

Substance for Success.



Technical Information L-RI 1

Rheology Additives

Rheology Additives

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Rheology of Coatings

Settling

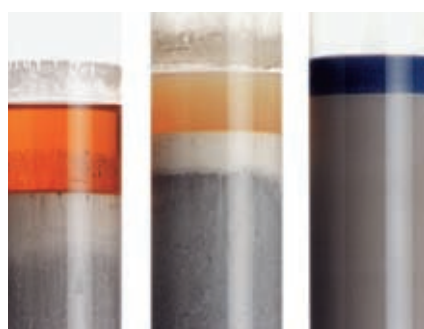


figure 1

Sagging

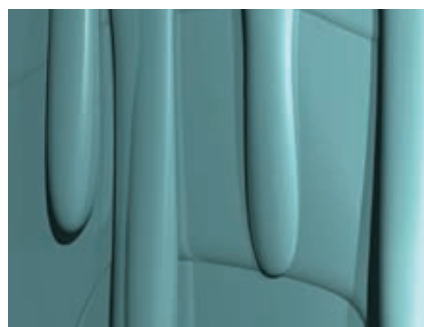


figure 2

Flow behavior is one of the more important characteristics of a liquid coating. To a great extent, flow behavior determines the handling and application properties of the coating.

A key factor in describing flow behavior is **viscosity η** . However, for most coating systems, viscosity is not a constant. It is dependent on a variety of parameters. In addition to its dependence on temperature, another primary parameter is the coating's response to **mechanical stress**, as this can influence application properties. **Rheology** is the complex interrelationship between viscosity and shear forces.

The rheology of a coating system is determined primarily by:

- binder (chemistry, molecular weight)
- solvent content and resin solubility
- pigmentation level

It can also be influenced by wetting and dispersing additives. Deflocculating additives (e.g. DISPERBYK-163, DISPERBYK-110) reduce the viscosity, while controlled flocculating additives (such as ANTI-TERRA-204) increase the viscosity and thixotropy.

These wetting and dispersing additives are primarily used for pigment stabilization, where their rheological impact is a desirable side effect (see Technical Information L-WI 1, Wetting and Dispersing Additives).

Rheology Additives

Consequently, special rheological additives are required for optimum adjustment of rheological properties. In most cases, these additives are used to improve **anti-settling** properties during storage and **sag resistance** during application. In addition, improved flow behavior controls the uniform orientation of special effect pigments (aluminum and pearlescent pigments) as well as matting agents and such factors as the image sharpness in printing inks. Numerous products designed to control rheology of coating systems are already on the market. Their mechanisms are essentially the same. In the liquid phase, these additives form three-dimensional **networks** (typically by hydrogen bonding). These lattice structures are temporarily destroyed by shear, recovering after shear is discontinued, to give the coating its pseudoplastic or thixotropic flow properties.

Sedimentation, Sagging

During storage, pigments and fillers in a coating can settle and form **sediments** that are difficult to reincorporate (figure 1). During application on inclined and vertical surfaces, **runs and sags** frequently occur at higher film thicknesses (figure 2). Higher viscosity at low shear in combination with a yield value can substantially reduce both sedimentation and sagging. This results in longer shelf life with less settling and better sag resistance during application. However, the rheological properties described above may also have undesirable effects on the deaeration/defoaming and leveling properties of the coating: air bubbles rise to the coating surface slower and surface leveling is impaired. Clearly the “right” flow behavior is always a compromise partly governed by the application parameters for each particular application.

Shear Rate

Of practical importance is the dependence of viscosity on the **shear rate $\dot{\gamma}$** . In practice a relatively large shear range must be considered (figure 3). During production (dispersing, blending and filling), and application (rolling, brushing or spraying), coatings are exposed to high shear rates ($>1000 \text{ s}^{-1}$); during storage and in the interval between application and hardening, shear rates are relatively low ($<1 \text{ s}^{-1}$). Rheological characterization over the entire shear range is best obtained with rotational viscometers. In all instruments of this type, the liquid to be tested is sheared between a stationary surface and a moving surface. A known rotational force is applied and the resulting rotation speed, dependent on the liquid's resistance to flow (viscosity), is measured. From the measured **shear rate $\dot{\gamma}$** (proportional to the rotation speed) and **shear stress τ** (proportional to the force applied), the **viscosity η** may be calculated according to the formula $\tau = \eta \cdot \dot{\gamma}$ and charted in a viscosity curve diagram (figure 4).

Newtonian Flow Behavior

The simplest form of flow behavior occurs if viscosity is independent of shear rate. This behavior, also known as Newtonian flow, only occurs in ideal liquids and can be observed in water, pure solvents and mineral oils, for example. Since viscosity does not depend on shear rate, it can be measured at any shear rate (single-point measurement) to obtain a complete rheological description of the system. In coating systems however, Newtonian flow behavior is not typical and actually not desirable (other than in some stain formulations): the slightest shear stress (gravity) induces flow, resulting in sagging after application. Such formulations also exhibit rapid settling. ➤

Typical Shear Ranges

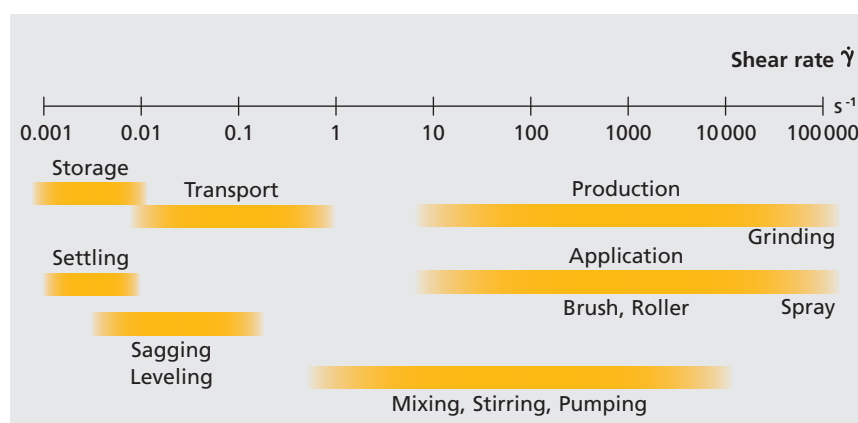


figure 3

Viscosity Curves

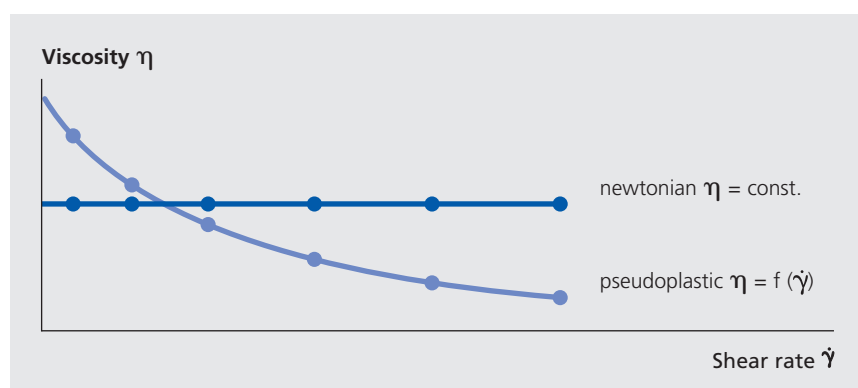


figure 4

> Rheology of Coatings

Thixotropy = Time Dependency of Viscosity

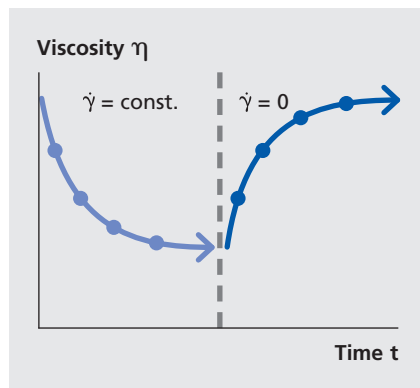


figure 5

Thixotropy (Viscosity Curve)

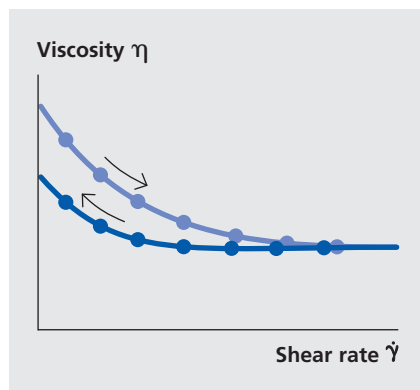


figure 6

Pseudoplastic Flow Behavior

More typical flow behavior seen in coating systems is pseudoplasticity, also known as “shear thinning”. Here, viscosity is inversely proportional to shear rate. Viscosity decreases with increasing shear; i.e. the coating material becomes thinner. Frequently, such liquids also exhibit a **yield value**; it does not flow at low shear; flow only begins after the yield value has been reached or exceeded. In terms of application properties, this type of flow behavior has advantages. Subjected to high shear, the coating has low viscosity, simplifying handling during production and application. At lower shear stresses, for example during storage, the coating’s viscosity is higher, thus effectively eliminating pigment sedimentation. At the same time, sag resistance following application on vertical surfaces is substantially improved. However, higher viscosity at lower shear rates may be undesirable for surface flow and deaeration of the freshly applied wet paint film. A stated viscosity for any pseudoplastic material is meaningful only if the corresponding shear rate is also indicated. Hence, a single-point measurement for such materials is of little value; the rheological behavior of the material can only be represented by the entire viscosity curve.

Thixotropic Flow Behavior

Thixotropy describes viscosity behaviors that are **time-dependent** as well as shear-dependent. A pseudoplastic substance exhibits different viscosities as a function of changing shear rates, but these viscosities are independent of time. When a thixotropic substance is sheared at a constant rate, viscosity decreases with increasing duration of shear (time). Once the shear is discontinued ($\dot{\gamma} = 0$), viscosity returns to the original value (figure 5). The viscosity curve of thixotropic liquids typically shows a “hysteresis loop”, i.e. viscosity recovery after shear does not replicate the initial shear thinning from equilibrium curve (figure 6). Recovery viscosity is lower than the shear down viscosity at every shear rate. This clearly shows that it is not possible to attribute a unique viscosity value at a given shear rate for a thixotropic material; the viscosity measured depends on the sample’s prior shear history.

Pseudoplasticity/Thixotropy

With regard to sedimentation behavior, pseudoplastic and thixotropic materials show very similar performance: high viscosity at low shear rates reduces settling. Differences between pseudoplastic and thixotropic liquids become more obvious when the focus is on sagging and sag resistance. Pseudoplastic materials allow application of fairly thick films without sagging, because viscosity recovery after application occurs very fast. Thixotropic materials also display increased sag resistance, however, the effect is less pronounced because the process of viscosity recovery is slower. On the other hand, this can be beneficial regarding deaeration and leveling.

Important Rheological Parameters

Parameter	Definition	Unit
Shear stress τ	Force/Unit Area	N/m ² = Pa (Pascal) Formerly: dyne/cm ² 1 dyne/cm ² = 0.1 Pa
Shear rate $\dot{\gamma}$	Velocity/Distance	(m/s)/m = 1/s = s ⁻¹
Viscosity η	$\tau/\dot{\gamma}$	Pa·s Formerly: P (Poise) 1 cP = 1 mPa·s

figure 7

Liquid Rheology Additives for Thixotropic Flow Behavior

BYK-410, BYK-411 and BYK-420 are three liquid rheology additives that create strong **thixotropic** flow behavior in coatings and printing inks. These products are solutions of modified ureas in N-methyl pyrrolidone (similar products containing N-ethyl pyrrolidone are also available). Their functional mechanism is based on the fact that the active substances in these additives are insoluble in common coating solvents and/or blends: properly incorporated into coating systems, the additive separates in a controlled manner, forming very fine, needle-like microcrystals, which in turn, form a three-dimensional lattice structure via hydrogen bonds (figure 9). The initial formation of this structure may take up to several hours.

During application of such a modified coating system, very low shear forces are sufficient to destroy these lattice structures, giving the coating the desired low application viscosity. Following application, the structure reforms in the delayed fashion characteristic for thixotropic materials and the viscosity of the applied wet coating layer increases again.

Using the example of a metallic basecoat, figure 10 shows how the sedimentation of aluminum pigments is clearly reduced by BYK-410, and figure 8 shows the improvement of sag resistance in a zinc dust primer. ➤

Incorporation and Network Formation

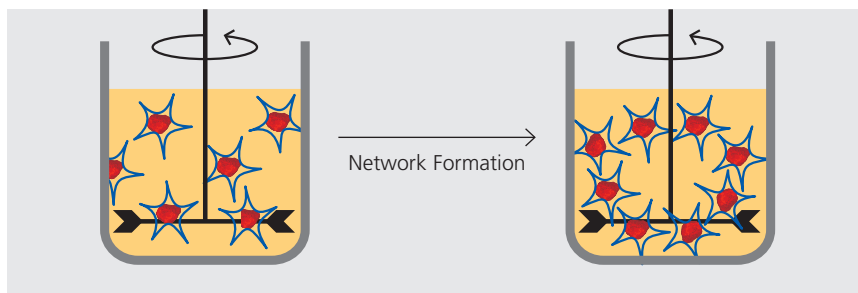


figure 9

Settling of a Metallic Basecoat

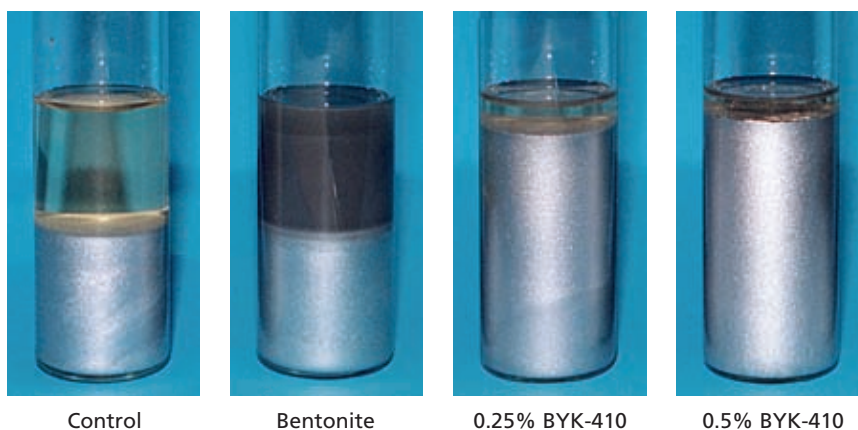


figure 10

Sagging Behavior of a Zinc Dust Primer

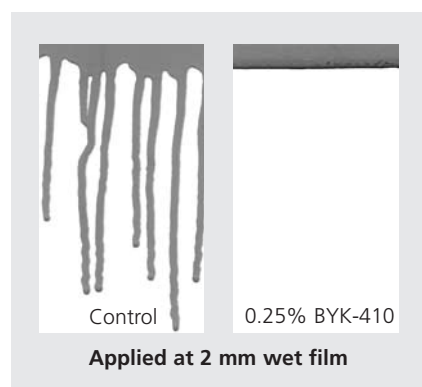
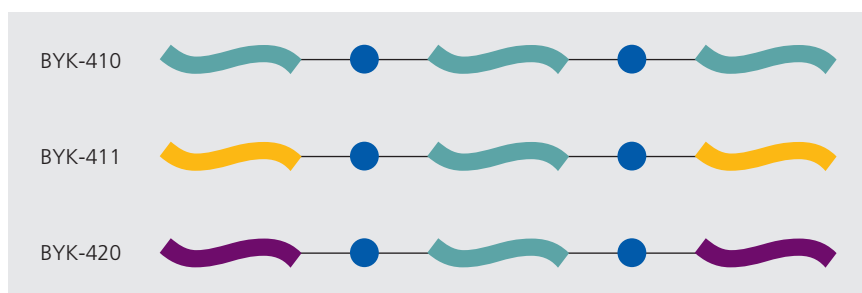


figure 8

> Liquid Rheology Additives for Thixotropic Flow Behavior

Chemical Structures



● Urea groups
 Modifying groups: high polar medium polar low polar

figure 11

Network Formation via Hydrogen Bonding

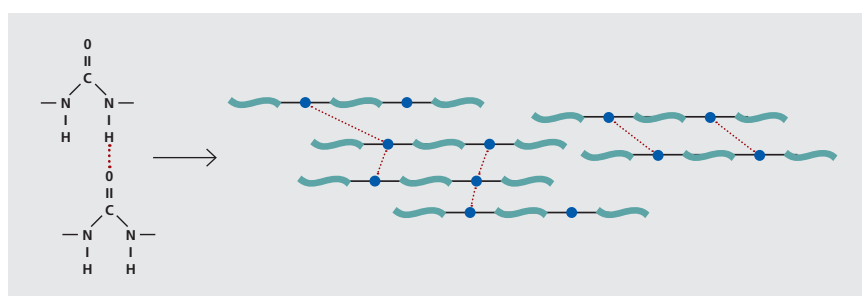
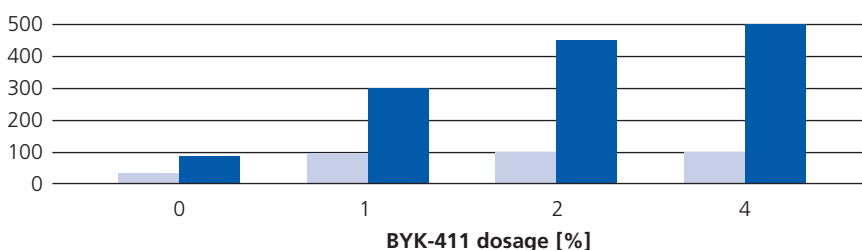


figure 12

Efficiency of BYK-411 Depends on Binder Content

Sag resistance [μm]



Alkyd clearcoat: 45% resin solids 55% resin solids

figure 13

The structures in figure 11 show the chemistry of the three additives. Binder compatible medium-polarity groups are between the urea groups. The terminal groups are different for the three different products: in BYK-410, the terminal groups are also medium-polar, in BYK-420 the terminal groups are more polar and in BYK-411 they are non-polar. These modifications control the application areas for the three products: BYK-410 is the standard product for solvent-borne and solvent-free formulations of medium polarity, BYK-411 shows significantly better efficiency and compatibility in low-polarity formulations, while BYK-420 is recommended for aqueous systems. In all cases hydrogen bonding between the urea groups of the individual molecules leads to the formation of the network structure (figure 12). In non-polar coating formulations (typically alkyd based coating systems), BYK-411 has another effect: the terminal non-polar groups of the urea molecules associate with the alkyd's non-polar fatty acid chains. The increase in the thickening effect of BYK-411 with increasing alkyd resin solids supports this mechanism (figure 13). In pure solvents and in very dilute binder solutions (resin solids less than 30%), virtually no increase in viscosity is detected with BYK-411. BYK-410 and BYK-420, on the other hand, are also rheologically active in pure solvents (or water) and do not require the presence of resins.

Notes on Use

Although these liquid additives are easy to use, several factors should be observed to achieve optimal results.

Polarity: BYK-410 has the widest application area of all three additives. It is most effective in medium-polarity coating systems and incompatible with non-polar and highly polar systems. This incompatibility manifests itself as turbidity or separation/seeding and substantially reduced efficiency. An overly polar or non-polar solvent/binder combination can often be corrected with the addition of small quantities of non-polar or polar solvents to make the combination compatible with BYK-410. A very simple and quick compatibility test is recommended before usage (figure 14). In very non-polar coating systems and in aqueous formulations, BYK-411 and BYK-420, respectively, are better alternatives.

Dosage: To a certain extent, use level is system-specific because the efficiency of the additive depends on the binder/solvent combination (polarity) for each case.

If the additives are used to improve anti-settling properties, low dosages are already sufficient. In most cases, good results are obtained with 0.1% to 0.3% additive.

To improve sag resistance on inclined surfaces, higher levels are needed, typically 0.5% to 1%, up to a maximum of 3%.

With very high dosages (>5%), possible turbidity (in clearcoats) and yellowing must be taken into consideration; in solvent-free systems, shrinkage stress cracking of the coating may occur. If very high quantities of additive are required to achieve sufficient thixotropy, this is an indication that the coating system may not be optimal polarity, even if there are no visible defects such as seeding or precipitation.

Incorporation: Since the additives are liquids, they can also be easily post-added to finished coatings. For trouble-free handling, incorporation should always be carried out with agitation. Midrange shear agitation (mixer, dissolver) is best for homogeneous incorporation; this procedure allows for optimal network formation, substantially improving sag resistance and anti-settling.

If the additive is incorporated using very low shear methods (manual stirring), the crystals formed will clump together and network formation is impaired. Distribution will be non-homogeneous and seeding may occur. Low shear incorporation is unsuitable and clearly not recommended. Incorporation using high shear forces (as during the pigment grinding stage) results in a finer crystal structure that reduces the density of the network formed. The resulting structure will still prevent pigment and extender particles from settling very effectively, but sag control will be reduced.

BYK-420 is especially recommended for the formulation of pigment or extender slurries in straight water to avoid sedimentation. It can also be

used in systems that do contain binder, but, depending on the resin chemistry involved, the rheological effect may be reduced. Therefore, binder compatibility with a given system should be checked before BYK-420 is used. The presence of small amounts of organic co-solvents in the formulation can improve incorporation and binder compatibility.

Combinations with other rheology additives that create a more pseudoplastic flow behavior, such as BYK-430, BYK-431 and BYK-425, are possible and in fact used in practice. Structure recovery after shear is then faster which can increase sag resistance.

All three additives make use of N-methyl pyrrolidone as solvent. NMP-free versions that contain N-ethyl pyrrolidone instead are also available under the names BYK-E 410, BYK-E 411 and BYK-E 420, because changes in labeling of NMP may restrict the usage of this solvent in the future. As of today, labeling of N-ethyl pyrrolidone will not change.

BYK-410: Compatibility Test

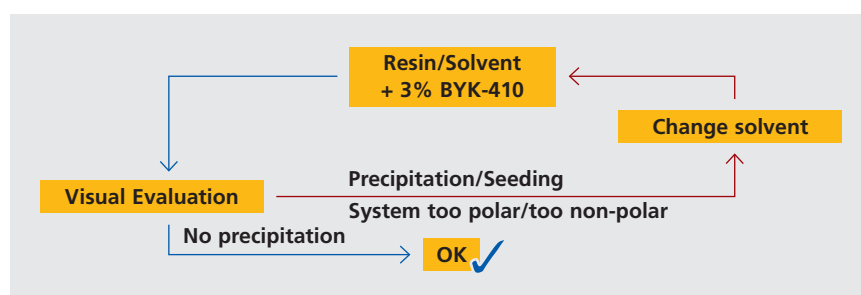
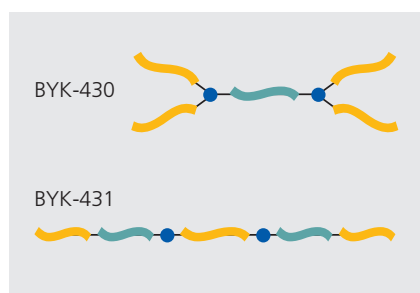


figure 14

Liquid Rheology Additives for Pseudoplastic Flow Behavior

Chemical Structures



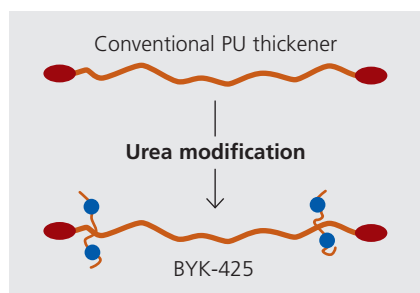
- Urea groups
- Polyamide
- Compatibility enhancing groups (alkyl, polyether)

figure 15

In contrast to the additives described in the previous chapter, the products BYK-430, BYK-431, BYK-425 and BYK-428 are liquid rheology additives which give a much more **pseudoplastic** flow behavior; they create no or only minimal thixotropy. These materials are ideal to avoid sagging when higher film thicknesses are required on inclined or vertical surfaces. They also provide anti-settling properties during storage. The chemical structures of BYK-430 and BYK-431 are shown in figure 15. These additives are based on polyamides modified with compatibility enhancing groups (alkyl and polyether segments)

to optimize their incorporation as well as their rheological activity. BYK-430 is recommended for medium polar systems and is used mostly in high build protective coatings. BYK-431 is designed for non-polar to medium polar architectural and industrial coatings. With BYK-425, which is especially developed for aqueous formulations, a different approach was chosen (figure 16). This product uses the well-known chemistry of hydrophobically modified urethane thickeners and combines it with the urea chemistry of BYK-420. The result is an additive that shows excellent anti-settling and anti-sagging performance in most aqueous binder systems. The rheological effect of BYK-425 comes from two mechanisms: association of the hydrophobic segments of several additive molecules (micelle formation) or with the binder and hydrogen bonding between the urea groups of the additive (figure 17). BYK-425 is a typical low shear thickener which is only active at medium and low shear rates. For optimal application properties (reduced roller spatter, sufficient brush drag resistance) as close as possible to the well-known solvent-borne alkyd paints, aqueous systems require higher viscosities in the high shear range. This can be achieved with high shear PUR thickeners like BYK-428 (figure 18). It is common practice to use combinations of a high shear and a low shear thickener.

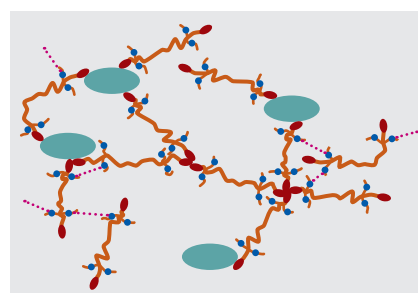
Chemical Structure of BYK-425



- Urea groups
- Hydrophobic groups

figure 16

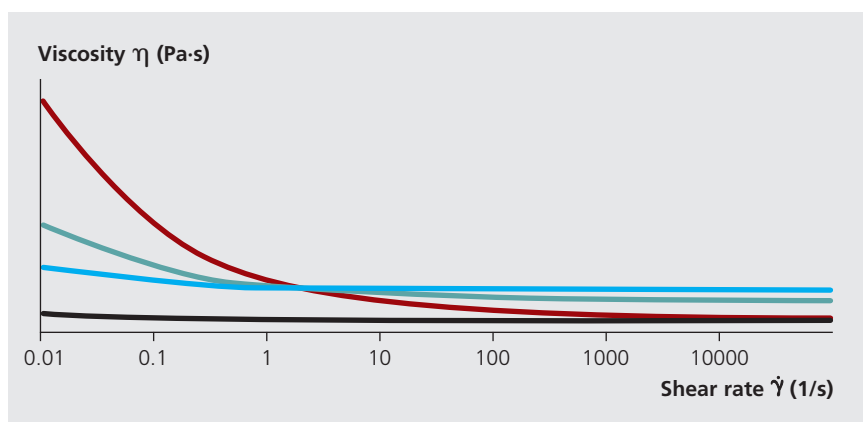
Mechanism of BYK-425



- Binder

figure 17

High shear/Low shear Thickener



- High shear thickener
- Thickener combination
- Low shear thickener
- Without thickener

figure 18

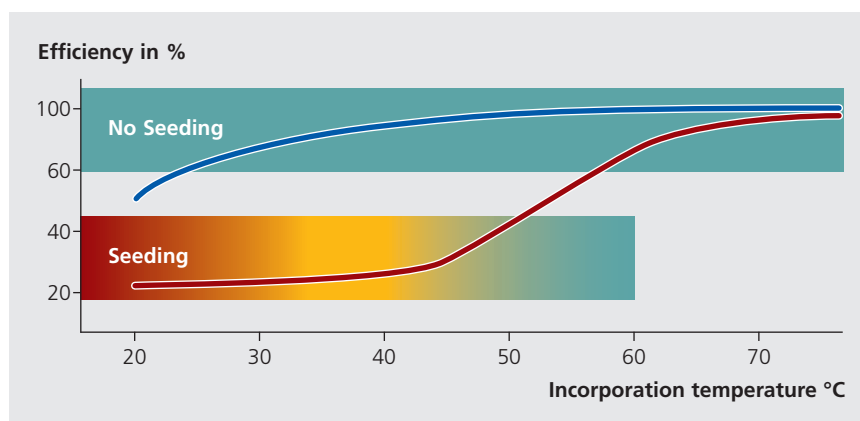
Notes on Use

Rheology additives based on polyamide (in form of powders or pastes) have the reputation of being not so easy and problem-free to incorporate in coating systems. High shear forces and an incorporation temperature above 60 °C are necessary to avoid seeding and to achieve a good rheological effect. The liquid additives BYK-430 and BYK-431 are much easier to handle (figure 19). They are easily incorporated at lower shear and lower temperatures without seeding and their effect on rheology is very strong.

Figure 20 shows a typical viscosity curve of BYK-430 in comparison with other rheology additives often used. It can also be seen, that BYK-431 gives a much more pseudoplastic flow behavior than the BYK-410.

The high sag resistance that can be achieved with BYK-430 is demonstrated in figure 21. In the tested epoxy primer no sagging is visible even at 500 µm wet film thickness; sagging starts only at 700 µm. ➤

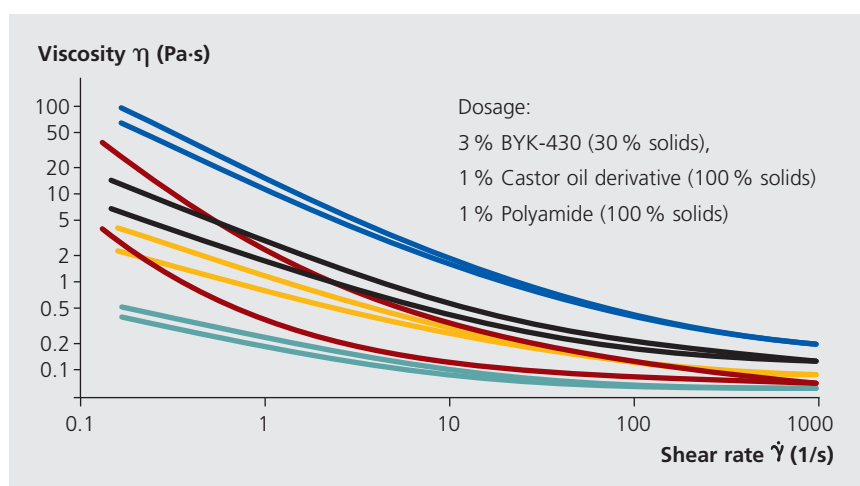
BYK-430/BYK-431: Easy Incorporation



■ BYK-430/BYK-431 (liquid) ■ Polyamide (powder/paste)

figure 19

BYK-430/BYK-431: Viscosity Curves



■ BYK-430/BYK-431 ■ BYK-410 ■ Polyamide ■ Castor oil derivative
■ Control

figure 20

BYK-430: Optimal Sag Resistance

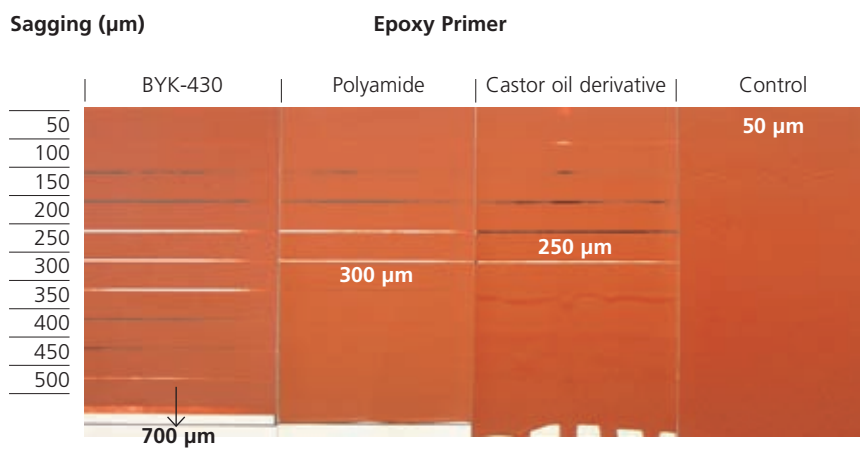
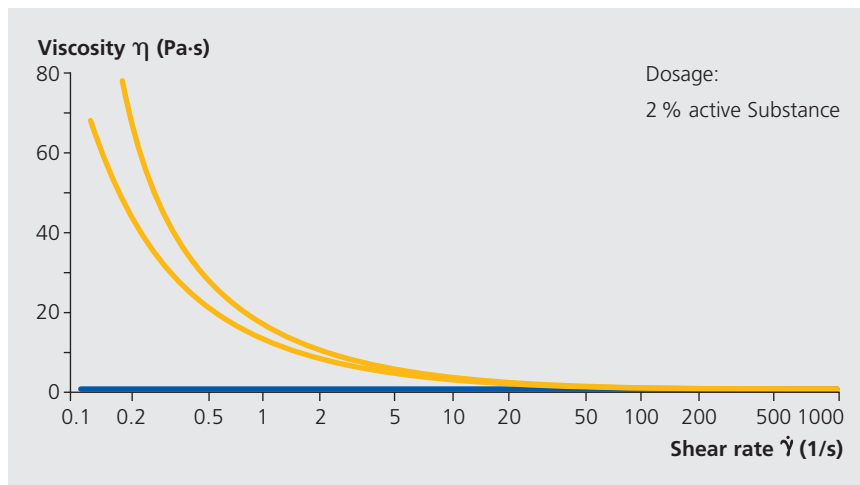


figure 21

› Liquid Rheology Additives for Pseudoplastic Flow Behavior

Efficiency in Straight Water

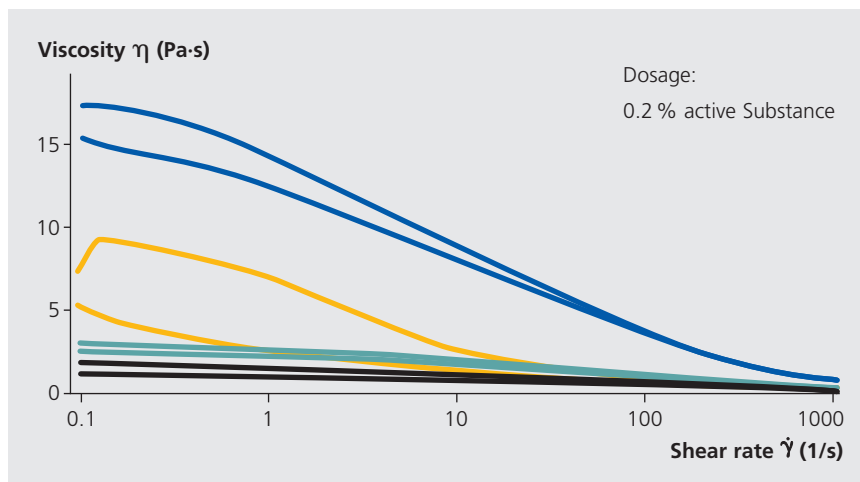


■ BYK-420 ■ BYK-425

figure 22

BYK-425 and BYK-428, like BYK-420, are all designed for aqueous coatings. They do create different types of flow behavior but there is one other difference: while BYK-420 is active already in straight water this is not the case for BYK-425 and BYK-428 (figure 22). The latter two products can only be used in systems that do contain resins. Figure 23 shows that, in an acrylic emulsion, both BYK-420 and BYK-425 are active. And it can also be seen, that BYK-420 creates a more thixotropic flow behavior, whereas the flow behavior with BYK-425 is more pseudoplastic.

Efficiency in Acrylic Emulsion



■ BYK-420 ■ BYK-425 ■ PU thickener ■ Control

figure 23

BYK-405, the Thixotropy Booster

The rheological additive BYK-405 can best be described as a thixotropy booster. Hydrophilic fumed silicas are used to control rheology in many coating formulations. These silica particles contain silanol groups on their surface that interact via hydrogen bonding to form bridging links to make three-dimensional structures (figure 24). Consequently, coating formulations with hydrophilic silicas display pseudoplastic and thixotropic behavior.

If the silica is used in combination with BYK-405, the latter behaves as a wetting and dispersing additive for the silica particles and also provides controlled flocculation. This additive has free OH groups that can participate in the hydrogen bonding along with the silica particles to create a denser bridging network. Because structures with more bridging are formed, coating thixotropy is therefore increased (figure 25).

BYK-405 stabilizes and increases the thixotropic behavior of formulations containing silica. It also facilitates the incorporation of fumed silica into the coating system. This last aspect is particularly beneficial in clear coats, as the shear forces normally available for silica incorporation are lower than in pigmented systems.

This additive also eliminates or reduces separation of the silica in the coating system. Figure 26 shows an example of how the addition of BYK-405 into a formulation with silica increases the system's low shear rate viscosity as well as its degree of thixotropy.

It is also possible to replace some of the silica with BYK-405 to minimize the effect of the silica on gloss and transparency while maintaining thixotropy.

Lattice Structure of Silica Particles

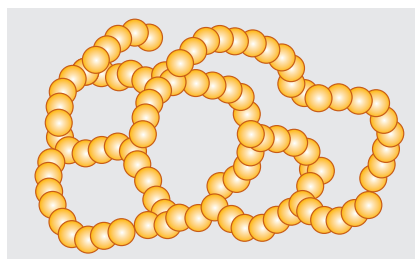


figure 24

Intensification of the Network by BYK-405

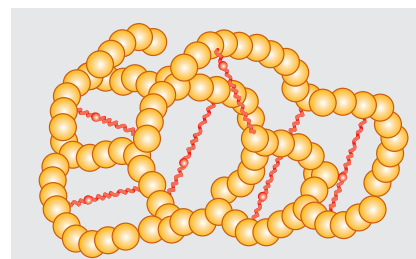
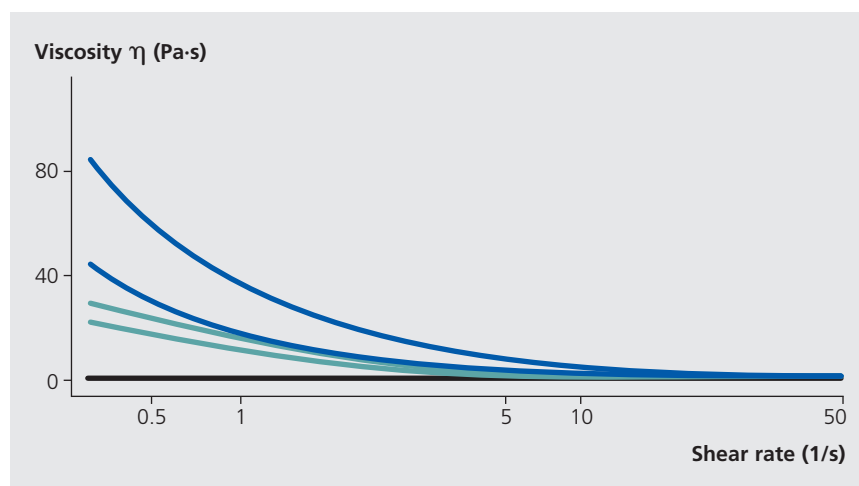


figure 25

Increase in Thixotropy by BYK-405



- Control (Plexigum PM 381)
- + 2.5% AEROSIL 200
- + 2.5% AEROSIL 200 + 2.5% BYK-405

figure 26

Wax Additives for Rheology Control

Wood Varnish (Cellulose Nitrate) with Silica Flatting Agent



figure 27

Waxes can also be used to control rheology. They are used in formulations containing effect pigments (aluminum and pearlescent pigments) or matting agents. The orientation of these solid particles is improved with wax additives; in the case of the effect pigments, the better orientation leads to better effect development and in the case of the matting agents, a more uniform matting is achieved. Settling of these solid particles during storage is also prevented, so that sediment formation is reduced.

Solvent-borne Systems

CERAMAT 258 is a wax preparation based on polyethylene wax that is used to eliminate sedimentation of matting agents and zinc stearate (which is used for better sandability) in solvent-based furniture and parquet varnishes as well as air-drying industrial coating systems (figure 27). It also contributes towards matting, and additionally provides good scratch resistance and better surface protection.

Waxes are used in effect coatings (metallic/pearlescent) on automobiles to achieve a uniform metallic effect with maximum flop and without mottling (figure 28). They are also used to reduce sedimentation of the effect pigments. CERAFAX 106 stabilizes effect pigments in packaged paints (unreduced). CERATIX 8461 was developed specifically to improve stability of reduced paints in closed loop circulation systems. Due to its powerful rheological influence, this product is used to prevent settling of effect pigments at spray viscosity (figure 29).

Because they are based on EVA copolymer waxes (ethylene vinyl acetate), both additives are specifically suited for lower polarity systems (basecoats formulated with polyester resins); in more polar formulations (basecoats with acrylic resins), CERAFAX 103 and CERATIX 8463 are more effective (wax base: ethylene acrylic acid, EAA).

CERAFAX 110 and CERATIX 8466 are similar products without aromatic solvents.

Metallic Basecoat without Mottling due to Wax Additive



figure 28

Sedimentation of a Metallic Base Coat after 48 h (Spray Viscosity)



figure 29

Waxes for Rheology Control

	Wax Type	Melting Point Wax Component in °C	Non-volatile Matter in %	Carrier
AQUACER 526	Modified EVA copolymer wax	105	30	Water
AQUATIX 8421	Modified EVA copolymer wax	105	20	Water
CERAFAX 103	EAA copolymer wax	110	6	Xylene/Butylacetate/Butanol 7/8/1
CERAFAX 106	EVA copolymer wax	105	6	Xylene/Butylacetate/Butanol 7/8/1
CERAFAX 110	EVA copolymer wax	100	6	Butylacetate/Butanol 15/1
CERAMAT 258	Oxidized HDPE wax	135	17.5	Butylacetate
CERATIX 8461	EVA copolymer wax	105	4.7	Xylene/Butylacetate/Butanol 3/6/1
CERATIX 8463	EVA/EAA copolymer wax mixture	110	4.4	Xylene/Butylacetate/Butanol 3/6/1
CERATIX 8466	EVA copolymer wax	100	4.7	Butylacetate/Butanol 9/1

figure 30

Aqueous Systems

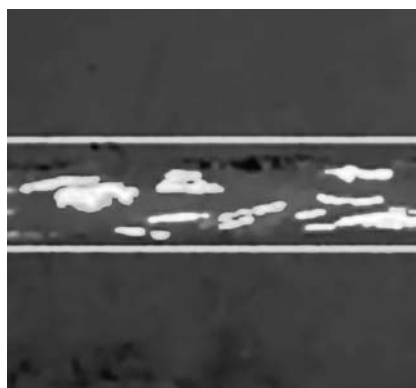
For aqueous effect coatings, the wax-based rheology additives AQUACER 526 and AQUATIX 8421 are available.

AQUACER 526 is recommended for industrial basecoats and one-layer topcoats (e.g., mobile phones and other consumer electronics). Figure 31 shows the improved effect pigment orientation in a basecoat (cross cut).

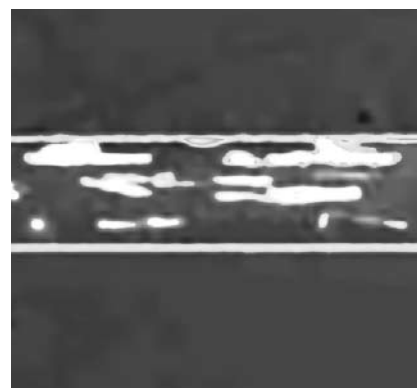
AQUATIX 8421 is designed to fulfill the high requirements of the automotive industry and can also be used in industrial and furniture coatings. It is a known fact, that control of effect pigment orientation is more difficult in aqueous systems than in solvent-borne systems. A high enough minimum viscosity of the coating in combination with pseudoplastic flow behavior is necessary but not sufficient. The viscoelastic behavior is quite decisive: after application the elastic part must be higher than the viscous part, in order to immobilize the effect pigments in a weak gel structure. AQUATIX 8421 is the first rheology additive for aqueous systems that is able to create such a flow behavior without a negative effect on other coating properties.

Pigment orientation, leveling and optical properties are optimal and the additive is easy to handle and incorporate because it is a liquid.

Effect Pigment Orientation with AQUACER 526



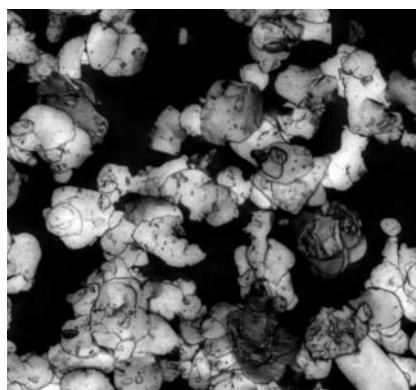
without wax additive



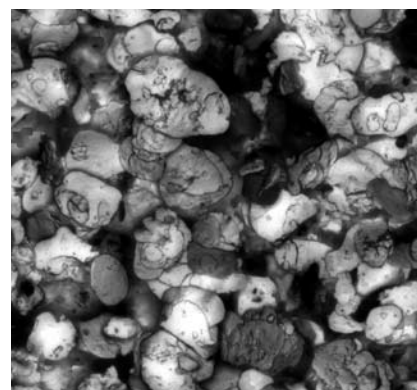
with 8 % AQUACER 526

figure 31

Effect Pigment Orientation with AQUATIX 8421



without rheology additive



with AQUATIX 8421

figure 32

Producing Perfect Organo Clay Gels

Organo clays (bentonites, hectorites) are widely used as thickeners in coating formulations to create or enhance pseudoplastic flow behavior and thixotropy in order to counteract settling and sagging. These materials are in powder form and they must be

properly dispersed in the coating system to achieve the desired results. To prepare pastes of organo clays in solvents (organo clay gels) as a masterbatch is oftentimes found very convenient because these pastes then can be introduced into various coating systems quite easily.

Theory...

The dry organo clay powder consists of particles, where many clay platelets are stacked together (figure 33). Solvents penetrate the space between the platelets and the stacks swell up. High shear forces are necessary to completely separate the platelets from each other. Water is used as chemical activator to create the organo clay gel: small amounts of water are sufficient to form links between several platelets via hydrogen bonds resulting in a three-dimensional network (figure 34). This network which is destroyed under shear and which rebuilds when no shear forces are present, is the reason for the pseudoplastic and thixotropic flow behavior.

...and practice

In practice, it is found that with high shear forces alone it is not possible to achieve a good dispersion of the clay platelets. Incomplete dispersion gives a highly viscous paste and strongly reduced rheological effect: insufficient anti-settling and anti-sagging properties (figure 35). It is common practice to use suitable wetting and dispersing additives to guarantee complete dispersion of the clay platelets. The resulting paste is lower in viscosity but shows excellent anti-settling and anti-sagging performance when incorporated into a coating system. Organo clay gels without and with wetting and dispersing additives are compared in figure 36 and figure 37: the wetting and dispersing additives create smaller particles which shows up in the improved transparency of the paste (as drawdown over a black&white substrate) and which is also proven by particle size measurements.

Well-Dispersed Organo Clay

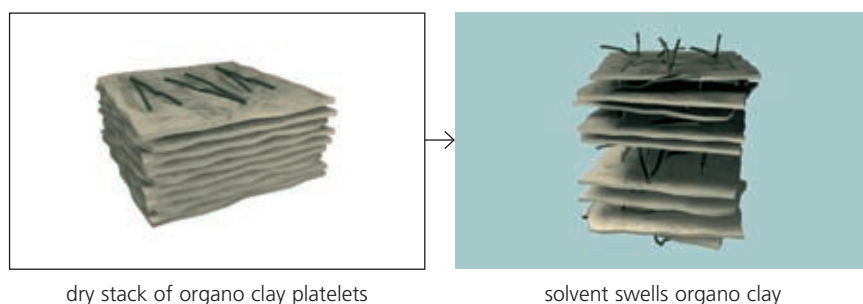


figure 33

Well-Dispersed Organo Clay

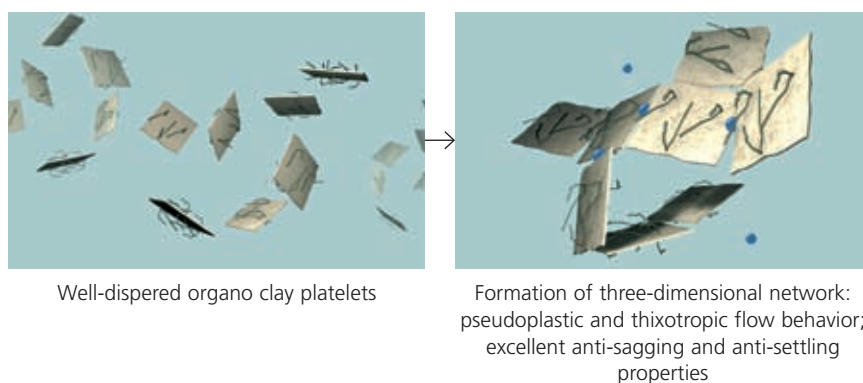


figure 34

Poorly Dispersed Organo Clay

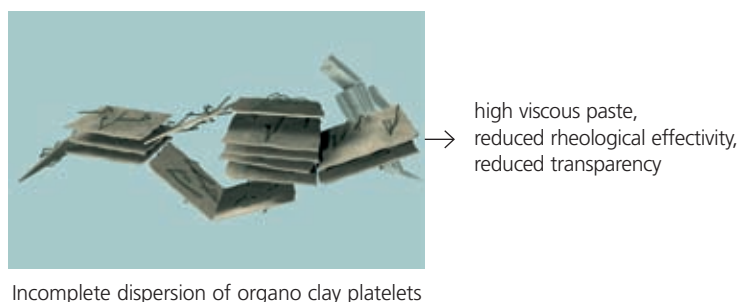


figure 35

Additive Recommendations

Several different additives are suitable for the formulation of organo clay gels. Our recommendations are summarized in figure 38.

For high gloss solvent-borne systems, ANTI-TERRA-U and ANTI-TERRA-U 100 are recommended. ANTI-TERRA-U contains xylene and isobutanol as solvents, whereas ANTI-TERRA-U is solvent-free and more suitable for aromatic-free formulations and situations where specific solvent mixtures have to be employed.

ANTI-TERRA-204 and ANTI-TERRA-205 are the right wetting and dispersing additives for highly filled systems, such as primers and undercoats. ANTI-TERRA-205 is aromatic-free whereas ANTI-TERRA-204 does contain aromatic solvents.

For aqueous gels, we recommend DISPERBYK, DISPERBYK-184 and ANTI-TERRA-206. DISPERBYK and DISPERBYK-184 are preferred in high gloss systems that contain no organic co-solvents and ANTI-TERRA-206 is used for filled systems and formulations that do contain organic co-solvents.

Formulations and Procedure

The formulation of organo clay gels is quite simple and basically the same in all cases (see figure 39): 85 parts (by weight) of solvents are combined with 5 parts of the wetting and dispersing additive and 10 parts of the organo clay. Slight variations are possible to allow for different contents of non-volatiles in the various additives and to optimize the organo clay gel. The procedure to produce organo clay gels is always the same and quite straightforward: the wetting and dispersing additive is mixed into the solvent and then the organo clay is added slowly under stirring. This results in reproducible organo clay gels with long-term stability and easy handling. They can be mixed into the coating formulations without problems and give strong and reproducible rheological effects.

For aqueous gels, clays without organic modification are used. The formulation of such gels is shown in figure 40. In aqueous gels, a suitable preservative should not be forgotten.

Drawdown of Organo Clay Gels over Black&White Substrate

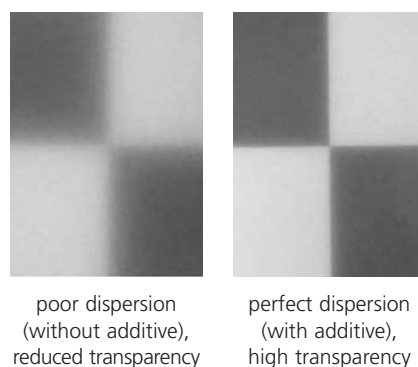
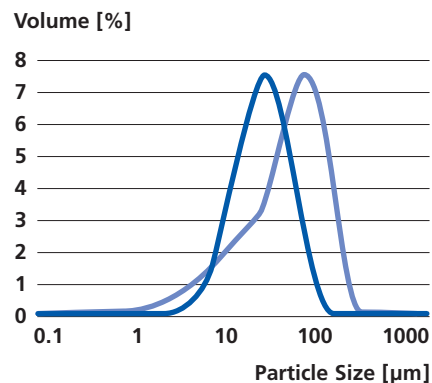


figure 36

Particle Size Distribution of Organo Clay Gels



■ With Additive ■ Without Additive figure 37

Wetting and Dispersing Additives for Organo Clay Gels

Solvent-borne coatings	
High gloss systems	ANTI-TERRA-U ANTI-TERRA-U 100
Filled systems	ANTI-TERRA-204 ANTI-TERRA-205
Aqueous coatings	
High gloss systems	DISPERBYK DISPERBYK-184
Filled systems	ANTI-TERRA-206

figure 38

Formulation of Solvent-borne Organo Clay Gels

Material	parts (by weight)
1. Solvents	85
2. Wetting and dispersing additive	5
3. Organo clay	10

figure 39

Formulation of Aqueous Gels

Material	parts (by weight)
1. Water	90
2. Wetting and dispersing additive	5
3. Clay	5

figure 40

Products and Applications

BYK Additives

Additives are used during the production of coatings, printing inks and plastics to optimize the production process and to improve the quality of the final product.

Product Range Additives

- Additives to improve surface slip, leveling and substrate wetting
- Adhesion promoters
- Defoamers and air release agents
- Foam stabilizers
- Processing additives
- Rheological additives
- UV-absorbers
- Viscosity depressants
- Waxes
- Wetting and dispersing additives for pigments and extenders

Application Areas

- Ambient curing resins (FRP)
- Architectural coatings
- Automotive OEM
- Automotive refinishes
- Can coatings
- Coil coatings
- Color masterbatches
- Industrial coatings
- Leather coatings
- Marine paints
- Molding compounds
- Paper coatings
- Pigment concentrates
- Polyurethane foams
- Powder coatings
- Printing inks
- Protective coatings
- PVC plastisols
- Thermoplastics
- Wood and furniture coatings

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