BYK
Additives & Instruments

Technical Information HC-TI 1

Additives for Cleaning, Surface and Fabric Care Products

A member of ALTANA

Additives for Cleaning, Surface and Fabric Care Products

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Introduction

Cleaning and care products are used primarily on objects with hard surfaces e.g. metal, glass, stone, ceramic, wood, plastic, rubber, leather etc. These surfaces can also still be coated or sealed.

Detergents and **fabric softeners** are used on textiles, i.e. much softer surfaces.

With cleaning, care and detergent products, we differentiate between products for **domestic use** and those for **industrial cleaning,** i.e. the industrial and the institutional areas. This includes products for professional cleaning in industry, offices, hospitals, car wash facilities etc.

Liquid detergent, care and cleaning products have very different **consistencies** according to their areas of application. Glass cleaners are transparent and as thin as water; hand dishwashing detergents are also transparent but viscous. By using polishing agents and abrasives, e.g. scouring cream cleansers and metal polishes can be given an opaque appearance and, in part, a pasty consistency.

The range of cleaning, surface care and detergent products is often classified using the following **application categories:**

- Cleaning products for the kitchen
- Cleaning products for bathrooms
- Cleaning products for living rooms
- Floor polishes
- Leather care
- Vehicle cleaners and care products
- Industrial cleaning products
- Detergents and care products for textiles

Composition of Cleaning, Care and Detergent Products

The composition of cleaning and detergent products is very complex today, and differs for each product category.

The main components of **detergents** are:
- Surfactants
- Water softeners
- Bleaching agents
- Enzymes

Cleaning products mainly contain:
- Surfactants
- Acids or lyes
- Water softeners and chelating agents
- Solvents

A number of other components could also be included, as well as those from the additives field. The following provides a brief description of the individual groups of **components.**

Surfactants reduce the surface tension of the water and therefore ensure a better wetting and release of dirt from the material that is being cleaned. Mainly anionic and non-ionic surfactants are used. Cationic surfactants are used in softeners in order to make the washing soft and provide it with anti-static properties.

Acids (inorganic and organic) are used in cleaners to remove limescale, urine scale or rust.

Lyes (alkalis) are used to remove persistent oily and greasy dirt and baked-on residues, e.g. in ovens and grill cleaners. Caustic soda, sodium carbonate and sodium hydrogen carbonate are frequently used alkalis.

Bleaches are used for the oxidative removal of colored soiling and unpleasant odors. They are either chlorine-based (sodium hypochlorite) or oxygen-based (hydrogen peroxide, percarbonates).

Water softeners (chelating agents) bind the calcium and magnesium ions in hard water. These would otherwise reduce the cleaning effect of many surfactants. Phosphate as a water softener has predominantly been replaced by zeolites and organic chelating agents such as polycarboxylates, citrates, nitrilotriacetic acid (NTA) and phosphonates.

Solvents: Many liquid cleaners are aqueous, with **water** as the sole "solvent". The use of **water-miscible solvents,** such as alcohols, acetone, glycols and esters, aids the cleaning effect of the surfactants on persistent dirt such as oil, grease, tar, aged coatings, paints and adhesives. **Non-water-miscible solvents,** such as white spirit and isoparaffins, perhaps combined with oils and waxes, are used in emulsions or in pure solvent-borne cleaners and care products for furniture, leather and vehicles.

Abrasives are grinding and polishing ingredients in scouring cleansers, metal polishes, stainless steel cleaners, glass ceramic cleaners or car polishes. Abrasives support the cleaning performance in a mechanical manner without damaging the surface. Examples are calcium carbonate, aluminum oxide, silicon dioxide or diatomaceous earth (kieselguhr).

After drying, **polymers** provide a protective film which has mechanical and chemical resistance. They are used in floor, furniture and shoe polishes, frequently in combination with waxes.

Waxes form a protective layer on surfaces. Buffability, gloss and water repellency are significant properties of waxes in car, furniture, floor and shoe polishes.

Silicone oils (polysiloxanes) form a very thin protective and water-repellent film on surfaces such as glass ceramics, furniture and automotive coatings. They are used in the respective cleaning and care products.

Other components used in cleaning and detergent products are enzymes, preservatives, colorants and fragrances.

From the range of BYK additives, it is predominantly **rheology additives** that are used. They increase the viscosity of liquid products ("thickeners") and are added to create optimum flow behavior for the respective application. These additives are used to prevent the settling of solid particles (e.g. abrasive materials, encapsulated fragrances) and to enable the material remains on vertical surfaces for as long as possible without sagging. However, it must also be possible to easily apply the liquid product e.g. by means of spraying, and without any problems.

The rheology additives must not impair the cleaning and caring properties of the product, they should ideally support them.

In addition, the use of BYK additives with detergent and dishwashing products that are offered as tablets can increase the **mechanical strength** of the tablets and also accelerate their **disintegration.**

Additives are used as **anti-static agents** in floor and carpet cleaners, and the **softening effect** is put to good use in textiles.

BYK Additives for Cleaning and Detergent Products – Rheology Control in Aqueous Systems

For aqueous cleaner systems, BYK offers two main types of **rheology additives:**

- Inorganic thickeners based on swellable hydrophilic layered silicates (bentonites, hectorites)
- Solutions of modified ureas

Other rheology additives, such as polysaccharides (cellulose ethers, xanthan gum), polyacrylate thickeners, associative thickeners and hydrophilic silicas can also be used. It is possible to combine different rheology additives for fine tuning of the rheology.

Layered silicates and modified ureas result in a **shear thinning (pseudoplastic)** and **thixotropic flow behavior** with a **yield point.** The high viscosity in the low shear range prevents the settling of solid particles and enables higher film thickness on vertical surfaces without dripping and sagging. The low viscosity at high shear rates enables the material to be applied easily (e.g. by means of spraying), and the time-dependent recovery of the high viscosity (thixotropy) provides sufficient opportunity for good leveling (figure 1).

Powdered **layered silicates** consist of platelet stacks. When added to water, the platelet stack swells and disintegrates into individual platelets. As the platelets have different charges on surfaces and edges, the electrostatic attraction forms a three-dimensional network which creates a shear-sensitive gel structure (figure 2). The destruction of the structure by means of shear forces and the subsequent rebuilding provides the pseudoplastic and thixotropic flow behavior.

The individual platelets are around 1 nm thick and, in the case of natural layered silicates (OPTIGEL products), have a diameter of several 100 nm, and only around 25 nm in the case of synthetic hectorites (LAPONITE products) (figure 3).

LAPONITE products (figure 4) are swellable layered silicates that are based on synthetic hectorites with a precisely controlled chemical composition. They are characterized by their very high purity and consistent performance. The outstanding whiteness and the formation of colorless gels or dispersions are particularly noteworthy properties.

Viscosity Curve of a Thixotropic Material

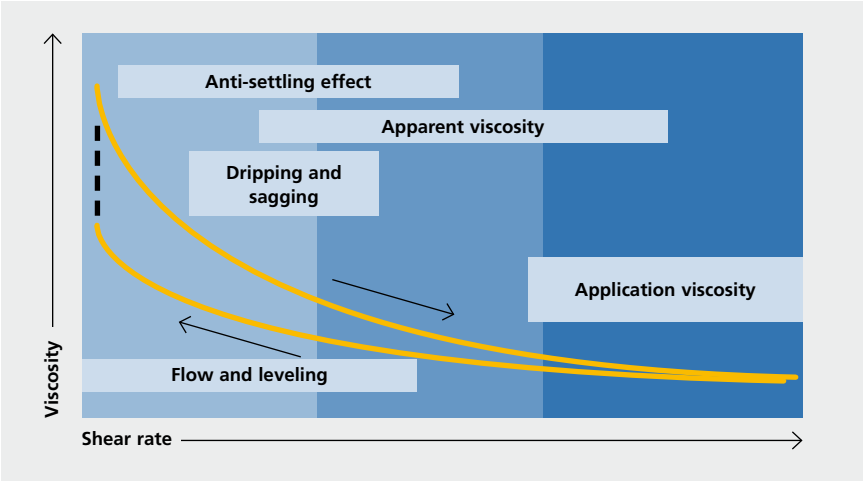


figure 1

Network Formation of Layered Silicates

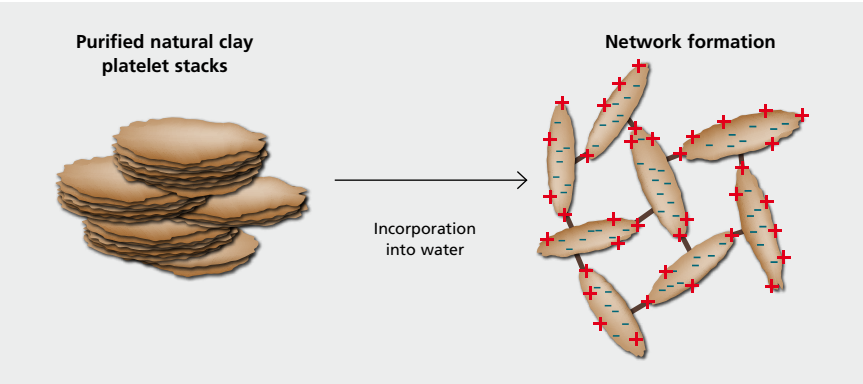


figure 2

Dimensions of the Layered Silicate Platelets

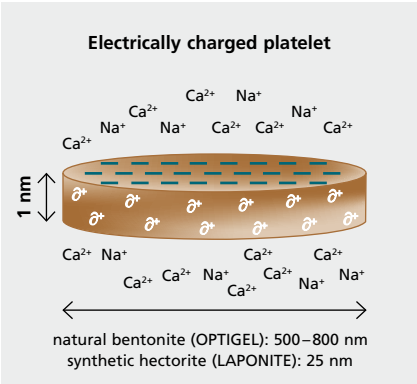


figure 3

Due to the special rheology profile, layered silicates such as LAPONITE-RD used in oven cleaner sprays and other cleaning products that are applied by spraying offer easy sprayability, a good spray pattern, good leveling with an even coverage of the item being cleaned, and with the simultaneous adhesion to vertical surfaces without dripping and sagging. Polysaccharides do have a stronger thickening effect, but have inferior **application properties** (figure 5).

OPTIGEL and **MINERAL COLLOID** products are activated and partially organic modified natural bentonites in the swellable sodium form. The types that are particularly suitable for use in cleaning and detergent products are described in figure 6.

The appropriate rheology additive is chosen depending on whether predominantly stabilization (against **settling** or sagging) is required or perhaps a stronger thickening effect is called for. With low viscosity, OPTIGEL-WX very effectively prevents syneresis and the settling of abrasive materials (figure 8).

Liquid rheology additives based on **modified ureas** can also be used to generate thixotropic flow behavior in aqueous systems and therefore improve the anti-sagging and anti-settling properties (figure 9). Due to their liquid delivery form they can be added directly to the formulations at sufficiently high shear rates, and post addition is also possible.

No Settling/Syneresis with Layered Silicates

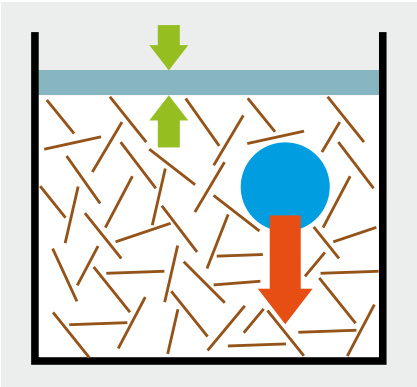
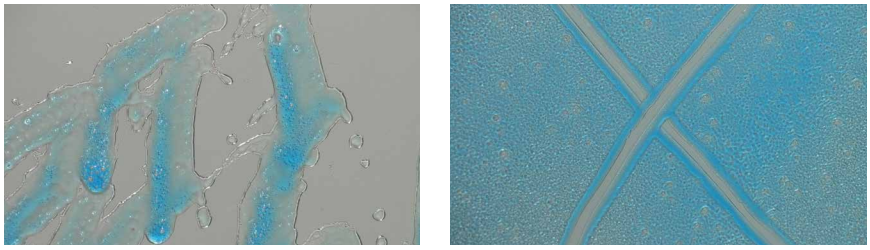


figure 7

LAPONITE-RD	Universal gel type. Can be combined with polymer co-thickeners.
LAPONITE-EP	Gel type with organic modification for "extra performance" and improved rheology under difficult conditions (extreme pH values, high concentrations of dissolved salts).
LAPONITE-S 482	Forms pourable aqueous dispersions with a concentration of up to 25 %. The thickening occurs by the interaction with surfactants, abrasive materials etc.
LAPONITE-SL 25	Ready-for-use aqueous dispersion of LAPONITE-S 482 with long-term stability. Suitable for use in all degrees of water hardness.

figure 4

LAPONITE-RD: Good Spray Pattern and Adhesion to Vertical Surfaces



With polysaccharide **With LAPONITE-RD**

figure 5

OPTIGEL-CK	All-purpose bentonite product with high purity. Thixotropic rheology additive.
MINERAL COLLOID-MO	Purified sodium bentonite with outstanding rheological properties, even in cleaners with extreme pH values from 1–14.
OPTIGEL-WX	Thixotropic rheology additive, produces storable systems without excessive thickening. Good anti-settling effect even for heavy abrasives. Suitable as low as pH 2.
OPTIGEL-WM	Rheology additive which combines thixotropic stabilization with a high thickening effect. Used to stabilize oil-in-water emulsions.
OPTIGEL-W 724	Rheology additive which combines thixotropic stabilization with a high thickening effect. Results in good electrolyte stability.

figure 6

Excellent Storage Stability with OPTIGEL-WX

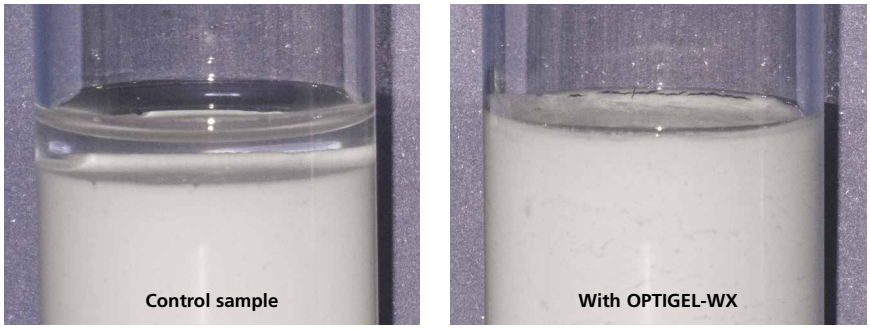


figure 8

BYK-D 420	The active substance is dissolved in dimethyl sulfoxide; the active substance content is 45 %.
BYK-7420 ES	The active substance is dissolved in amide ester; the active substance content is 40 %.

figure 9

The **rheological effects** and **incorporation conditions** of the layered silicates and modified ureas for aqueous systems are summarized in the following (figure 10).

Alongside the rheological requirement profile, the physical **properties** (color, transparency etc.) and the **compatibility** with the chemical environment of the respective detergent and cleaning product also determine the choice of the best suited rheology additive (figure 11).

	LAPONITE-RD	LAPONITE-EP	LAPONITE-S 482	LAPONITE-SL 25	OPTIGEL-CK	MINERAL COLLOID-MO	OPTIGEL-WX	OPTIGEL-WM	OPTIGEL-W 724	BYK-D 420	BYK-7420 ES
Resulting effects											
Shear thinning/ pseudoplastic rheology	++	++	*	*	++	++	++	+	+	++	++
Thixotropic behavior	+	+	*	*	++	++	+	+	+	++	++
Stabilization against settling and syneresis	+	++	*	*	+	+	++	+	+	+	+
Adhesion to vertical surfaces (Anti-sagging effect)	+	++	*	*	+	+	++	+	+	+	+
Thickening effect	+	+	*	*	o	o	+	++	++	+	+
Temperature-stable rheology	+	++	+	+	+	+	++	+	+	o	o
Incorporation conditions											
Pre-dispersion in water at high shear rates					•	•	•	•	•		
Pre-dispersion in water at moderate shear rates	•	•	•								
Post-addition				•						•	•

++ = very high + = high o = average * = system-dependent • = recommended

figure 10

	LAPONITE-RD	LAPONITE-EP	LAPONITE-S 482	LAPONITE-SL 25	OPTIGEL-CK	MINERAL COLLOID-MO	OPTIGEL-WX	OPTIGEL-WM	OPTIGEL-W 724	BYK-D 420	BYK-7420 ES
Composition	Synthetic hectorite derivatives				Activated bentonites		Organically modified bentonites			Modified ureas	
Supplied as	Powder			Liquid	Powder		Powder			Liquid	
Brightness (Elrepho R 457) as powder (%)	90	85	90		60	55	60	60	60		
Transparency of the gel	+	+	+	+	–	–	–	–	–	++	++
pH resistance	5–13	0–14	5–13	5–13	2–13	1–14	2–13	5–11	5–11	2–13	2–13
Electrolyte resistance* (Sodium salt)	o	++	o	o	+	+	++	+	+	++	++
Compatibility with chlorine bleach	+	–	+	+	+	+	–	–	–	–	–
Compatibility with water-miscible solvents	+	+	+	+	o	o	+	o	+	+	+
Compatibility with surfactants**	+	++	+	+	+	+	++	+	+	++	++
Preservatives/biocides	•	••	•	Contains biocides	•	•	••	••	••	•	•
Typical use levels (%)	0.5–2	0.3–1.5	0.5–2	2–8	0.5–3	0.5–3	0.5–2	0.3–1.5	0.3–1.5	0.3–3	0.3–3

++ = very high + = high o = average – = low • = recommended depending on application •• = required

figure 11

*Higher concentrations of soluble calcium, magnesium, ammonium and potassium salts impair the effect of hectorites and bentonites.

**The gel structure of hydrophilic layered silicates is not stable in formulations containing cationic surfactants.

Rheology Control in Solvent-borne Systems

In liquid cleaning and detergent products based on organic media (solvents, oil, water-free non-ionic surfactants), it is predominantly organophilic layered silicates that are used:

- Organophilic layered silicates based on bentonites (TIXOGEL products)
- Organophilic layered silicates based on mixed mineral technology (GARAMITE products)

These additives produce a **shear thinning (pseudoplastic)** and **thixotropic flow behavior** with a **yield point** with the same application advantages familiar from hydrophilic layered silicates. A combination with hydrophobic silica is sometimes used for rheological fine tuning.

Other types of rheology additives (hydrogenated castor oil derivatives, polyamides and modified ureas) can also be used.

Organophilic layered silicates are made from natural, hydrophilic layered silicates by means of modification with quaternary ammonium compounds, which must contain at least one longer alkyl chain (figure 12). The **TIXOGEL layered silicates** are added to the solvent in the manner similar to that of hydrophilic layered silicates in water. The gel structure is again based on a three-dimensional network but the interaction does not involve electrostatic attraction, rather hydrogen bonds between the edges of the platelets (figure 13). **Conventional types** require the addition of so-called polar activators for gelling, i.e. for developing hydrogen bridge bonds. Activators are small polar molecules like alcohols, acetone, water or propylene carbonate, in quantities from 20–60 % based on the layered silicate. **Self-activating types** do not need activators and are also easier to disperse (figure 14).

Modification of Layered Silicates with Quaternary Ammonium Compounds

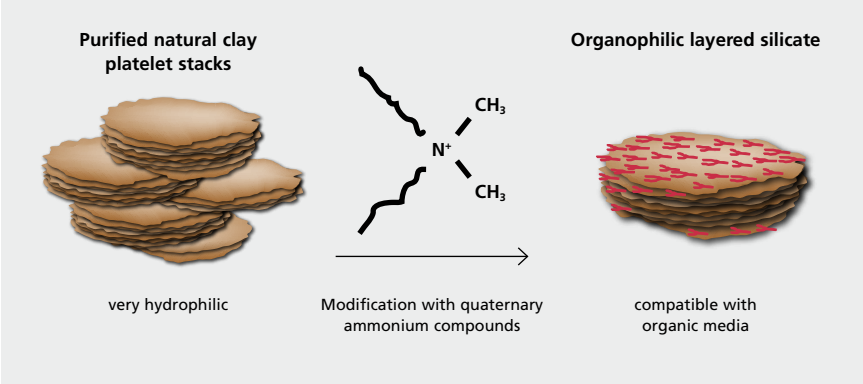


figure 12

Network Formation via Hydrogen Bonds

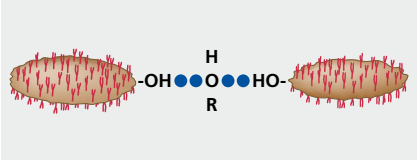


figure 13

TIXOGEL products are organophilic bentonites for the thixotropic thickening of organic systems. The most common types for use in cleaning and detergent products are described in the following table (figure 15).

Conventional and Self-activating Organophilic Layered Silicates

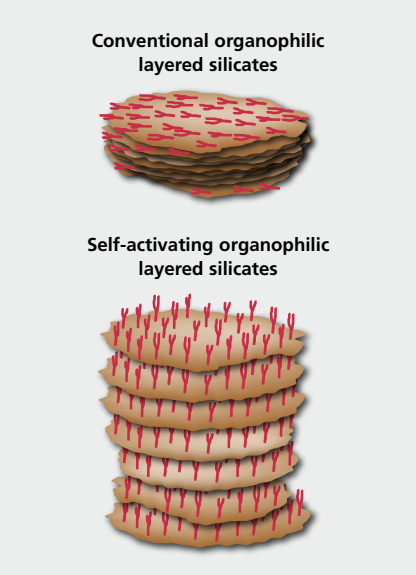


figure 14

TIXOGEL-VP	Optimized for use in low polarity systems based on mineral oils, isoparaffin, white spirit and silicone oils. Requires an activator for gelling.
TIXOGEL-VZ	A gelling agent for medium-polarity to high-polarity systems that contain aromatics, alcohols, glycols, esters etc. Requires an activator except for in highly polar systems.
TIXOGEL-MP 100	Self-activating, easy to disperse type for low polarity solvent systems. Requires no or (in aliphatic systems) only a small amount of activator.
TIXOGEL-MP 250	Self-activating, easy to disperse type for medium- to high-polarity solvent systems. Requires no activator.

figure 15

GARAMITE products are organophilic layered silicates based on a **mineral mix** made of rod-like sepiolite- and plate-like bentonite minerals (figure 16). In solvent systems, they produce a range of special properties, which differentiate them from standard organophilic layered silicates. Firstly, they are very easily incorporated, even at moderate shear rates and, secondly, they require no polar activators for gelling. Their rheology is insensitive to polarity fluctuations, e.g. when different fragrances are added.

The two types for different polar solvents and oils in cleaning and detergent products are described in the following table (figure 17).

The choice of the most suitable organoclays is based on the polarity of the organic medium as well as on the available incorporation conditions. The following table shows the respective **selection criteria** (figure 18).

GARAMITE Layered Silicate

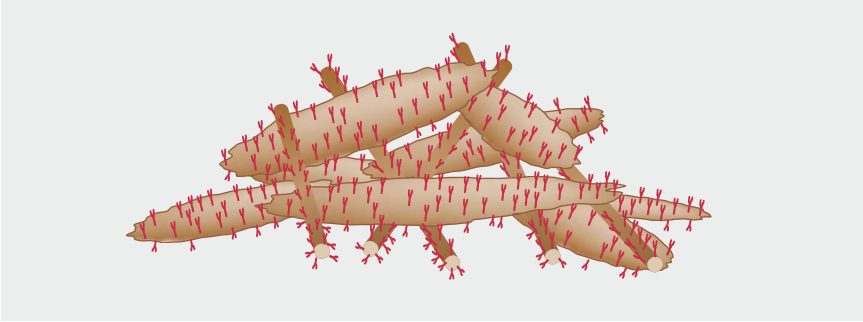


figure 16

GARAMITE-7303	Optimized for use in low- to medium-polarity systems based on mineral oils, isoparaffin, white spirits, silicone oils and aromatic solvents.
GARAMITE-7305	A gelling agent for medium-polarity to high-polarity systems that contain aromatics, alcohols, glycols, glycerol, esters, ketones etc.

figure 17

Polarity Selection Table

Low polarity → **High polarity**

Hydrocarbons			**Esters, ketones and alcohols**	
Aliphatic	**Aromatic**		**High molecular weight**	**Low molecular weight**
	Low aromatic content	**High aromatic content**		
Aromatic-free mineral spirits Mineral oils Isoparaffins	Paraffin White spirit	Toluene Xylene Styrene Aromatic naphtha	Ethyl acetate Butyl acetate Glycol ether	Ethanol/IPA Butanol Acetone MIBK/MEK

Conventional organophilic layered silicates (require an activator)

TIXOGEL-VP

TIXOGEL-VZ

Self-activating organophilic layered silicates (require no or only a small amount of activator)

TIXOGEL-MP 100

TIXOGEL-MP 250

Organophilic layered silicates based on mixed mineral technology (require no activator)

GARAMITE-7303

GARAMITE-7305

figure 18

Binding and Dispersing Effect

It is common for dishwashing detergent and detergent products to be offered in pressed molded articles, **tablets (tabs)** and granulates. On the one hand, these must have mechanical strength so that they do not break during storage and have as little as possible abrasion. On the other hand, they must be able to disintegrate fully and as quickly as possible upon contact with water, so that the active substances are released and can develop their full cleaning and washing effect. On account of their platelet structure and their high specific surface, hydrophilic layered silicates are ideal **binders** for tablets and make these mechanically stable. The layered silicates swell rapidly as soon as the tablets come into contact with water. On account of the volume increase, they act as a **disintegrant** for tablets. The tablets disintegrate rapidly and dissolve completely.

LAPONITE-RD has a BET surface of 370 m^2/g. The small LAPONITE platelets accumulate between the active substance particles of the cleaning and detergent tabs, thereby increasing their strength. In comparison with organic binders, as a chemically inert mineral LAPONITE does not migrate, it remains as a protective layer on the interfaces of the partially reactive active substances. As a very white mineral, LAPONITE-RD has a positive influence on the appearance of the tablets.

OPTIGEL-CK as a natural layered silicate functions similarly. In typical dosages of 3 – 5 %, the slightly beige intrinsic coloration of the product is concealed by the colorants which are usually added.

Anti-static

Hydrophilic layered silicates are natural **film formers.** Due to their platelet-shaped crystalline form in conjunction with their anionic character, they are capable of forming conductive, anti-static films. To achieve a sufficient concentration on the substrate, e.g. the floor or the carpet fibers, an aqueous dispersion of an unmodified layered silicate is produced using a liquefier (polycarboxylate, phosphonate, etc.). Using the LAPONITE sol-type LAPONITE-S 482, even without any further additives, can produce a dispersion of up to 25 % concentration. The adhesion to the substrate is further improved by adding a suitable dispersion binder, such as polyurethane or polyacrylate.

The effect of layered silicates as **anti-static agents** is shown by the fact that after coating with OPTIGEL or LAPONITE, the substrate becomes conductive in two ways:

1. The electronic conductivity:
A coating with layered silicates forms a continuous film made up of interconnected, overlapping, electrically-charged particles (figure 19). This mechanism is not influenced by fluctuations in the relative moisture.

2. The ionic conductivity:
With a relative humidity of 50 %, a layered silicate film absorbs up to 15 % free moisture. This is bound within the crystalline structure as ion hydration water. Part of this water is lost at very low humidity.
Electrical charge is conducted through the hydrated ions, which form a virtually concentrated ion solution. This mechanism is influenced by fluctuations in relative humidity.

Layered silicates as anti-static agents have advantages compared with polymer resins:

- The conductivity of the films is less influenced by fluctuations in relative humidity.
- The coatings feel dry and not sticky.

LAPONITE-S 482 as a sol-type is particularly suitable for producing anti-static coatings because it can be processed to create a concentrated, low-viscosity dispersion that is easy to apply.

LAPONITE-SL 25 is the ready-for-use and long-term stable 25 % aqueous dispersion of LAPONITE-S 482.

Film Made up of Overlapping Layered Silicate Platelets

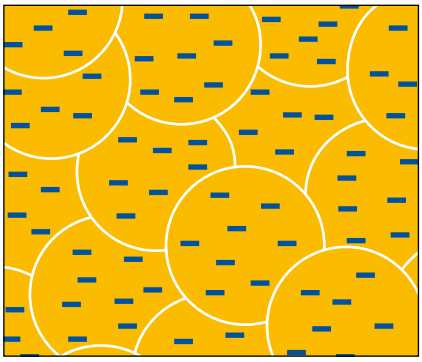


figure 19

At a concentration of 5 – 7 % in water, **OPTIGEL-CK** already forms very strong gels. When a liquefying dispersing agent is added to OPTIGEL-CK, low viscosity sols with concentrations of 15 % and above can also be created. HEDP (1-hydroxyethylidine-1,1-diphosphonate) in an addition level of 5 – 10 %, based on OPTIGEL-CK, is particularly effective.

Fabric Softening

Bentonite has a remarkable, long-known **fabric softening effect,** particularly on cotton and wool.

Quaternary ammonium salts as standard softener ingredients are cationic surfactants and therefore not compatible with the anionic surfactants contained in the detergent products. They would neutralize these and mutually inactivate each other, so are therefore used as a separate product in the subsequent rinse cycle.

However, bentonite is anionic, compatible with all the raw materials contained in the detergent product, and can therefore be used directly in the detergent product. This means that it can soften already during the wash. Products that wash and soften at the same time are called **2-in-1 detergents** or **"softergents".**

Softening Effect on Textile Fibers

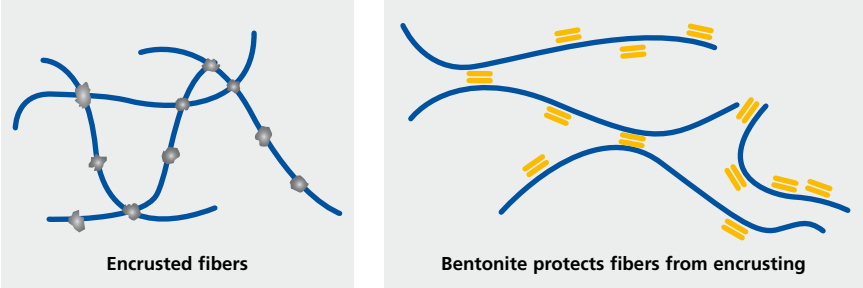


figure 20

The common explanation for the softening effect of bentonite states that bentonite prevents fibers from being encrusted with calcium and magnesium salts, and that instead bentonite itself is deposited as a thin protective layer on the fibers (figure 20). In this way, the slip effect of the layered silicate platelet stacks and the soft feel of the bentonite are transferred to the fabric. It also makes the fabric easier to iron. The hydrophilic properties of bentonites and the absorption of perspiration also improve the wear comfort of the clothing.

BYK offers **layered silicates in powder form,** which have fabric softening properties as a primary or secondary effect. They are used in 2-in-1 powder detergents, 2-in-1 liquid detergents, detergent compounds, detergent additives and in tumble-dryer sheets. The typical levels are 6 – 12 %. Alongside the best possible softening effect, the highest possible whiteness of the bentonite additive is also desired for aesthetic reasons. To be able to incorporate high dosages without excessively thickening the liquid detergent, but also in the manufacturing process of powder detergents, Ca-bentonite is also used as it does not swell as much and is not rheologically active.

BENTOLITE-L is a very white, purified natural calcium bentonite in powder form that has virtually no thickening effect and can therefore be used in all types of softergents and softening detergent additives.

LAPONITE-RD is used where high whiteness and very good softening effect is necessary even at low dosages of around 3 %.

OPTIGEL-CK combines a good softening effect with rheological stabilization effects where these are required.

Areas of Application

	LAPONITE-RD	LAPONITE-EP	LAPONITE-S 482	LAPONITE-SL 25	OPTIGEL-CK	MINERAL COLLOID-MO	OPTIGEL-WX	OPTIGEL-WM	OPTIGEL-W 724	BENTOLITE-L	BYK-D 420	BYK-7420 ES	TIXOGEL-VP	TIXOGEL-VZ	TIXOGEL-MP 100	TIXOGEL-MP 250	GARAMITE-7303	GARAMITE-7305
Cleaning products for the kitchen																		
Scouring cream cleansers					■		■											
Metal polishes	□				■		■											
Stainless steel cleaners					■		■											
Glass ceramic cleaners		■					□											
Oven and grill cleaners	■	■			■		■											
Detergents for dishwashers	■				■													
Dishwashing detergent tabs	●				○													
Hand dishwashing detergents	□		□															
Cleaning products for bathrooms																		
Toilet cleaners		■			□	■	■				■	□						
Bathroom cleaners	□	□			■		□											
Cleaning products with chlorine bleach	■				□													
Cleaning products for living rooms																		
Glass and window cleaners	■																	
Carpet cleaners			▲	▲	△													
Furniture polishes	□	□					□						■		■			
Floor polishes																		
Floor polishes		□																
Floor cleaning products		■	△	▲			□											
Leather care																		
Shoe polishes	■		□	□			□	□										
Vehicle cleaners and care products																		
Wheel rim cleaners		■					■	□										
Car polishes	■	□			□		□		■				■		■			
Industrial cleaning products																		
Cleaners for print cylinders														■				
Industrial cleaners (Polar solvents)														■		■		■
Industrial cleaners (Non-polar solvents)																	■	
Detergents and care products for textiles																		
Liquid detergents (Aqueous)	■	■	■	■			■				□	■						
Non-aqueous liquid detergents																■		■
Detergent tabs	●				○													
2-in-1 detergents (Softergents)	◇				◇					◆								
Tumble-dryer sheets										◆								

Aqueous rheology adjustment: ■ especially recommended □ recommended
Solvent-borne rheology adjustment: ■ especially recommended □ recommended
Binding and dispersing effect: ● especially recommended ○ recommended
Anti-static: ▲ especially recommended △ recommended
Fabric softening: ◆ especially recommended ◇ recommended

figure 21

For more information about our additives and instruments, as well as our additive sample orders please visit:

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Additive Guide

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