



A BETTER WAY TO FORMULATE

SYNERGEL[®]

HOUSEHOLD & INDUSTRIAL GELS

Penreco[®] has developed a unique system for thickening and gelling ingredients. With an infinite number of customized rheological properties available, these Synergel products are clear, colorless, hydrophobic, thermally reversible, and without syneresis.

Synergel products are available in multiple viscosity ranges and are compatible with many ingredients. Synergel products are visually appealing and do not discolor with age. They are easier and safer to formulate with than gels that use metal stearates or fumed silica and they provide fragrance retention and waterproofing properties.

With a wide range of customization, the range of possibilities are nearly endless.

If you are interested in a gelled system for one of these products or have an idea of your own, please contact your Penreco sales representative and our technical experts will be happy to find a solution that's right for you.

penreco[®]

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To request a sample, visit penreco.com.

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 **CALUMET**

SYNERGEL®

DI-BLOCK COPOLYMER SYSTEM

MINERAL OIL-BASED

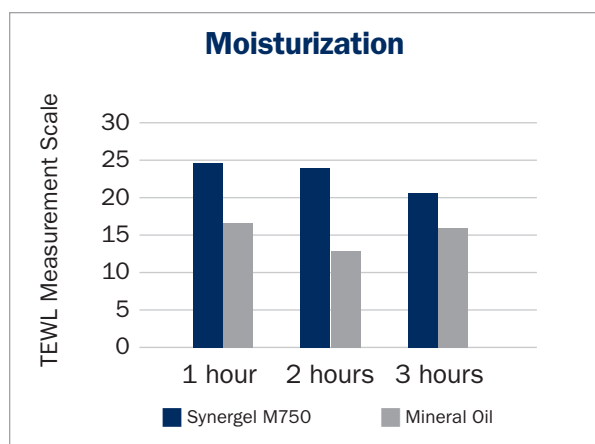
The Synergel white oil based products are based on gelling USP/NF grade white mineral oil in such a way as it promotes superior moisture retention by creating a continuous film enabling oil to be easily spread with no pooling of the product. It also provides a low moisture system for protection of water sensitive additive packages/ingredients.

In liquid systems fine particles don't easily remain in suspension and tend to settle at the bottom and agglomerate. As shown below in the suspension stability testing Synergel provides excellent suspension properties as the polymers act as additional dispersants and prevents movement.

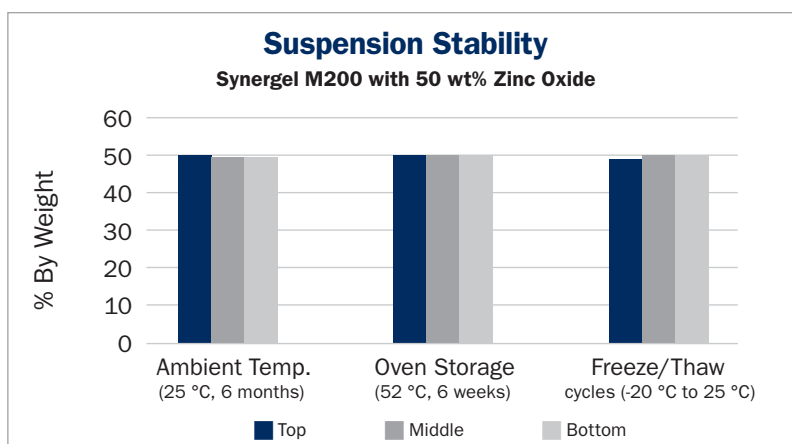
For applications where optical clarity is required, Synergel products retain the sparkling transparency of the starting hydrocarbon fluid. The high clarity/water white base material allows the customer to tailor/tint products for a custom color aesthetic.

TYPICAL PROPERTIES

Product	Base Material	Viscosity @ 130 °C D2983 (cPs)	Viscosity @ 25 °C D2983 (cPs)	Saybolt Color ASTM D156	Flash Point COC (°F) ASTM D92	Specific Gravity @ 25 °C ASTM D4052
BG	225 Vis White Oil	600 - 800 typical		27 min	>300	0.8600
PC	70 & 225 Vis White Oils	1,500 - 2,500 typical		27 min	>300	0.8480
M 500	70 Vis White Oil		47,000 - 57,000	27 min	>300	0.8430
M 750	70 Vis White Oil		67,000 - 83,000	27 min	>300	0.8442
M 1600	70 Vis White Oil		132,000 - 198,000	27 min	>300	0.8383
MR 500	600 Vis White Oil		38,000 - 53,000	27 min	>300	0.8689



The TEWL test shows gelled mineral oil moisturization improves by 53% compared to mineral oil alone. Using a gelled product in a final formulation can aid in prevention of moisture loss ie. "reconditioning" properties for porous materials, such as furniture.



No change in suspension capabilities under test conditions. Gelled mineral oil maintains suspension of active ingredients at a very high load.

SYNERGEL®

DI-BLOCK COPOLYMER SYSTEM

SOLVENT-BASED

The Synergel solvent based products are highly efficient with a rheological property additive designed for use in primers, paints and coatings. They have a pourable gelled system that eliminates the need for high shear and heat and the potential for poor dispersion of conventional, dry powder rheology additives such as organoclay and fumed silica.

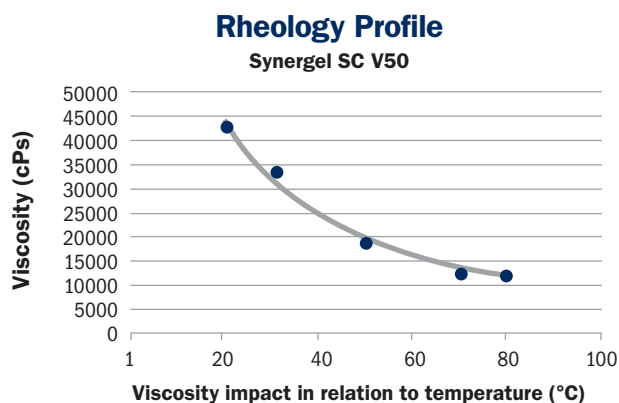
- Reduces dripping, spattering
- Excellent SAG resistance
- Enhances storage stability, shelf life
- Prevents sedimentation of pigments

TYPICAL PROPERTIES

Product	Base Material	Viscosity @ 25 °C D2983 (cPs)	Saybolt Color ASTM D156	Flash Point PMCC (°F) ASTM D93	Specific Gravity @ 25 °C ASTM D4052
LVP 100	LVP 100	35,000 Typical		200 typical	0.7950
SA V50	Conosol C-145	30,000 - 60,000		147	0.7750
SC V50	Conosol C-200	40,000 - 60,000	27 min	188	0.8160
VM&P	VM&P Naphtha	40,000 - 50,000	20 min	65.5	0.7486

Rheological Properties

All Synergel products are thermally reversible. By applying a thermal stress, all the Synergel products will drop in viscosity; however, this is a reversible phenomenon and this cycle can continue almost indefinitely.



By applying a thermal stress, the product drops in viscosity.
(Test: Brookfield Thermocel Visometer)

SYNERGEL®

SINGLE COPOLYMER SYSTEM

SOLVENTS AND MINERAL OIL-BASED

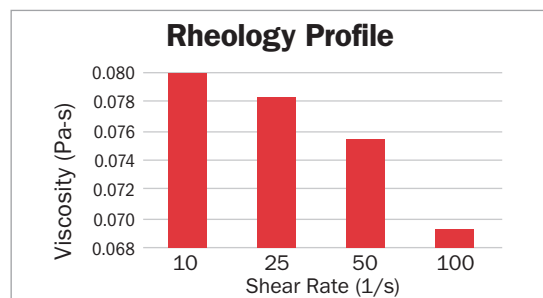
Synergel HB technology can be used in spray applications. The gelled substrate is very pure with low aromatic content and is VOC compliant. The chemical properties, combined with the narrow distillation range, give our specialty products distinct advantages in meeting environmental regulations and VOC requirements.

Synergel HB technology is shear thinning and can be used in spray applications. Shear is created when you spray through a small opening such as a nozzle. The Synergel products provide a good dispersion and spray pattern in end applications such as furniture cleaners.

The high viscosity white oil and solvent by themselves are very fluid. Thus by gelling the substrates, product is easily applied to the area needed and has great adhesion properties.

TYPICAL PROPERTIES

Product	Base Material	Viscosity @ 100 °F (SUS) ASTM D2161	Saybolt color ASTM D156	Flash Point COC °F ASTM D92	Specific Gravity @ 25 °C ASTM D4052
HB 125	C-340 & 70 Vis White Oil	115 - 135	20 min	>300	0.8494



Synergel HB 125 exhibits an instantaneous and temporary decrease in viscosity with shear. Synergel products can either be shear thinning or shear thickening. Once the shear stress is removed, it will return to its original viscosity.

Rheological measurements of the gel shown in the Rheology Profile graph show a 14 % decrease in viscosity as the shear rate increased from 10 sec⁻¹ to 100 sec⁻¹.

SYNERGEL[®]

SPRAY APPLICATIONS

Anhydrous bases for spray-on applications are commonly used due to their innate water resistance and moisturization. We completed a study on our innovative thickening technology that allows gelled anhydrous products to be delivered through a pump spray while maintaining body, suspension or emulsion stability, and an acceptable spray pattern.

Anhydrous fluids used in spray trigger products often are mineral oil-based, due to the low cost and readily availability of these oils. In general, the finished products also have a low viscosity, below 100 SUS at 100 °F. For low viscosity anhydrous products, the types of spray trigger systems currently in use can ensure an excellent spray pattern. However, when sprayed on a non-horizontal surface, a low viscosity liquid will drip, spill, or run down the surface. This leads to a poor coverage, wasting of the product, and low effectiveness in use.

It is well known that mineral oil is considered a Newtonian fluid, which means that the oil's viscosity does not change when shear stress is applied. By comparison, Synergel products have viscoelastic, non-Newtonian properties. While most of these gels are shear thickening (rheopectic/dilatant) products, shear thinning (thixotropic/pseudoplastic) gels can be created by rigorous control of the polymer system.

The Synergel low viscosity gels can be dispensed through a spray trigger nozzle due to their shear thinning properties. The gel will drop in viscosity as it passes through the spray trigger (shear stress) and rebuild viscosity when the stress ceases.

Spray Patterns of Gels Compared to Mineral Oils

We conducted a spray pattern analyses for gelled mineral oil versus ungelled mineral oil, where both products have the same viscosity. For example, a gel with a viscosity of 250 SUS at 100 °F was compared with a mineral oil with the same viscosity. Since the polymer gellants increase the viscosity of mineral oil, an oil with a viscosity less than 250 SUS was gelled up to a viscosity of 250 SUS.

Figure 1 shows the spray pattern of the *ungelled* mineral oil while **Figure 2** shows the spray pattern of the *gelled* mineral oil. There is a noticeable difference between the two spray patterns with the gel having a greater spreadability. This is due to the ability of the gel to thin when sheared by the spray trigger mechanism. The ungelled oil does not thin when sheared, so it results in a spray pattern of less area.

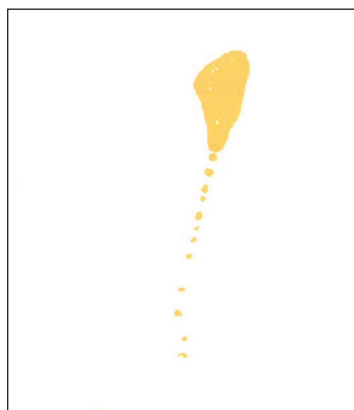


Figure 1

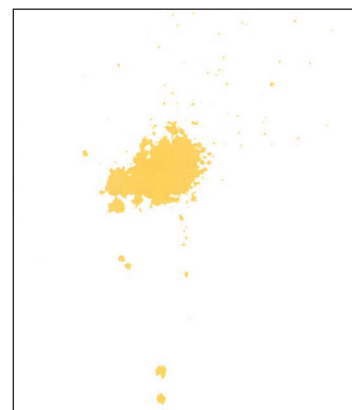


Figure 2

A second spray pattern experiment was conducted on a *hydrocarbon gel* which has a viscosity of 600 SUS at 100 °F (**Figure 3**) compared to a *mineral oil* with a viscosity of 600 SUS at 100 °F (**Figure 4**). As expected, the gel had a better spray pattern.

With spray trigger products gaining in popularity in household applications, the use of improved ingredients in these applications is becoming more important to both formulators and consumers. Pseudoplastic gels have great potential in spray trigger products due to their ability to drop in viscosity when shear stress is applied.



Figure 3



Figure 4

SYNERGEL®

WHY FORMULATE WITH SYNERGEL

VERSATILITY

- Compatible with a wide variety of low polarity ingredients
- Broad range of viscosity profiles that don't change over time
- Ease of incorporation in post batch modifications

PERFORMANCE

- Strength and durability
- Enhanced lubrication
- Excellent flexibility and crack resistance
- Exceptional product and emulsion stability

STABILITY

- Self-preserving formulation base
- Resists growth/proliferation of microorganisms
- Heat processed and micro-filtered
- No harsh chemicals and low toxicity

COST EFFECTIVE & FORMULATION FRIENDLY

- Reduces the amount of structural material required to make a formulation
- No child-resistant packaging required
- Easy to use with a high level of formulation processability
- Efficient delivery system

APPLICATIONS

- Automotive Products
- Ballistics/Firearms
- Chemical Processing
- Coatings
- Degreasers
- Fishing Bait
- Hand Cleaners
- Household and Industrial Cleaners
- Lighter Fluid
- Metal Rolling Oils
- Metalworking
- Mineral Seal Oils
- Paints
- Polishing
- Printing Ink Oils
- Pyrotechnics
- Solvents
- Spray Furniture Polish
- Spray Paint
- Strippers
- Water Treatment Chemicals

All Synergel products are processed in a segregated and dedicated area of a FDA Registered Drug Establishment. However, Synergel products are NOT food/pharmaceutical grade products.

- FSSC 22000 (GFSI)
- cGMP standards
- USP Testing capability
- State Dept. of Health registration
- ISO 9001:2015
- Kosher OU
- FDA Registered Drug Establishment

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