderbilt Reports and information about ordering our versatile VEEGUM / VAN GEL product lines!

RECOMMENDED READING

Vanderbilt Reports:

The VEEGUM Ultra Formulary, No. 923
VEEGUM in Face Masks, No. 915 (rev.)
VEEGUM D in Dentifrice Products, No. 914
VEEGUM in Color Cosmetics, No. 907 (rev.)
Hard Surface Cleaners and Polishes, No. 922 (rev.)
Crop Protection Pesticide Formulations, No. 921
Rheology Control Additives, No. 920
VEEGUM® and VAN GEL® Clays

VEEGUM Magnesium Aluminum Silicate and VAN GEL Magnesium Aluminum Silicate are natural smectite clays that have been water-washed to optimize purity and performance. Smectite clay (also known as bentonite) is valued for its ability to swell in water and to impart useful rheological properties to aqueous compositions. VEEGUM and VAN GEL clays have consistently been the formulator’s choice to stabilize suspensions, perfect emulsions and optimize flow properties.

Vanderbilt Minerals, LLC diversified reserves in the U.S. southwest are the foundation of our clay’s reputation for uniformity and quality. This secure resource base also enables the continuing development of new grades in response to customer needs.

The clay ores used to make VEEGUM and VAN GEL products are mined in Nevada, Arizona and California. They are milled in Nevada and shipped to the Vanderbilt Chemicals - Murray Division processing plant in Murray, KY.

VEEGUM products are offered primarily for pharmaceutical and personal care 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 clays undergo the same water-washing process and meet the same standard of clay purity. Pharmaceutical and personal care grades of VEEGUM clay are also controlled for arsenic, lead and bacteria content. The rheological, chemical and colloidal properties of these products are tailored through careful smectite ore selection.
HOW THEY WORK

The value of VEEGUM® and VAN GEL® clays 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. A single platelet is one nanometer thick and up to several hundred nanometers across. 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. These charge-balancing ions are associated with platelet faces and are termed “exchangeable” since they are readily substituted by other cations.

Hydration - When clay and water are mixed, water penetrates between the platelets, forcing them further apart. The cations begin to diffuse away from platelet faces. Diffusion, the movement of cations from between platelets out into the water, and osmosis, the movement of water into the space between platelets, then promote delamination of the platelets until they are completely separated.

For most VEEGUM and VAN GEL grades, the speed with which platelet separation occurs is directly related to the amount of energy introduced during hydration. Both mechanical and thermal energy 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 or even prevent hydration by inhibiting the diffusion and osmosis essential to platelet separation.
Once the clay is hydrated (i.e., the platelets are separated) the weakly positive platelet edges are attracted to the negatively charged platelet faces. A three dimensional colloidal structure forms, commonly called the “house of cards”. The formation of this colloidal structure accounts for the characteristic rheology imparted by these clays.

Dispersions of VEEGUM® and VAN GEL® clays are thixotropic and pseudoplastic, in addition to contributing useful yield value.

This colloidal structure is particularly valued for its ability to trap and segregate solids in suspensions, oils in emulsions, and gases in foams or mousses.

**Rheology** - Once the clay is hydrated, the colloidal structure builds rapidly at first, providing 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. The 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 the rate of applied shear (thereby increasing structure breakdown) results 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® clays 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 clays in the presence of other ingredients, not just 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 provide 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 effect of electrolytes and water-miscible solvents can be explained by double layer theory. According to this model, most of the exchangeable ions in the clay dispersion tend to accumulate, due to electrostatic attraction, near the negative faces of the platelets, but simultaneously have a tendency to diffuse away from platelet surfaces toward the
bulk of the water, where their concentration is low. The equilibration of these opposing effects causes the formation of a diffuse atmosphere of counterions, with concentration diminishing with distance from the platelet face. A negative “double layer” is thus established, consisting of the negative surface charge plus the diffuse counterions.

The analogous positive double layer is established in association with platelet edges.

The house of cards colloidal structure is therefore based on the interaction of smectite platelet edge and face double layers.

When electrolyte or polar solvent is added to the dispersion, the double layers are compressed. This allows the platelet edges and faces to approach more closely, resulting in a more rigid structure and consequently higher viscosity and yield value.

If the double layers become sufficiently compressed, face-to-face van der Waals attraction will predominate and the house of cards colloidal structure will be lost, along with thickening and suspending efficiency.
The effect of electrolytes on the clay dispersion depends on cation valence and size as well as concentration. Cations with greater positive charge and/or smaller hydrated radius are more strongly attracted than cations with lower positive charge and/or larger hydrated radius, because they can get closer to the clay surface and/or neutralize more negative charges. The higher the cation valence, the less electrolyte the clay can accommodate before the colloidal structure collapses. In short, monovalent cations have the weakest flocculating effect and are the most compatible with VEEGUM® and VAN GEL® clays. Divalent cations have a stronger flocculating effect, and trivalent cations the strongest.

The following lyotropic series indicates the relative ability of cations to replace one another if present in equivalent quantities based on ionic charge and size (hydrated radius).

\[ \text{Al}^{3+} > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ = \text{NH}_4^+ > \text{Na}^+ > \text{Li}^+ \]

According to the Law of Mass Action, however, adding large amounts of one cation will replace others, regardless of their position in the lyotropic series.

The properties of individual smectite clays - e.g., viscosity, hydration rate, electrolyte tolerance - vary according to their particular structure, exchange cations and exchange capacity. Each of these properties can be manipulated by the choice of smectite clay, based on location and type, and by blending smectites from different locations so as to obtain the desired balance of properties. For example, VEEGUM K clay provides greater electrolyte tolerance while VEEGUM clay provides greater viscosity and yield value. In addition, certain gums, such as xanthan gum and CMC, act as synergists and protective colloids when used together with VEEGUM and VAN GEL® products. They can significantly improve the compatibility of the clay with relatively high levels of water solubles.
FORMULATION BENEFITS

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

Stabilize Emulsions - One of the most useful features of VEEGUM and VAN GEL clays 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 clays reduce the tendency of emulsions to thin out and break at elevated temperatures. Small amounts (typically 1-2%) will stabilize emulsions containing anionic or nonionic surfactants that include a wide variety of oils, fats, and waxes.

In addition, VEEGUM clay 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 clay has been used in the formulation of fluid W/O emulsions that are otherwise difficult to stabilize.

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

VEEGUM and VAN GEL products 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® clay 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® clays are often used with organic thickeners to enhance 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 clays 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 clays 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 clays 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 clays 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 clays 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.
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## RECOMMENDED READING

**Vanderbilt Reports:**

- The **VEEGUM Ultra** Formulary, No. 923
- **VEEGUM** in Face Masks, No. 915 (rev.)
- **VEEGUM D** in Dentifrice Products, No. 914
- **VEEGUM** in Color Cosmetics, No. 907 (rev.)
- Hard Surface Cleaners and Polishes, No. 922 (rev.)
- Crop Protection Pesticide Formulations, No. 921
- Rheology Control Additives, No. 920
Ten grades of VEEGUM® clay are available to the personal care and pharmaceutical industries. Four of these - VEEGUM, VEEGUM F, VEEGUM HV and VEEGUM K clays - conform to the USP/NF monograph for Magnesium Aluminum Silicate. 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 and moisture content, acid demand, microbiology, color, and x-ray diffraction identification. These five grades, and the five others listed below, are also used in household, institutional, agricultural, and industrial formulations, where they provide similar benefits.

Products corresponding to the Magnesium Aluminum Silicate NF grades are available that comply with the European Pharmacopoeia monograph for Aluminium Magnesium Silicate: VEEGUM EP, VEEGUM F EP, VEEGUM HV EP and VEEGUM K EP clays. While complying with different monograph requirements, the composition and performance of each product are the same as that of the equivalent NF grade.

**Pharmaceutical and Personal Care Grades**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Viscosity Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEEGUM®</td>
<td>225-600 cps 5% Dispersion</td>
<td>VEEGUM® clay is a 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% Magnesium Aluminum Silicate NF Type IA. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM F</td>
<td>150-400 cps 5% Dispersion</td>
<td>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% Magnesium Aluminum Silicate NF Type IB. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM HV</td>
<td>800-2200 cps 5% Dispersion</td>
<td>VEEGUM HV clay is indicated 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% Magnesium Aluminum Silicate NF Type IC. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM K</td>
<td>100-300 cps 5% Dispersion</td>
<td>VEEGUM K clay 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% Magnesium Aluminum Silicate NF Type IIA. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>Grade</td>
<td>Viscosity Range</td>
<td>Description</td>
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<tr>
<td>VEEGUM® HS</td>
<td>40-200 cps</td>
<td>VEEGUM® HS clay 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%. Purified Bentonite NF. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM Ultra</td>
<td>220-400 cps</td>
<td>VEEGUM Ultra clay 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, which carries over to the finished formula. Typical use levels are between 0.5% and 2%. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM D</td>
<td>100-300 cps</td>
<td>VEEGUM D clay 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: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM Pure</td>
<td>225-600 cps</td>
<td>VEEGUM Pure clay is specially processed for organic skin treatments and cosmetics. It is OMRI™-listed and the ideal emulsion stabilizer, suspension aid and thickener for formulators creating organic personal products. Typical use levels are between 0.5% and 3.0%. INCI Name: Magnesium Aluminum Silicate.</td>
</tr>
<tr>
<td>VEEGUM PRO</td>
<td>300-550 cps</td>
<td>VEEGUM PRO clay 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.</td>
</tr>
</tbody>
</table>
Household and Industrial Grades

The industrial grades of VEEGUM® and VAN GEL® products 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, emulsion stabilization, and tailored rheology even at pH extremes.

### Household and Industrial Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Viscosity Range</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>VAN GEL B</td>
<td>300-900 cps 4% Dispersion</td>
<td>VAN GEL® B clay is recommended for general industrial applications in the pH 2 to pH 13 range. It is used in agricultural pesticide suspensions 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%</td>
</tr>
<tr>
<td>VAN GEL ES</td>
<td>40-200 cps 5% Dispersion</td>
<td>VAN GEL ES clay is the suspension and thickening agent for products with high levels of electrolytes and surfactants. It is recommended for both acid and alkaline cleaners as well as liquid detergents. Typical use levels are between 0.5% and 4%</td>
</tr>
<tr>
<td>VAN GEL O</td>
<td>70-350 cps 6% Dispersion</td>
<td>VAN GEL O clay 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%</td>
</tr>
</tbody>
</table>
**PREPARATION of DISPERSIONS**

**VEEGUM®** and **VAN GEL®** products must be properly dispersed in water and hydrated to provide the desired performance properties. The two guides to successful hydration are:

- **THE BEST DISPERSIONS ARE PREPARED IN WATER FREE OF ADDITIVES.**
- **MORE ENERGY INPUT GIVES QUICKER HYDRATION.**

Any materials present in the water when **VEEGUM** or **VAN GEL** clay 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, each separated by a 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:

- Shear, or mixing intensity
- Heat input, or water temperature
- Mixing time
The degree of clay hydration is increased by greater mechanical energy from shear and by longer mixing times. Shear is generally more efficient than mixing time in promoting hydration, as demonstrated here by the viscosity of 5% VEEGUM® clay dispersions. Yield value is likewise increased in proportion to the degree of hydration.

Heat energy, in the form of heated water, has the greatest effect on degree of hydration, as demonstrated here by 5% VEEGUM clay dispersions mixed at low shear with a 1000 rpm prop mixer. When only low shear mixers are available for hydration, even a modest increase in water temperature can significantly improve clay 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 clay 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 its degree of hydration.
The following table provides guidelines for the minimum amounts of time suggested for the hydration of **VEEGUM®** and **VAN GEL®** clays. 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 consistent performance of **VEEGUM** and **VAN GEL** products is consistent conditions of hydration. Changes in hydration time, mixer shear, vessel size or water temperature will change results.

<table>
<thead>
<tr>
<th>Minimum Suggested Hydration Times</th>
<th>Normal Hydrating Grades</th>
<th>Quick Hydrating Grades</th>
<th>Ultra Hydrating Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEEGUM®</td>
<td>VEEGUM HS</td>
<td>VEEGUM Ultra</td>
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<tr>
<td>VEEGUM F</td>
<td>VEEGUM D</td>
<td></td>
<td></td>
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<tr>
<td>VEEGUM K</td>
<td>VAN GEL O</td>
<td></td>
<td></td>
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<tr>
<td>VEEGUM HV</td>
<td>VAN GEL ES</td>
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<tr>
<td>VEEGUM Pure</td>
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<tr>
<td>VEEGUM PRO</td>
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<td>VEEGUM T</td>
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<tr>
<td>VAN GEL® B</td>
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</tbody>
</table>

**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
**VEEGUM® and VAN GEL®** products are often used synergistically with organic thickeners. The viscosity or stability of formulations containing these mixtures will be greater than that of the same formulation made with either component. 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® clay and xanthan gum combinations are widely used to stabilize flowable, concentrated (up to 70% solids) agricultural pesticide suspensions. VEEGUM® clay is frequently used with nonionic cellulosic thickeners to provide a balance of suspension stability and smooth flow properties in dandruff shampoos. VEEGUM® clay and carboxymethylcellulose are often combined in liquid makeups.

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

- The combination may be more economical than the use of either component alone.
- VEEGUM® and VAN GEL® clays can impart yield value to systems thickened with high efficiency organic polymers or gums.
- Because the colloidal structure of VEEGUM® and VAN GEL® clays 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® clays 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:

<table>
<thead>
<tr>
<th>Organic Thickener</th>
<th>Weight to Weight Ratio Range of VEEGUM® or VAN GEL® to Organic Thickener</th>
<th>Recommended Mixing Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyacrylates</td>
<td>5:1 to 1:1</td>
<td>A</td>
</tr>
<tr>
<td>Carbomers</td>
<td>10:1 to 1:1</td>
<td>A,B</td>
</tr>
<tr>
<td>Cellulosics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium Carboxymethylcellulose</td>
<td>10:1 to 1:1</td>
<td>C</td>
</tr>
<tr>
<td>Hydroxyethyl Cellulose</td>
<td>1:1</td>
<td>A,D</td>
</tr>
<tr>
<td>Hydroxypropyl Cellulose</td>
<td>1:1</td>
<td>A,D</td>
</tr>
<tr>
<td>Hydroxypropylmethylcellulose</td>
<td>1:1</td>
<td>A,D</td>
</tr>
<tr>
<td>Methylcellulose</td>
<td>1:1</td>
<td>A,D</td>
</tr>
<tr>
<td>Natural Gums</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xanthan Gum</td>
<td>10:1 to 1:1</td>
<td>C</td>
</tr>
<tr>
<td>Sodium Carrageenan</td>
<td>10:1 to 1:1</td>
<td>C</td>
</tr>
<tr>
<td>Sodium Alginate</td>
<td>2:1 to 1:1</td>
<td>C</td>
</tr>
<tr>
<td>Hydroxypropyl Guar</td>
<td>1:1</td>
<td>A</td>
</tr>
<tr>
<td>Gum Arabic (Acacia)</td>
<td>4:1 to 2:1</td>
<td>C</td>
</tr>
<tr>
<td>Gum Tragacanth</td>
<td>9:1 to 2:1</td>
<td>C</td>
</tr>
</tbody>
</table>

*For initial evaluations. Ratios are based on rheological studies in water alone. Preferable or optimum ratios may be different in formulated products.
A. Divide the available water and prepare the VEEGUM® or VAN GEL® clay dispersion and the organic thickener solution separately. Slowly add the thickener solution to the VEEGUM or VAN GEL clay dispersion with good agitation. Mix until uniform before adding other formula ingredients.

B. Add the acid pH VEEGUM Ultra clay 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 or VAN GEL clay 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 or VAN GEL clay in hot water. Add the gum to the hot clay dispersion with good agitation. Cool the dispersion with continued agitation until the gum is completely dissolved.