# Technical Information L-WI 1

## Wetting and Dispersing Additives

### Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why are Wetting and Dispersing Additives utilized?</td>
<td>3</td>
</tr>
<tr>
<td>The Process of Pigment Grinding</td>
<td>4</td>
</tr>
<tr>
<td>Wetting Additives</td>
<td>4</td>
</tr>
<tr>
<td>Dispersing Additives</td>
<td>5-6</td>
</tr>
<tr>
<td>Deflocculating Wetting and Dispersing Additives</td>
<td>7-9</td>
</tr>
<tr>
<td>Controlled Flocculating Wetting and Dispersing Additives</td>
<td>10-11</td>
</tr>
<tr>
<td>Star Polymers for the Stabilization of Universal Colorants</td>
<td>12</td>
</tr>
<tr>
<td>Prevention of Flooding and Floating</td>
<td>13</td>
</tr>
<tr>
<td>Practical Hints and Suggestions</td>
<td>14-15</td>
</tr>
</tbody>
</table>
One of the most important steps in the production of pigmented coatings is the homogeneous distribution of solid pigments within the liquid binder solution. If this pigment grinding step is not optimised, then a wide variety of defects can occur:

- Flocculation
- Gloss decrease
- Color shift
- Flooding/floating
- Bénard cells
- Settling

In addition, rheology-related properties such as the following can be negatively affected:

- Sagging
- Leveling

Pigment agglomerates are reduced in size during the pigment grinding phase; ideally this leads to the production of primary particles. Agglomerates represent pigment “groupings” in which the interstitial spaces between the individual pigment particles contain air and moisture. These individual pigment particles are in contact with one another only along their edges and corners. Interactive forces between the particles are relatively small so that such forces can be overcome by traditional dispersing equipment. (In contrast, aggregates are more compact and exhibit planar contacts between the individual pigment particles and it is much more difficult to split them into primary particles.)

In the dispersing phase (figure 2), energy is added to the system and therefore smaller particles (with a larger interface to the resin solution) are formed. The system then endeavors to escape this energy-rich state in order to revert to its previous low energy condition. This is evidenced by the finely distributed pigments coming back together to form flocculates. Effects such as reduced color strength, decreased gloss, and altered rheology then occur. From a structural standpoint, the flocculates are very similar to the agglomerates; nevertheless, the interstitial spaces between the pigments are now filled with resin solution rather than air.
The Process of Pigment Grinding

The various processes which occur during pigment grinding can be divided into the following three steps (figure 3):

During **Step 1**, all of the air and moisture at the pigment surface is driven off and then replaced by the resin solution. The solid/gaseous interface (pigment/air) is transformed into a solid/liquid interface (pigment/resin solution). The resin solution must penetrate into the space between the agglomerates.

**Step 2** represents the true pigment grinding stage. Through mechanical energy (impact and shear forces), the pigment agglomerates are broken up and accordingly reduced in size. In the concluding **Step 3**, the pigment dispersion must be **stabilized** in order to prevent the formation of uncontrolled flocculates. As described later, special techniques make it possible to keep the pigment particles at appropriate distances from one another so that they do not resume contact. In most applications the stabilization of the deflocculated condition is desirable; in other applications the pigment dispersion can be stabilized by controlled co-flocculation (which will be discussed later).

Steps 1 (wetting) and 3 (stabilizing) can be influenced by additives. **Wetting additives** accelerate the wetting of pigment agglomerates by the resin; **dispersing additives** improve the stabilization of the pigment dispersion. One and the same product can oftentimes function as both the wetting and the dispersing additive.

### The Wetting and Dispersing Process

![Diagram](figure3)

**1 Wetting**

**2 Dispersing**

**3 Stabilizing**

### Washburn Equation

\[
\frac{dl}{dt} = \frac{r}{2l\eta} \cdot \gamma \cos \Theta
\]

- \(v\) = penetration speed
- \(l\) = penetration depth
- \(t\) = time
- \(r\) = capillary radius
- \(\eta\) = viscosity of liquid
- \(\gamma\) = surface tension of liquid
- \(\Theta\) = contact angle

### Wetting Additives

The wetting of pigment agglomerates through the resin solution is influenced by many factors. The penetration speed of the liquid phase into the interstices between the agglomerates is – under considerably simplified conditions – mathematically expressed by the **Washburn equation** (figure 4).

The capillaries between the pigment particles are assumed to be cylindrical tubes with radius \(r\). The first factor on the right hand side of the equation shows that for fast wetting (high penetration speed) loosely packed agglomerates and low viscosity of the liquid are favourable. However, the agglomerate structure cannot be influenced by the paint producer and the possibilities for viscosity reduction are fairly limited.

The second factor looks more promising: here we have the surface tension of the penetrating liquid and the contact angle. Both can be influenced by wetting additives but they are not independent from each other: it is not possible to have a high surface tension together with a low contact angle. In practice wetting additives are used to lower the surface tension as far as necessary to bring the contact angle close to zero; further reduction should be avoided.

**Wetting additives** can be defined as substances which are designed to reduce the contact angle between pigment and resin solution and which, as a result speed up the penetration of the liquid into the agglomerate structure. Characteristic for such substances is their surface-active structure: polar, hydrophilic structural elements along with nonpolar, hydrophobic structural elements combined in one molecule. Because of this very structure, such molecular combinations are interfacially active. (For example, wetting additives migrate to the pigment/binder solution interface.) From a chemical standpoint, wetting additives can be classified as either ionic or non-ionic – according to exactly how the polar segment is incorporated into the molecule. The non-polar segment is, as a rule, represented by hydrocarbon chains.
Dispersing Additives

Dispersing additives absorb onto the pigment surface and therefore maintain proper pigment spacing through electrostatic repulsion and/or steric hindrance, thus reducing the tendency towards uncontrolled flocculation. Both stabilization mechanisms are described below.

**Electrostatic Repulsion**

The pigment particles in the liquid paint carry electrical charges on their surfaces. Through the usage of additives, it is possible to increase the charges and, furthermore, to make all pigment particles equivalently charged. Counterions concentrate in the vicinity of the pigment surfaces (in the liquid phase) so that an “electrical doublelayer” is formed (figure 5). Stabilization increases along with the thickness of this layer. The electrostatic repulsion stabilization mechanism is especially useful in waterbased latex dispersion and related systems. Chemically speaking, the additives used for dispersion in such systems are polyelectrolytes – higher molecular weight products which contain a multitude of electrical charges in the side chains.

Because of their chemical structure, such additives display hardly any wetting properties; therefore, in practice, it is necessary to combine them with wetting additives.

**Steric Stabilization**

Dispersing additives which function by steric hindrance display two special structural features. First, such products contain one or more so-called “pigment-affinic” groups – anchor groups or adhesive groups – that all together provide a strong, durable adsorption onto the pigment surface. Second, such products contain resin-compatible chains (hydro-carbon entities) which, after adsorption of the additive onto the pigment surface, protrude as far as possible from the pigment into the surrounding resin solution. This layer of adsorbed additive molecules with the protruding chains is referred to steric hindrance or “entropic stabilization” (figure 6).

The above stabilization is further accentuated by the interaction of the additives polymeric segments with the resin polymers in such a way that the “envelope”, so to speak, around the pigment particles is enlarged. This stabilization mechanism occurs in solvent-borne systems and in water-reducible systems which contain solvated resins. Through specific structural elements composed of pigmentaffinic groups (polar) and resin-compatible chains (non-polar), these additives exhibit definitive surface-active properties. In other words, they not only stabilize the pigment dispersion, but they also function as wetting additives.
Dispersing Additives

Controlled Flocculation
If the pigment affinic groups are not merely confined to a small region of the additive molecule, but are distributed in a special fashion over the molecule – then such an additive can function as a bridge between various pigment particles. Because of the additive’s designs three-dimensional wetting structures are formed as shown in the figure 7. The size and stability of such flocculates are determined by the additive – in particular, through the additive-additive and additive-pigment interactions. In this case, controlled flocculation states occur in which the degree of flocculation is dependent upon the chemical structure and the usage level of the additive. Also in this chemical structure, the single pigment particles (because of the additive molecules) remain separated from each other. This type of pigment stabilization leads to different paint properties than in the case of deflocculation of the pigments. Details you can find in the following chapters. In each situation it must be decided which kind of stabilization is more advantageous.

Controlled Flocculation
Deflocculating Wetting and Dispersing Additives

Deflocculation generates a rather Newtonian flow behavior along with reduced viscosity. In this manner, flow behavior is improved and a higher pigment loading is possible. Due to the small particle size of the deflocculated pigments, high gloss is obtained and color strength is increased. Likewise, transparency and hiding power are also improved, dependent upon whether the pigment at hand was designed by the manufacturer to be transparent or opaque.

Deflocculation leads in general to an improved, more efficient pigment utilization, which (especially in the case of the sometimes rather expensive organic pigments) is not economically unimportant. The flocculation level also has an influence upon the developed shade or tint of a pigment (figure 8). If, for example, a system tends to flocculate upon storage, then color shift can result. In situations where this is especially critical (such as in the base component of a mixing system), the only way to produce coatings with a constant and defined shade is through complete deflocculation. All in all, the properties described above are of special interest for topcoats.

Low Molecular Weight, Polymeric Wetting and Dispersing Additives for Solventborne Systems

The structure of the classical deflocculating additives has already been described (see figure 6) as one or more spatially close pigment affinic groups and a number of resin-like chain structures. Such additives are low molecular weight polymers that adsorb upon the pigment surface and that stabilized the deflocculated condition by steric hindrance. ANTI-TERRA-U is an additive from this group that has proven its effectivity during several decades and is still widely in use. Newer developments include products like DISPERBYK-107 or DISPERBYK-108 that fulfil modern requirements such as containing no aromatic solvents or no solvents at all. Specific developments for universal colorants are discussed on page 11.

High Molecular Weight Polymeric Wetting and Dispersing Additives for Solventborne Systems

In order for additives to be effective, a durable and permanent adsorption onto the pigment surface is of utmost importance. The surface properties of the pigment particles are crucial to the additive’s effectiveness. Inorganic pigments are ionically constructed and display relatively high surface polarities, thus making adsorption of the additives relatively easy. With organic pigments however, the pigment crystals are composed of individual molecules which themselves are dominantly non-polar. As a result, organic pigments have very non-polar surfaces and therefore make proper adsorption of conventional additives rather difficult. In practice, this means that organic pigments are insufficiently deflocculated and stabilized by traditional wetting and dispersing additives. For the above reason, a new group of additives has been developed over the past few years – high molecular weight polymeric wetting and dispersing additives (figure 9). Such additives differentiate themselves from the conventional low molecular weight polymers through considerably higher molecular weights which allow the attainment of a resin-like character. In addition, the newer additives contain a considerably higher number of adhesion groups. Because of these structural features, such additives can form durable adsorption layers upon many organic pigments. Stabilization arises from steric hindrance (as with the conventional products) in which well solvated polymer chains are utilized. Optimal stabilization is possible only when such polymer chains are properly unfurled and therefore quite compatible with the surrounding resin solution. If this compatibility is obstructed, then the polymer chains collapse. Consequently, all chances for steric hindrance and the resultant stabilization are lost.

Color Shift

[Diagram of color shift: Deflocculation → Flocculation]
The compatibility of a high molecular weight polymeric product with various coatings resins is considerably more restricted than that of a low molecular weight variety. Accordingly, an entire family of chemically related additives (classified according to molecular weight, polarity and compatibility) is available. The recommended usage levels of the high molecular weight polymers are considerably higher than those of the classical low molecular weight molecules. (For details about usage levels, please refer to page 14). Even though the polymeric wetting and dispersing additive were developed for organic pigments, they may also be utilized equally well with inorganic pigments. Major products in this group are DISPERBYK-161 for high quality industrial systems such as automotive coatings and DISPERBYK-163 or DISPERBYK-167 (no aromatic solvents) for a wide range of industrial applications. The additives of the DISPERBYK-160-family contain cationic anchor groups which in isolated cases may interact with acidic components in the coating formulation (e.g. acid catalysts in coil coatings). In these cases additives from our DISPERBYK-170-family are recommended which make use of a different anchor group chemistry and thus avoid such problems. Also additives that are specific for the stabilization of titanium dioxide (e.g. DISPERBYK-110) are included in this group.

**Water-borne Coating Systems**

In emulsion systems electrostatic repulsion is the main mechanism for pigment stabilization and polyelectrolytes are used as very effective dispersing additives. They adsorb onto the pigment surface and consequently transfer their charge to the pigment particle. The strong electric charges drastically reduce flocculation and thus stabilize the deflocculated state. Ammonium and sodium salts of polycarboxylic acids (such as BYK-154 and BYK-155) are widely used for this purpose. Stabilization strongly depends on the thickness of the electrical double layer and this thickness itself is drastically reduced in the presence of (multivalent) ions. Even small amounts of salts should therefore be avoided in systems that are stabilized by electrostatic repulsion because they will interfere with the stabilization mechanism. As mentioned earlier, polyelectrolytes act only as dispersing additives but they have no effect on pigment wetting. If better pigment wetting is required they must be combined with wetting additives such as DISPERBYK-187.

Aqueous systems that are based on water-soluble resins or combinations of emulsions and water-soluble resins (hybrid systems) can also use electrostatic repulsion in principle for pigment stabilization. However, in practice it is found that steric stabilization with polymeric wetting and dispersing additives is oftentimes preferred, especially in high quality industrial coatings. The mechanism works in the same way as in solvent-born coatings, the only requirement being that the polymeric additives must be polar enough to ensure compatibility with the aqueous surroundings. It is not necessarily desirable for such additives to be water-soluble since too high a polarity could adversely affect the durability of the coating system (e.g. water-resistance). A proper balance must be achieved. Typical products representing this group of additives include DISPERBYK-180, DISPERBYK-184 and DISPERBYK-190. Compared to the polyelectrolytes described above, the efficiency of additives of this type will not be reduced in the presence of electrolytes due to their different stabilization mechanism.

In this method of stabilization, the influence of the organic co-solvent is more important, considering that nearly every present day water-borne formulation contains small amounts of co-solvents. These organic solvents can alter the solvation properties of the dissolved polymeric structures and thus can considerably influence viscosity. Presently there are many ventures to formulate co-solvent-free systems; nevertheless, very few successful systems have been introduced to date.
Modern Polymerization Methods

To synthesize effective additives, not only must the appropriate monomers for the pigment affinic groups and the binder compatible groups be selected, but their arrangement in the copolymer chain is also crucial. If the monomers are statistically distributed along the chain, no improvement of pigment stabilization will be observed. As already described above, block structures are more favourable for wetting and dispersing additives. These block structures can be modified in several ways to create structured block copolymers (see figure 10). The segments consisting of the A monomers (pigment affinic groups) do not need to be compatible with the binder system, because the B segments are responsible for compatibility. However, if block A is too incompatible, the handling of the additives becomes difficult and reduced efficiency will also be observed. Therefore it can be beneficial to have some B monomers within the A block. Another possibility is to make the sharp transition between the A and B segments smoother by synthesizing a gradient copolymer, where the concentration of B monomers increases along the chain while the A monomers decreases.

The knowledge about interactions between copolymer structure and additive efficiency is only helpful, when it is possible to reproduce the complex copolymer structures not only in the laboratory but also in production. And in this respect the situation today looks much better than several years ago. For some years now, modern polymerization methods (ATRP, NMP, C-RAFT, S-RAFT, GTP) have been available to provide very high control of the copolymer’s finestructure. These methods (the first four are often summarized as “CRP”, controlled radical polymerization) all have their specific features and advantages/disadvantages and can be used to polymerize a wide range of monomers under controlled conditions. DISPERBYK-2000 and DISPERBYK-2001 were our first wetting and dispersing additives produced by controlled polymerization (GTP) and were introduced in 1999. Newer products such as DISPERBYK-2010 and DISPERBYK-2020 make full use of the possibilities that modern CRP methods offer today.
The concept “flocculation” carries rather negative connotations; however, there are indeed certain conditions under which *controlled* flocculation may actually be more desirable than complete flocculation. It is important to clarify the difference between the above flocculation state and the “normal” flocculation state. Without additives, the pigment particles make direct contact with one another as *uncontrolled* floculates. In contrast, no direct pigment-pigment contact occurs in controlled flocculates; additive molecules are always between the pigment particles (figure 7). Although uncontrolled flocculation is always undesirable (since a variety of negative effects occur), controlled flocculation can purposefully be used to attain certain desired effects in the coating system. The controlled flocculation state forms three-dimensional *network structures* which lead to thixotropic flow behavior within the coating. Through these structures, the resting state viscosity is rather high. However, when shear forces are applied, the structures (pigment flocculates) break apart and induce lower viscosity. Afterwards (following removal of the shear forces), the floculates can rebuild. Generally, such systems display a flow threshold. Through the above rheological behavior, properties such as sagging and settling can be positively influenced. During paint processing and handling, the shear forces maintain viscosity at a low enough level to assure easy processability. Then, in the resting state (such as after application), the viscosity increases quickly and leads to excellent stability on vertical surfaces even at high film thicknesses. The same positive influence is observed in regard to settling properties.
Through the high resting state viscosity (in this case, during storage), pigment particle settling speed is greatly reduced. In regard to settling, an additional factor should be considered. Oftentimes a small, yet rather hard and compact layer may build up and be resistant to re-incorporation. However, in a controlled flocculation system, this does not occur since additive molecules are always between the pigments. Sedimentation (if it occurs at all) is much softer, larger in volume, and therefore easily re-incorporated. Through controlled flocculation, both flooding and floating can also be controlled since the different pigments are bound together in the flocculates, and consequently cannot separate from the mixture. The building of flocculates can naturally reduce coating gloss; systems should be evaluated on a case-by-case basis for possible undesirable effects. Especially in primers and primer surfacers, lower gloss is generally acceptable.

Controlled flocculating additives can also oftentimes be utilized in topcoat systems; dependent upon the resin system and the additive usage level, lower gloss may not necessarily occur. The primary application area for controlled flocculating additives is found in primers, undercoats and in protective coating systems, whereas deflocculating additives demonstrate special utility in topcoats demanding optimal appearance and excellent surface properties (figure 11).

Controlled flocculating additives are also often used in combination with other rheological additives (BYK-410, fumed silicas, dehydrated castor oils, and bentonites – see brochure L-RI 1 Rheology Additives) because of frequently occurring synergistic effects. The two most widely used controlled flocculating additives are ANTI-TERRA-203 and ANTI-TERRA-204. BYK-P 104 demonstrates moderate controlled flocculation behavior and was specially developed to combat flooding/floating in titanium dioxide and color pigment combinations. Optimal performance, without adverse effects upon gloss and rheology, is achieved through co-flocculation. High gloss, flood/float-free systems can be formulated to meet the performance requirements of general industrial coatings.
Star Polymers for the Stabilization of Universal Colorants

Universal colorants must have optimal compatibility with polar and non-polar binder systems. Wetting and dispersing additives form an integral part of such colorants and must also work in systems ranging from aqueous resins to long oil alkyds. These requirements can be fulfilled with the patented technology of star polymers. Wetting and dispersing additives using this approach are based on polymers having a characteristic star-like structure. These additives, in addition to their pigment affinic anchoring group, contain three side chains of different polarity (see figure 12).

Depending on the types of resins that are used, different stabilization mechanisms are employed (see figure 13). In coatings based on organic solvents the effect of the additive can be explained by steric stabilization through the non-polar side chains. In aqueous systems, the main stabilization comes from electrostatic repulsion with only a minor contribution from steric stabilization through the polar side chains. DISPERBYK-2091 and DISPERBYK-2090 are recommended for this application.
Prevention of Flooding and Floating

Most pigmented coating systems contain more than one pigment type. Flooding and floating occur when the various pigments separate from one another and are no longer homogeneously distributed.

If, in the paint surface, local differences in concentrations occur, one speaks of “horizontal” floating. This results in Bénard cells, silking or streaking (figure 14).

The paint surface then does not show a homogeneous color, but a dotted, silky one. If there are no concentration differences in the paint surface, but there are in the vertical direction, the phenomenon is called “vertical” flooding. In this case the coating layer shows a uniform color; the defect is only visible when the “rub-up” test is utilized (figure 14, right).

Pigment Mobility

Differences in pigment mobility is often the decisive factor that causes pigments to no longer be homogeneously distributed. When solvents evaporate from a paint film, eddies and currents form within the film. Such movements inside the film can be traced back to small intrafilm differences in temperature, density, and surface tension (figure 15). The pigments naturally participate in such movements; and when differential pigment mobilities occur – pigment separation along with flooding and floating occur.

Differential mobility can be equilibrated through the usage of controlled flocculating additives.

Of course, controlled flocculation is undesirable in many topcoat systems, especially premium quality systems. High molecular weight polymeric additives offer an appropriate solution in the above coatings. They have proven performance in equilibrating pigment mobility, while simultaneously providing complete deflocculation of all pigments. Through the intense interaction of the adsorbed polymeric additives with the surrounding resin solution, the deflocculated pigment particles are tightly incorporated into the resin system. Consequently, the mobility is then no longer determined by particle size and density; in contrast, the overwhelming factor is this interaction. This explains how flooding and floating can be eliminated even in the presence of smaller, deflocculated organic pigment particles and larger, inorganic pigments.

Pigment Charge

It is certainly no new discovery that pigments in liquid paints can carry electrical charges. In water-borne systems, the electrostatic repulsion between like-charged pigment particles serves as the primary mechanism for stabilization of the deflocculated state (figure 5). In solvent-borne systems, stabilization is achieved mainly through steric hindrance since the pigment charges are considerably weaker. In spite of the relative weakness of the charges, the electrostatic repulsion effects still play an important role in the stability state of pigment dispersion. The particular charge carried by a pigment depends not only upon the pigment itself, but also upon the resin solution. A pigment that is ground in different resins can display different charges. Different pigments that are ground in the same resin can also display different charges (figure 16). Obviously, strong flocculation can occur when different pigment charges exist within the same paint. It is interesting to note, that all additives of the DISPERBYK-160/DISPERBYK-170/DISPERBYK-180 family provide positively charged pigments. In other words, when the pigment in the control system is already positive, then no change in charge occurs upon additive usage; however, if the pigments were negatively charged, then the additive imparts a positive charge. The additive provides an additional stabilizing effect and therefore equilibrates not only the mobilities of the various pigments (in addition to providing steric hindrance), but also assures the avoidance of instability by imparting the same exact charge (positive) to all pigment particles.

Flow Pattern in Coatings (Bénard Cells)

Control of Pigment Charge

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Pigment Charge</th>
<th>Without Additive</th>
<th>With Additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quinacridone red</td>
<td></td>
<td></td>
<td>☑</td>
</tr>
<tr>
<td>Perylene red</td>
<td>☑️</td>
<td></td>
<td>☑️</td>
</tr>
<tr>
<td>Phthalo blue</td>
<td>☑️</td>
<td></td>
<td>☑️</td>
</tr>
<tr>
<td>Oxide yellow</td>
<td>☑️</td>
<td></td>
<td>☑️</td>
</tr>
<tr>
<td>Binder: OH-Acrylic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Recommended Usage Levels**

The proper usage levels of the wetting and dispersing additive, as with all additives, is of prime importance. Since the additive is designed to attach to the pigment surface, then the required dosage of additive depends upon the amount of pigment surface present.

**Classical wetting and dispersing additives** based upon low molecular weight polymers should be utilized in quantities of 0.5-2.0% with inorganic pigments and in quantities of 1.0 to 5.0% with organic pigments (additive delivery form based upon pigment weight). Based on the entire formulation weight, additive usage levels of 0.1 to 1.0% are generally employed.

Considerably higher usage levels of the **high molecular weight additives** are necessary, especially with small particle size organic pigments. These high dosages are needed since pigment surface area with organics is much greater than with inorganics. In practice, this means that increased usage levels are required to match the higher pigment surface area. Such levels are no cause for concern though, since the resin-like properties of the polymeric additives have no negative influence on coating durability. Based upon both outdoor tests in Florida and tests in weather-simulating devices and over 10 years in practice, the above has been confirmed. With inorganic pigments, the recommended usage levels are reduced (because of the smaller surface areas involved) to levels equivalent to those generally used with the low molecular weight products.

Typical usage levels for inorganic pigments are 1-10%; for organic pigments, usage levels are 10-30% (additive in active substance based upon pigment weight). With very fine-particle pigments (for example, some carbon blacks), usage levels of 60-80% are necessary.

As indicators of proper stabilization, gloss and transparency should be considered. Concerning mixtures, flood/float-behavior should be evaluated with the “rub-up” test. When laboratory studies are scaled up to production levels, one must be careful to assure that equivalent grinding conditions are created. Only in this fashion can comparable grinding results be achieved.

**Usage levels**

<table>
<thead>
<tr>
<th>Type of Wetting and Dispersing Additive</th>
<th>Inorganic Pigments</th>
<th>Organic Pigments</th>
<th>Total Formulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical, low molecular weight polymers</td>
<td>0.5-2% additive on pigment</td>
<td>1-5% additive on pigment</td>
<td>0.1-1% additive</td>
</tr>
<tr>
<td>High molecular weight polymers</td>
<td>1-10% additive on pigment</td>
<td>10-80% additive on pigment</td>
<td>0.2-3% additive</td>
</tr>
</tbody>
</table>

**Point of Addition**

Wetting and dispersing additives should be incorporated into the grind to achieve optimum performance. The formulation of the grind ("resin-poor", "resin-rich") and the order of addition of the individual components can certainly influence the grinding quality.

Theoretically, the best results can be achieved when – first of all – only the pigment, solvent(s) and additive are mixed together ("pre-mix"). This allows the additive to attach to the pigments without having to compete with the resin polymers. In practice, however, this method is only necessary for "worstcase scenarios". Demands are sometimes placed upon additives to perform in "post-add"-situations and also in finished batches to correct flood/float and/or flocculation problems. Certain additives are more appropriate than others for such usage. As a rule, higher dosages are necessary.
Single Grinds and Co-grinds
Whenever only one pigment is being dispersed, then all important parameters (additive quantity and grinding conditions) can be optimized. The end result is the best possible grind quality. In practice, however, co-grinds with several pigments are generally the rule. Compromises in regard to grinding parameters are therefore necessary. This means that results cannot be compared to those of single grind systems. In any event, one should closely examine all individual pigments in the system, in order to identify “difficult-to-handle” pigments. Additional corrective measures should be determined on an individual basis. As example, problematic pigments can be exchanged for other pigments, they can be ground separately, or can even be added as pigment concentrates.

Pigment Concentrates
Pigment concentrates (pigment pastes) have found broad application in the coatings industry. They are used either as tinting/shading bases or as full mixing (intermix) systems. In regard to achieving proper pigment stability and improved ease of handling – wetting and dispersing additives are irreplaceable components of such concentrates. Additional information about this interesting topic is available (brochure L-TI 1 “Pigment Concentrates”).

Combinations with Rheological Additives
As already described, wetting and dispersing additives can influence paint system rheology. This, however, is only a side-effect of such additives. For true rheological control, they are used in combination with other rheological additives (BYK-410, BYK-420, BYK-425 fumed silicas, bentonites and dehydrated castor oils). Synergistic effects can be observed in many cases. Organo-clays (bentonites) are commonly added as pastes. Here, wetting and dispersing additives can help optimize the production of such pastes. Bentonites can be activated with deflocculating as well as with controlled flocculating additives. The question of which product should be employed depends upon the performance desired in the final paint. ANTI-TERRA-204 and ANTI-TERRA-U are the most universal products for this application.

Combinations with Silicone Additives
Page 13 summarizes, first of all, the causes of flood/float behavior, and then describes exactly how flood/float can be prevented with wetting and dispersing additives. In practice, surface-active silicone additives are utilized in combination with the above wetting and dispersing additives in order to repress Bénard cell formulation. BYK-310, for example, has proven itself to be a very compatible, heat-stable silicone additive for this purpose.

Some additives like BYK-P 104 S contain small quantities of silicone functionality so that separate silicone addition is often unnecessary. Additional performance and application details about silicone additives for coatings can be found in our brochure L-SI 1 “Surface Additives”.

Side-effects of Wetting and Dispersing Additives
Two primary reasons for using wetting and dispersing additives are (1) the wetting of pigments and (2) the stabilization of pigment dispersions. In addition, such additives influence other paint properties. For example, rheological effects (such as the hindrance of sagging and settling) have already been described. It is important to realize that alteration of rheological properties can influence the flow behavior along with foaming properties. That is why deflocculating wetting and dispersing additives can also function as flow and leveling aids, as well as preventing foam formation and enhancing defoamer performance. Improperly selected wetting and dispersing additives can also impair film formation and decrease anti-corrosion properties. On the other hand, properly selected additives can even improve anti-corrosion and related properties. The above examples are highlighted to emphasize that two important factors must simultaneously be considered when selecting the proper wetting and dispersing additive. The first factor is, of course, the additive’s influence upon wetting and dispersing properties; the second factor is the summation of the additive’s influence upon all the properties within the formulated coating system.
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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

BYK Instruments
BYK offers a complete line of testing instruments to solve your needs in many application areas:
• Gloss/Appearance
• Color

Portable or stationary laboratory equipment – including easy to use quality control software.

This information is given to the best of our knowledge. Because of the multitude of formulations, production, and application conditions, all the above mentioned statements have to be adjusted to the circumstances of the processor. No liabilities, including those for patent rights, can be derived from this fact for individual cases. This brochure replaces all previous issues – printed in Germany.