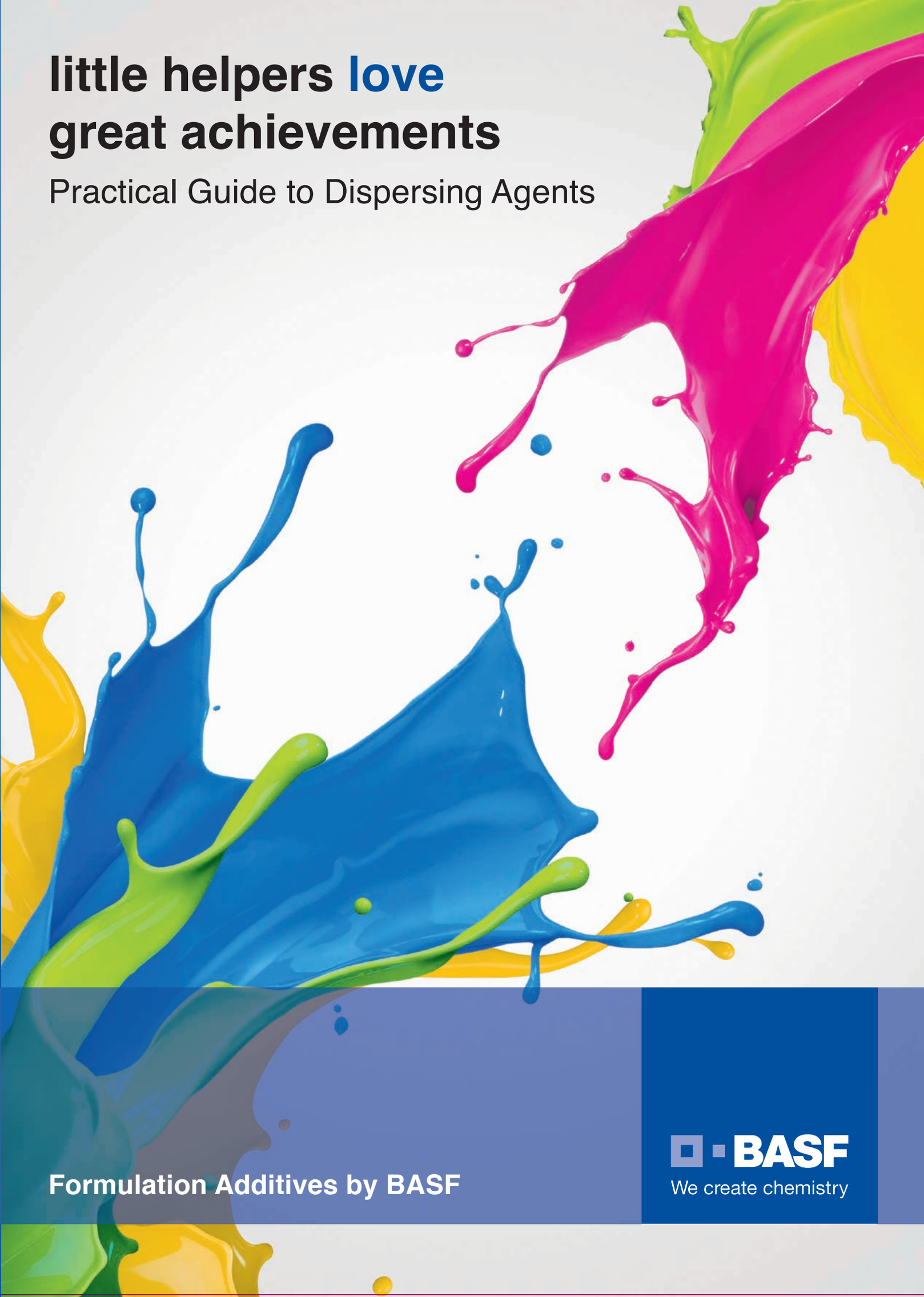
little helpers love great achievements

Practical Guide to Dispersing Agents



Formulation Additives by BASF

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PREAMBLE

BASF

the world's leading chemical company, is a premier provider of innovative solutions for the paints and coatings industry. BASF offers virtually every ingredient needed to make high quality coatings – along with the know-how to solve formulation challenges and support the development of new coating concepts. Our portfolio encompasses dispersions, pigments, resins and a broad range of additives such as light stabilizers and photoinitiators and formulation additives.

When it comes to formulation additives, BASF offers a strong portfolio of industry-leading products that help to enable sustainable and performance-driven solutions. Our offer comprises the broadest technology base of dispersing agents, wetting agents & surface modifiers, defoamers, rheology modifiers and film forming agents.

We put our understanding, listening & collaboration skills at the forefront to serve our customer's needs. With global manufacturing capabilities, a strong research and development platform, full-service regional technical laboratories, pre-screening capabilities and a team of knowledgeable, experienced experts, BASF can help to make your coatings better and your business more successful.

This booklet has been developed in order to give paint formulators and technicians first hand guidance on the use of Dispersing Agents from BASF and on making the most out of their performance characteristics.

Looking for innovative solutions where little helpers make all the difference for your high quality coatings?

BASF - We create chemistry

Table of Contents

Dispersing Agents: An Introduction

Paints and coatings make our world more beautiful. They give color and protection to things that are valuable to us.

Solid particles such as pigments and fillers are important components of paints, coatings and inks and need to be dispersed and stabilized well in the formulations to assure consistent color, quality and durability.

Highly specialized additives are needed to wet, disperse and stabilize dry pigment powders in liquid formulations. These dispersing agents represent an essential component of most paint and coating formulations. Their specialized function ensures color strength, gloss, viscosity stability and prevents sedimentation of particles. Today, high quality coatings of high brilliance and color strength are characterized by a perfect pigment dispersion, optimal pigment particle size and long-term stabilization of the dispersed particles in the formulation.

BASF's knowledge of pigment chemistry and surface treatments combined with our know-how about dispersing agents and their technology enables us to find optimum solutions for our customers and their formulation challenges.

Figure 1:
Dry pigments.

To produce paint and coatings with high color intensity, gloss and hiding power, dry pigment powders have to be dispersed and stabilized in an optimal way. Dry pigments are made up of agglomerates or aggregates of primary pigment particles. During the dispersion process they have to be broken down, as far as possible, into primary particles. A mixture of crushing action and mechanical shearing force is necessary to achieve an optimal dispersion. During this process the surface of the pigment particles is being wetted and stabilized by dispersing agents which absorb onto the pigment surface. Usually, the pigment dispersion process is one of the most difficult and time-/energy-consuming parts of the paint production process.

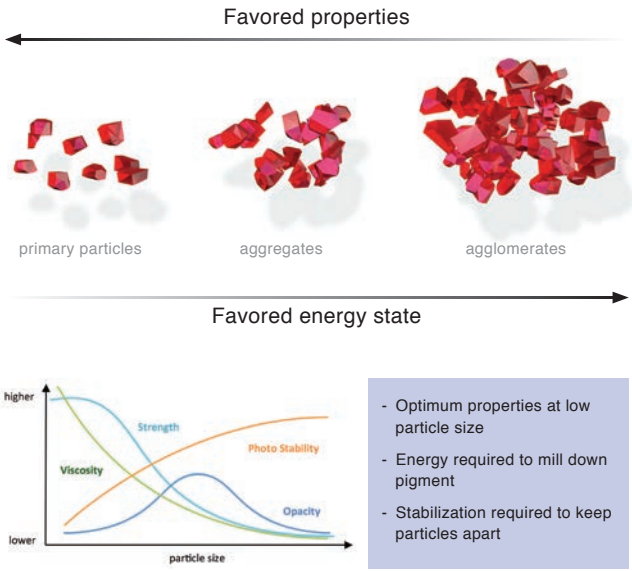


Figure 2:
Need for dispersion, whereby optimum properties of a pigment are achieved at low particle size.

Figure 2 gives an overview of the correlation between particle size and key properties like photo stability, opacity and color strength. Generally, higher color strength is achieved at lower particle sizes. However, the surface area has to be stabilized to avoid re-agglomeration of the small particles. Also viscosity is high at low particle sizes, limiting the amount of pigment in a formulation and creating the need for viscosity reduction. Both viscosity reduction and stabilization can be achieved by using optimized dispersing agents.

Good to know:

- **Benefits of dispersing agents**
  - Shorter dispersion time
  - Enhanced gloss
  - Increased color-strength and hiding power
  - Reduced viscosities
  - Improved tone development
  - Prevention of flooding and floating
  - Prevention of flocculation
  - Prevention of settling of pigments and fillers

The Dispersion Process

The Dispersion Process

Any pigment dispersion process can be divided into three stages: Wetting, dispersion and stabilization (Figure 3).

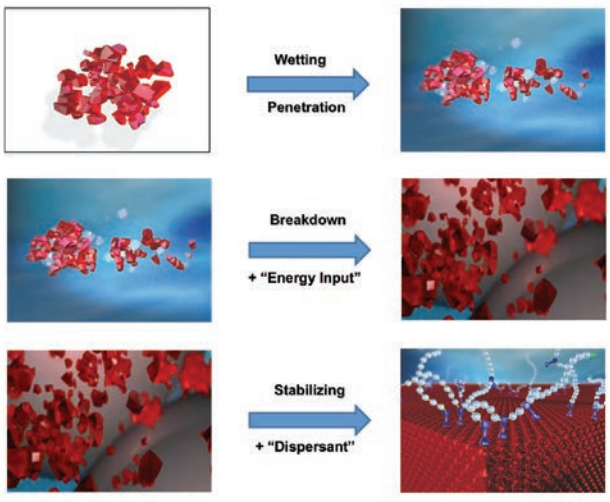


Figure 3:
Wetting, dispersion (breakdown) and stabilization of pigment particles.

Wetting of pigment particles

During the grinding process the particle surface needs to be wetted by the surrounding liquid. Usually the dry pigment powder contains entrapped air, which has to be removed and replaced by the liquid. To make this happen the liquid needs to wet the particle surface. Wetting takes place if the surface tension of the liquid is lower than the surface energy of the particle's surface. This criterion for wetting is also known as the wetting condition and is pictured in Figure 4.

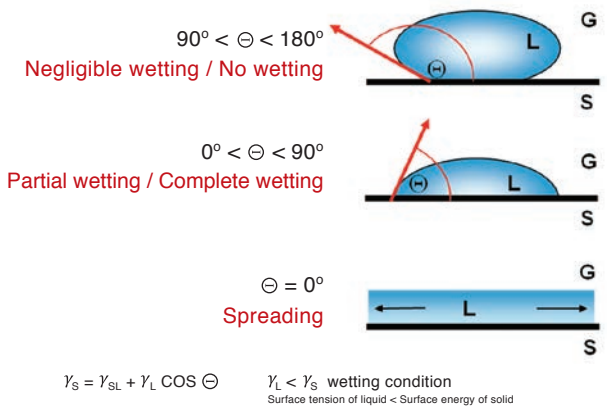


Figure 4:
Three wetting conditions and their relation to contact angles.

There is a significant difference in this process between solvent-borne and water-borne systems. The wetting step in solvent-borne systems is generally quite easy because of the low surface tension of organic solvents:

Xylene	:	30 mN/m
Butylacetate	:	25 mN/m
White spirit	:	24 mN/m
Soya bean long oil alkyd	:	37 mN/m

Due to the significantly higher surface tension of water, special additives are required to lower the surface tension and enable sufficient pigment wetting:

Water	:	72.7 mN/m
Aqueous dispersion	:	35-45 mN/m

Thus an effective wetting agent for a coating formulation should have surfactant characteristics in order to lower the surface tension of the liquid to allow the liquid to wet the pigment surface. This is especially of importance if hydrophobic pigments have to be dispersed in aqueous media. The high surface tension of the aqueous carrier fluid has to be lowered down by a suitable wetting or dispersing agent to achieve optimal pigment wetting.

But it should not be assumed that a low surface tension is the only criterion for a dispersing agent in the wetting process. This is only partly true due to the fact that the dispersing medium should also be able to penetrate into the pores of pigment agglomerates, which is achieved by capillary flow.

For fast penetration of the dispersing medium into agglomerates and pigment pores, it is most beneficial to have a certain surface tension. In order to achieve capillary flow the wetting condition should be fulfilled (Cos Theta (Θ) > 0) thus creating an upper limit to the liquid surface tension. Furthermore, other factors like large capillary radius (loosely packed particles) and low liquid viscosity help to optimize flow and wetting.

The Dispersion Process

Dispersing

During the grinding or dispersion step the agglomerated particles are mechanically broken down to smaller particles. This is usually done by using grinding equipment such as dissolvers, bead mills or three-roll mills.

The ideal condition is to disperse the particles to their primary particle size or to as small as possible aggregates which usually cannot be broken down further.

Pigment agglomerates are crushed to smaller particles and the newly formed surfaces have to be wetted by the liquid carrier. The use of suitable wetting and dispersing agents increases the speed of pigment surface wetting and for this reason can reduce the dispersion time significantly.

On the other hand, wetting and dispersing agents reduce the interactions between the pigment particles and lower the viscosity of the mill base. This allows higher pigment loads and easier processing.

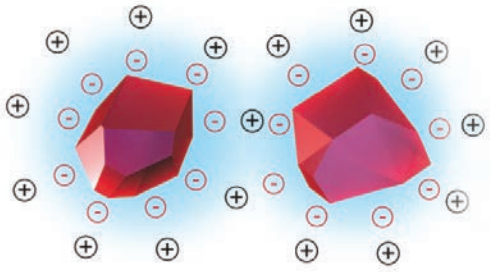
Stabilization

During the dispersion process, particle agglomerates and aggregates have been broken down to smaller particles, like primary particles or aggregates. The formation of smaller particles results in an increase of the surface area of the solid particles. This newly formed surface area has to be stabilized to avoid reagglomeration. The higher the interfacial tension between liquid and solid, the stronger are the forces to reduce the interfacial area – in other words to reagglomerate or to form flocculates. Therefore an effective long term stabilization of the pigment particles is important. Insufficient stabilization can cause negative effects like flocculation, color shift, sedimentation or changes in viscosity of the dispersion.

Basically, dispersing additives provide stabilization of pigment dispersions by two main stabilization mechanisms: electrostatic or steric stabilization. (Figure 5)

Charge Stabilization

Electrostatic Repulsion

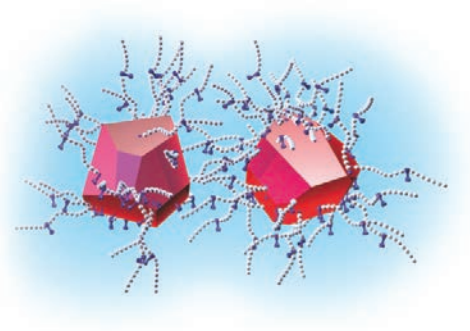


repulsive force

- Particles carry surface charge
- Model of electric double layer
- Main relevance for dispersions in water and inorganic pigments
- Stability can be affected by high salt concentrations

Steric or Entropic Stabilization

Steric Hindrance



repulsive force (osmotic pressure)

- Solvent soluble polymer chains anchored to the particles
- Effective in both solvent and water
- Robust stabilizing mechanism

Figure 5:
Mechanisms of pigment dispersion stabilization: electrostatic or steric stabilization.

Electrostatic stabilization occurs if particles bear the same electrical surface charge and, as a result, repulsion takes place. As this mechanism depends on the separation of ionic charges, it is mainly relevant in systems of high polarity like aqueous paints. The charge around the particle is arranged into a double layer in which each layer possesses an equal charge. If two particles approach each other, their charged double layers overlap and repulsion takes place. At the same time, London van-der-Waals forces cause the particles to attract. If the attractive forces are stronger than the repulsive forces the dispersion will be unstable. However, if repulsive forces predominate, the system will be non-flocculating.

Steric stabilization is characterized by adsorbed polymers on the pigment surface and applies to both water- and solvent-borne systems. This stabilization mechanism is dependent on the structure and dimensions of the adsorbed polymer layer. The dispersing polymer adsorbs onto the pigment surface with so-called ”anchoring groups” or segments that have strong affinity to the pigment surface. The remaining polymer segments can be regarded as “dissolved” and are responsible for compatibility with the solvents and resins. They also stabilize the pigment dispersion by protruding into the surrounding solvent.

These extended parts of the stabilizing polymer are the first point of contact between two approaching particles. If the particles come closer to each other, the polymer chains start to interpenetrate thus increasing the local concentration of polymer chains. As a result of osmotic pressure, the solvent molecules start to migrate into the zone of the interpenetrating polymer layers and re-separate the two particles again. In this way a balance is achieved between attraction and repulsion. The thickness of the absorbed polymer layer determines whether the distance between the particles is large enough to overcome the London van-der-Waals attraction forces between the molecules. In practice, it is generally accepted that a molecular weight of at least 5,000 g/mol is required to achieve the most desired distance.

Modern dispersing agents combine electrostatic and steric stabilization mechanisms. This is usually referred to as “electrosteric stabilization”. Especially dispersing additives for high quality water-borne applications use this combined stabilization mechanism in order to fulfill today’s demands in terms of stability, color development and compatibility/gloss. (Figure 6)

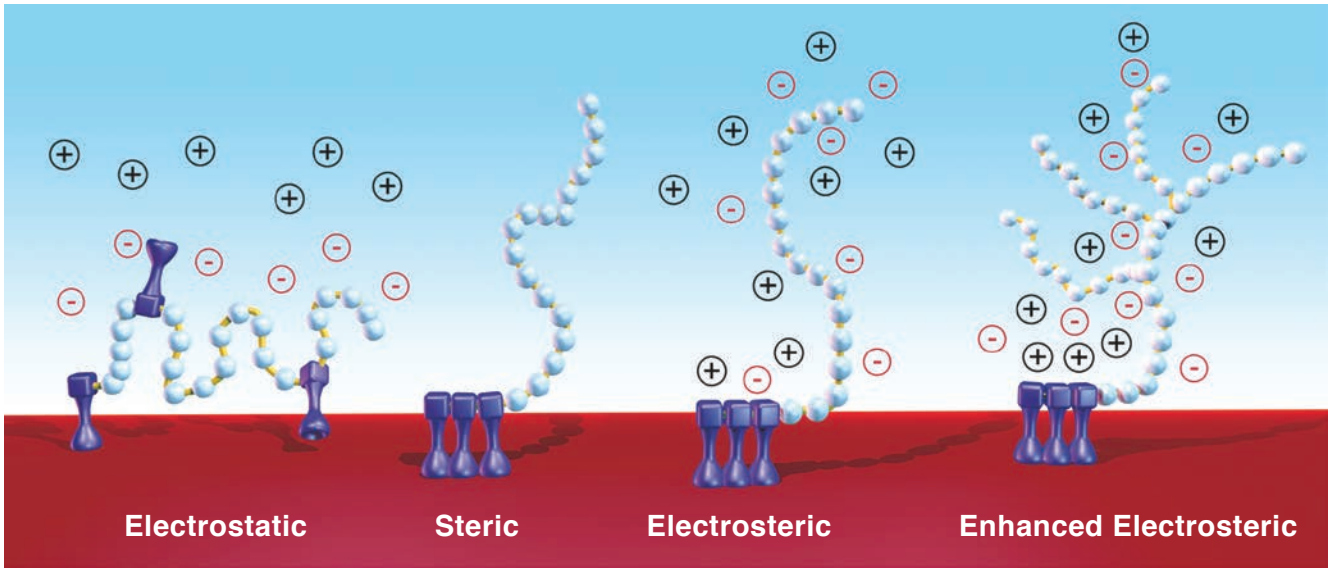


Figure 6:
Different types of pigment stabilization in aqueous systems.

Dispersing Agents by BASF

Dispersing Agents by BASF

BASF Formulation Additives offer a full range of dispersing agents for all coating and ink formulations containing highly efficient solutions for aqueous, solvent-based, high-solid or 100% solids systems and for pigment concentrates. The broad technology portfolio includes polymeric, oligomeric and surfactant-based dispersing agents. Especially, the award-winning controlled free radical polymerization (CFRP) allows for higher efficiency and broader compatibility which creates optimal rheology and improved coloristics. Benefits are outstanding viscosity reduction, enhanced gloss, increased color intensity and hiding power.

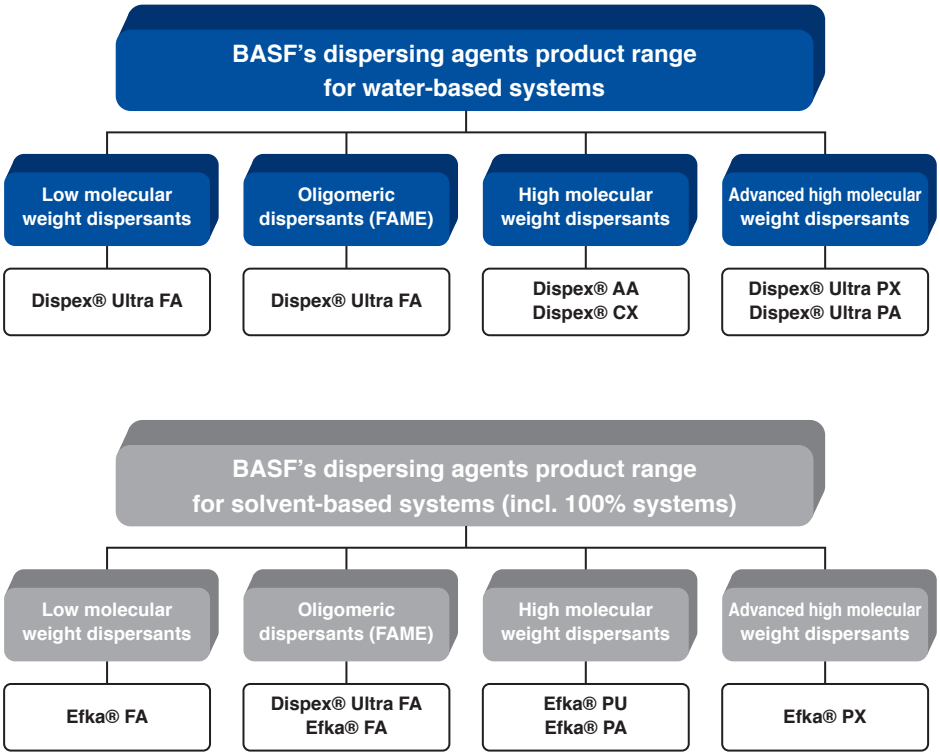


Figure 7:
Overview of dispersing agents for aqueous and solvent-based systems.

BASF Dispersing Agents Product Range

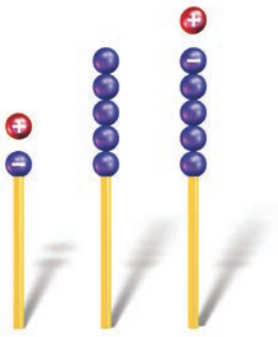
Low molecular weight dispersants

Dispex® Ultra FA and Efka® FA types

Low molecular weight dispersants are an established class of surfactant type products and are categorized according to their chemical structure as anionic, cationic, electro-neutral or non-ionic. The molecular weight of these products is low, usually between 300 and 2,000 g/mol.

Among the low molecular weight dispersants the formulator can find products for water-based and solvent-based formulations. Low molecular weight type dispersing agents are well established products in the industry and their broad applicability and compatibility is especially appreciated.

Figure 8:
Schematic representation of surfactant-type low molecular weight dispersants.



Nonionic and anionic surfactant-type structures

In this range, also mono functional oleo-alkylene oxide block copolymers are offered, which provide excellent wetting and dispersing properties in binder and solvent-free, aqueous pigment pastes. In this group of products excellent alternatives to alkylphenol ethoxylate (APEO) based surfactants can be found, allowing the paint producer to formulate so-called universal pigment concentrates which are suitable for both water- and solvent-borne paints.

BASF Dispersing Agents Product Range

Oligomeric dispersants

Dispex® Ultra FA and Efka® FA types

A very versatile group of oligomeric dispersants are fatty acid modified emulsifiers (FAME). These products are based upon fatty acid chemistry, having polar heads based on tertiary amines. These anchoring groups are similar to those of our high molecular weight dispersants, and have proven affinity to pigment surfaces. Typically, these molecules are oligo-functional, meaning that more than two amino anchoring groups are present. The molecular weight ranges from 1,000 to 3,000 g/mol.

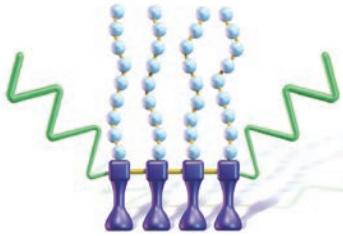


Figure 9:
Schematic representation of oligomeric dispersant.

The hydrophilic heads of these new types of emulsifiers contain tertiary amines which allow the products to be effective dispersing agents by acting as excellent anchoring groups for all kinds of organic and inorganic pigments. Oligomeric dispersants can also be used effectively when combining water-borne colorants into solvent-borne base paints. This technology enables paint producers to easily develop universal colorants for the decorative market. It is also possible to improve color acceptance of base paints by using these oligomeric dispersants as part of the formulation.

High molecular weight dispersants

High molecular weight dispersing agents offer a pronounced stabilization effect. This is due to a high number of anchoring groups along the polymer backbone which bind to numerous sites on the pigment surface. These high molecular weight dispersing agents can be linear or branched molecules with molecular weights between 5,000 and 20,000 g/mol.

BASF Formulation Additives offer the following types of high molecular weight dispersants:

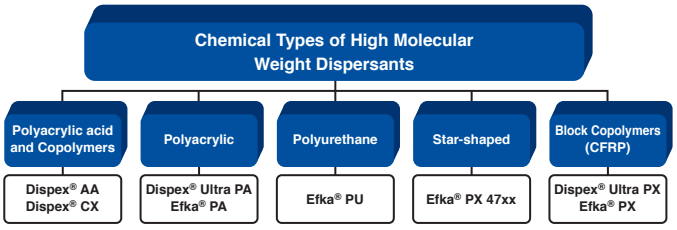


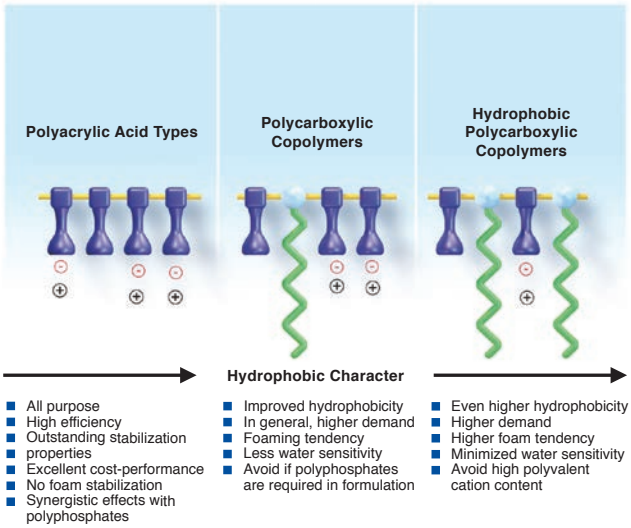
Figure 10:
Overview of high molecular weight dispersants.

BASF Dispersing Agents Product Range

Polyacrylic acid and copolymer dispersants

Dispex® AA and Dispex® CX-grades

Dispex® AA and Dispex® CX-grades are anionic dispersing agents based on polycarboxylic (co-)polymers. They are standard dispersing agents in most aqueous decorative paints and coatings. Their narrow molecular weight distributions provide optimum dispersion efficiency, translating into maximum performance at the lowest possible formulation cost. Anionic dispersants are especially effective in stabilizing inorganic pigments and fillers.



Anionic dispersants are used particularly in the paint industry to achieve the highest possible loading of fillers and pigments in the grind phase. Higher loadings allow finer grinds that in turn improve the hiding power of the paint so as to extract the maximum value from the pigments.

In order to increase the scrub resistance of decorative paints, often dispersants with medium to high hydrophobic character are used. The optimal choice of the dispersing agent can increase the scrub resistance significantly.

Figure 11:
From pure polycarboxylic (co-)polymer based dispersants to more hydrophobic copolymers.

Polyacrylates

Efka® PA and Dispex® Ultra PA grades

Polyacrylates are a higher quality range of dispersants with special grades for water-based as well as for solvent-based systems mainly used in the industrial field. Generally they have a higher molecular weight which provides effective interparticle separation.

Polyacrylic dispersing agents have linear structures with a C-C backbone that bears various functional side groups and short side chains. The main difference to polyurethane-based dispersants is their higher molecular weight.

Figure 12:
Schematic representation of a polyacrylate dispersant.

Polyurethanes

Efka® PU-grades

Efka® PU-grades are best suited dispersants for viscosity depression in solvent-based and solvent-free systems in the mill base. This leads to higher pigment loads, more economical mill base formulations and lower VOCs.

Polyurethane dispersants usually have a branched backbone with a three dimensional network structure. Different anchoring groups are introduced at various points on this network structure.

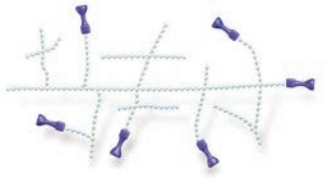


Figure 13:
Schematic representation of a polyurethane dispersant.

Star-shaped dispersing polymers

Efka® PX

Efka PX 47xx Star-shaped dispersing polymers have a core-shell morphology. They are highly efficient dispersing polymers with a very broad applicability and excellent viscosity reduction of pigment concentrates. During the dispersing step the polymer segments in the core adsorb on the pigment surface. The very high density of pigment affinic groups results in a very strong adhesion on the pigment surface. The polymer chains in the shell orient into the solvent and stabilize the pigment very effectively.

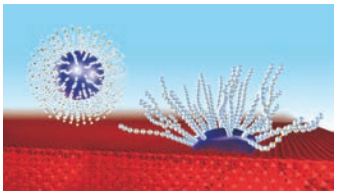


Figure 14:
Schematic representation of a star-shaped dispersant.

Block copolymers based on Controlled Free Radical Polymerization (CFRP) technology

Efka® PX-grades and Dispex® Ultra PX-grades

Efka® PX- and Dispex® Ultra PX grades are very versatile and powerful product groups for solvent-based and aqueous applications, respectively. Although non-controlled free-radical polymerization can lead to good dispersing agents, polymers with a highly defined architecture can be more efficient, resulting in improved colorant stability and broader system compatibilities. This exact degree of control in polymer synthesis is created by the award winning Controlled Free Radical Polymerization (CFRP) technology. It enables the precise design of polymer structures. With the CFRP technology, well-defined block copolymers can be prepared that are designed to optimally fit pigment and resin chemistry. (Figure 15 middle)

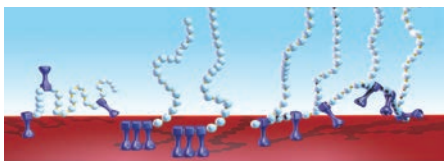


Figure 15:
Dispersing agents: CFRP and anchoring efficiency.

As illustrated in Figure 16, dispersing agents designed with CFRP consist of two defined blocks that are produced by sequential polymerization of monomers or monomer mixtures. Typically, a longer stabilizer block is synthesized first, which has to be compatible with the relevant paint systems. The anchoring block contains functional groups which interact strongly with the pigment surface to allow for efficient and stable adsorption. For demanding applications like organic pigments, the anchoring block typically contains aminic groups, which can optionally be modified further.

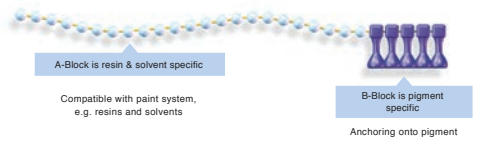


Figure 16:
Structure of dispersing agents designed with CFRP technology.

CFRP-based products not only show excellent results in solvent-based systems, but also in aqueous formulations exhibiting the same technical benefits.

Dispersing Agents: Test Methods

Dispersing Agents: Test Methods

BASF experts have a high degree of experience in selecting the right dispersing agent for a specific application or paint formulation. They will support customers in selecting the right dispersing agent for their individual formulation needs.

In this practical guide, methods to theoretically calculate the dispersing additive demand and to check the performance of a dispersing agent are given.

Practical determination of the optimum dispersing additive dosage (ladder study)

The optimal dispersing additive demand is an important factor to check. Different dispersing additives can have very different effectiveness which leads to different dispersing additive demands:

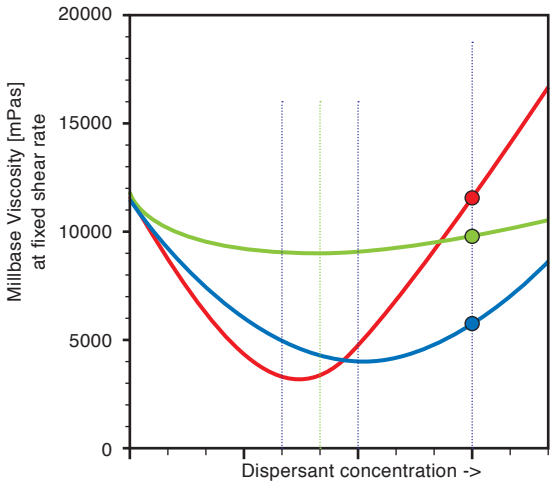


Figure 17:
Dispersant demand curves of various dispersing additives and resulting mill base viscosities.

Usually, it is desirable to identify the minimum of the L-shaped viscosity curve (Figure 17). This should always be determined by a ladder study. Since the shape of the curve might vary from dispersing additive to dispersing additive, it is important to not just replace an additive 1:1 as this might lead to missinterpretation of results (see Figure 17). It is advised to check at least three points along the viscosity curve in order to determine the shape of the curve. To add some safety margin, it is recommended to add at least 10% extra dispersing agent to the determined optimum additive amount.

Dispersing Agents: Test Methods

Theoretical estimation method for the dispersing additive demand

As a rule of thumb, the required additive demand can be estimated if the surface area of the pigments is taken into account: oil absorption of dibutyl phthalate value (DBP value) or N_2-adsorption (BET-value). The BET-value is defined as being the surface area of a pigment per weight, and is determined by the N_2-adsorption method according to Brunauer, Emmet and Teller.

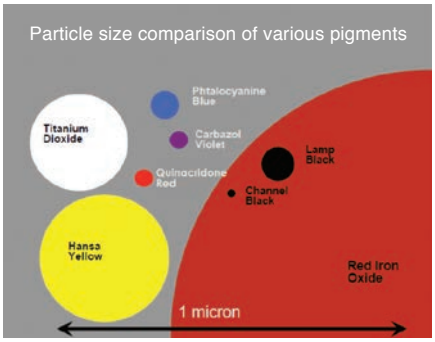


Figure 18:
Due to the very different particle sizes of the various pigment types, the dispersing additive demand strongly depends on the surface area of the pigment.

With organic pigments, it is more difficult to determine the quantity of polymeric dispersant required. For some pigments, such as red, orange and yellow, 50% of the BET value is necessary, whereas with phthalocyanine blue or green, for example, 25% is sufficient to achieve a stable dispersion. It is therefore recommended to carry out tests with 25% and 50% of the BET value, in order to establish the optimum quantity. If the BET value of a pigment is unknown, 20% dispersing agent active substance calculated on the pigment by weight is a good starting point.

Storage stability test

In order to check long-term stability of the pigment dispersions, it is recommended to store them at elevated temperatures (50-60°C) for two weeks and to check viscosity and color strength afterwards.

An insufficient storage stability might lead to flocculation. This is the general term for weakly stabilized pigment particles which then reflocculate or reagglomerate. Flocculation leads to an increase of particle size, loss of gloss, loss of color strength and settling tendency. A side effect could be floating and flooding.

Inorganic pigments at approximately 10% of the oil absorption value, e.g.:

Pigment	Oil absorption value	Dispersing agent active substance / pigment
Titanium dioxide	19	1.9 wt.%
Iron oxide yellow	35	3.5 wt.%

Black pigments at approximately 20% of DBP value, e.g.:

Pigment	DBP absorption value	Dispersing agent active substance/pigment
Color Black FW 200	150	30 wt.%
Special Black	110	22 wt.%

Organic pigments at approximately 25 - 50% of the BET value, e.g.:

Pigment	BET value (m^2/g)	Dispersing agent active substance/pigment
Irgazin® Red 2030	27.2	14 wt.%
Irgazin® Yellow 2RLT	48	25 wt.%

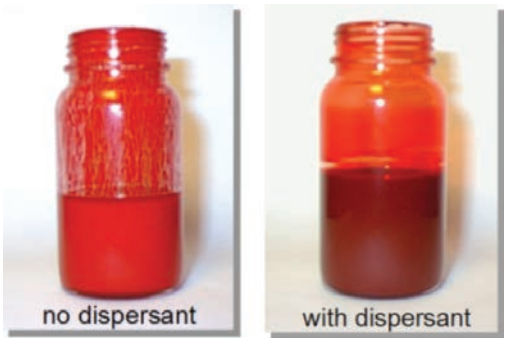


Figure 19:
Flocculated pigments (left) vs. optimal pigment dispersion (right)

Draw-down test

The most common and fastest test method is to make a draw-down of the final paint and to check color strength and transparency (or opacity).

Rub-out test

Rub-out (some people say “rub-up”) is the color difference between an unrubbed part of a paint film and a part of the paint film which has been rubbed with a finger after application, when it is nearly dry. If there is a big difference, there will be an indication of incompatibility of a colorant with the base paint. This sometimes even happens in readily formulated paints.

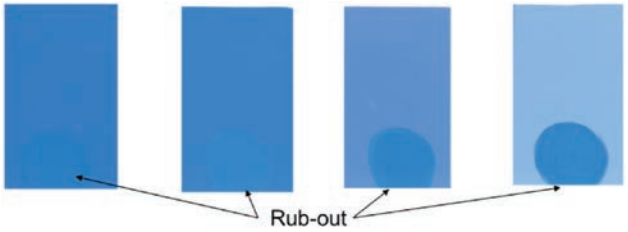


Figure 20:
Draw-downs of blue tinted paint with little (left) to strong (right) rub-out.

“Flooding” and “Floating”

Both terms describe a demixing of at least two pigments in a wet paint film. Flooding results in a uniformly colored paint film with one pigment enriched at the film surface. Flooding can easily be made visible by rub-out tests. Floating shows poor color uniformity. Pigment separation occurs on the film surface often in the form of hexagonal cells, the so-called “Bénard cells”. In both cases, the pigments are not properly stabilized by the dispersant in order to withstand the turbulences which take place during solvent evaporation.

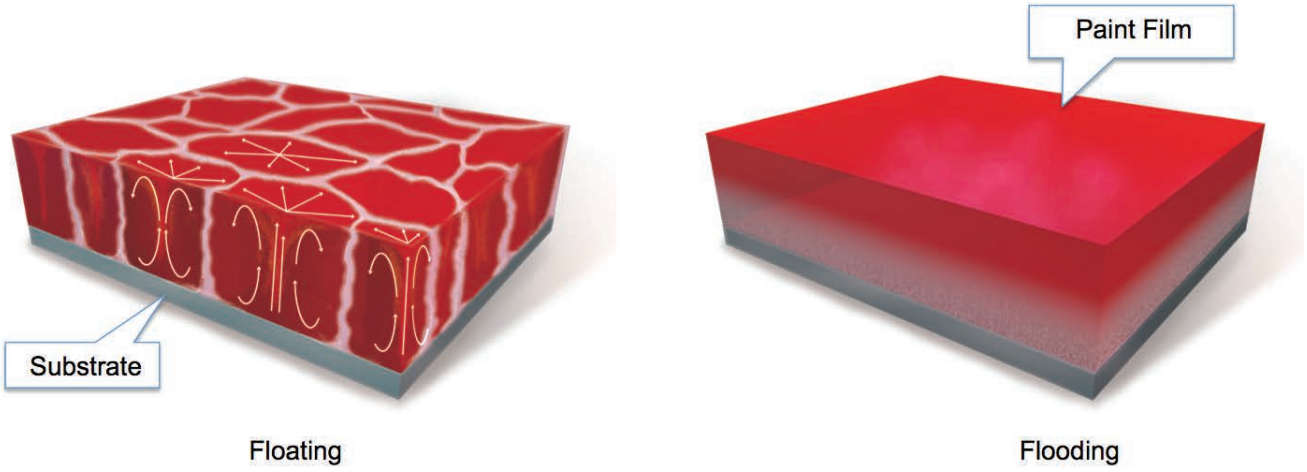


Figure 21:
Illustration of floating and flooding of pigments in a paint film.

Application Areas for Dispersing Agents by BASF

Every application area within the paints and coatings market has special requirements regarding the dispersing agents used within the formulations. The wide variety of products and technologies in the dispersing agents portfolio of BASF Formulation Additives ensures that for almost all formulation challenges the right dispersing additive is available.

Figure 22:
Market areas served.

Application Areas for Dispersing Agents by BASF

Decorative Market

In Europe already about 90% of the decorative paint market is comprised of water-based paints and coatings. In this market area it is important to stabilize high loads of titanium dioxide and fillers like calcium carbonate or clay with relatively low amounts of dispersants in aqueous systems.

Interior coatings in particular often contain up to 80% pigments and fillers and less than 10% of latex. As a producer of polymer dispersions, pigments and additives, BASF has an excellent understanding about the interactions between these paint ingredients.

The right selection of the dispersing agent and binder can significantly improve quality aspects like the contrast ratio (hiding power) or wet scrub resistance.

BASF Formulation Additives offers a wide range of dispersants for the decorative paints and coatings market. Preferred dispersants are polyacrylic acid types and copolymers like the Dispex® AA-types or Dispex® CX types. They are highly efficient and dosages of 0.2 – 0.3% based on total formulations are sufficient to stabilize the paints, together with suitable rheology modifiers.

For exterior coatings, the protective aspect is as important as long-lasting optical effect reflected by low dirt pick-up and good color stability. This is not only achieved by higher percentages and higher quality latex types but also by medium hydrophobic dispersants like Dispex® CX-copolymers.

Apart from the interior and exterior high volume paints which are mainly white and can be tinted with tinting pastes (see separate chapter) there is a category of high quality trim paints. Traditionally, trim paints are based on air-drying alkyd binders. These are classical solvent-borne alkyd paints, which are used to paint doors, window frames and interior and exterior metal substrates. Here dispersants and anti-settling agents like Efka® FA-types are widely used. Especially in Europe, more and more pure acrylates or alkyd emulsions are used as binders for these applications. In such cases, polymeric dispersants like the Dispex® Ultra PA/ -PX family are the perfect choice.

Product group recommendations

- **Interior decorative coatings**
  - Dispex® AA
- **Exterior decorative coatings**
  - Dispex® CX
- **Trim paints (sb)**
  - Efka® FA
- **Trim paints (wb)**
  - Dispex® Ultra PX , Dispex® Ultra PA

Application Areas for Dispersing Agents by BASF

Industrial Market

The industrial finishes category consists of a diverse group of coatings that are applied to all kinds of substrates like metal, plastic, wood, etc. The market is characterized by a continuing move away from conventional solvent-based coatings towards water-based, high solids, powder and radiation cured coatings. The industrial coatings market can be divided into the following sub groups:

Can and Coil Coatings

Can & Coil application is mainly based on traditional solvent-based polyester-melamine systems. There is a high demand in long-term performance as well as in flexibility and durability. For topcoat applications the **Efka® PA** range as well as the **Efka® PX** range give the best color development and stability as well as the highest gloss levels. Additionally, it is possible to create a resin-free flexible tinting system with the **Efka® PX** product range.

Product group recommendations

- **Can & Coil Coatings**
  Efka® PA, Efka® PX
- **Furniture & Flooring Coatings**
  Efka® FA, Efka® PX
  Efka® PX 47xx for UV coatings
  Dispex® Ultra PX , Dispex® Ultra PA
- **Industrial Maintenance**
  Efka® PA, Efka® PU, Efka® PX
  Dispex® Ultra PA, Dispex® Ultra PX
- **Marine Coatings**
  Efka® FA, Efka® PU, Efka® PX
- **Industrial Mixing Systems**
  Efka® PX with Laropal® A 81

Furniture and Flooring

Furniture and Flooring wood coatings are used to finish furniture, cabinets, fixtures and wood flat stock products. The main part of the wood coating technologies are un-pigmented systems. In case matting agents are used in a solvent-based / solvent-free system, the **Efka® FA** series gives advantages in wetting, reducing viscosities and prevention of settling. In radiation curing systems there is a series of 100% active special products available in the form of our **Efka® PX 47XX** range.

For water-based applications, **Dispex® Ultra PX** and **Dispex® Ultra PA** are the best choice to stabilize organic pigments or transparent iron oxides.

Industrial maintainance

Industrial maintenance coatings are designed and formulated to provide protection for exterior and interior substrates from corrosion, abrasion, thermal, chemical and ultraviolet (UV) degradation in both industrial and critical service environments. This market is characterized by the widest range of resin systems, starting with short oil alkyds for quick drying applications to high end polyurethane and epoxy systems for strong corrosion and chemical protection. The main part of the systems is still solvent-based with a strong trend to high solids systems. In specific applications there is a trend to switch to water-based systems.

Due to the broad variety of resin systems and pigments used in this area our versatile **Efka® PX** range of products is very well suited to fulfil all specific system needs. Specifically, when it comes to “universal” coloring systems the **Efka® PX** range in combination with Laropal® A 81 grinding resin offers a perfect solution for economy, complexity reduction, ease of tinting and performance.

In water-based applications our **Dispex® Ultra PA** and **Dispex® Ultra PX** are very suitable for dispersing the organic and inorganic pigments without negatively influencing the final film properties of the resin system.

Marine Coatings

Marine coating systems are applied to vessels and structures in marine and fresh water environments to protect against substrate deterioration and to maintain appearance. Marine coatings are mainly based on epoxy chemistry to maximize corrosion control, durability and chemical resistance. Modifications to epoxy chemistry are used to improve specific features such as appearance and weatherability while minimizing the compromise in base epoxy properties. Polyurethane chemistry is also used for improved weatherability and appearance retention.

Efka® FA types of dispersing agents are frequently used in primer systems to increase the filler and extender levels of the formulation without increasing the viscosity of the overall systems. In colored top-coats the **Efka® PU** types and **Efka® PX** types are used to achieve the best color development and stability without negatively influencing the overall chemical and water-resistance of the final paint film.

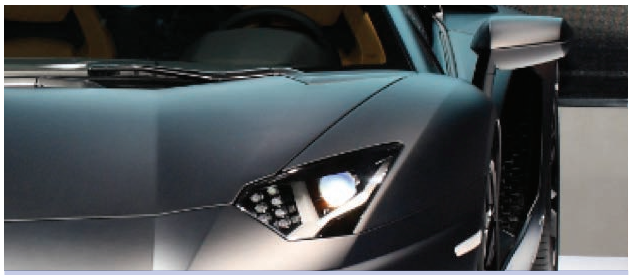
Automotive OEM Market

Automotive OEM coatings have considerable demands and performance requirements. There is a need for “body” protection, such as anti-corrosion and stone-chip resistance, and for a durable and appealing finish. Products also have to be appropriate to mass-production conditions, and in this respect, must be robust, flexible and economic to use.

For automotive refinish coatings, environmental and regulatory pressures are leading to new high-solids and water-based coating systems. **Efka® PU** and the new **Efka® PX** products are particularly suitable for high-solids coatings whereas **Dispex® Ultra PX** types are designes for water-based systems.

Dispersing agents are an essential component in all pigmented layers starting with the ED-coating, followed by the primer and primer surfacer and the basecoat. Only the clear coat is (typically) without any dispersing agent. Besides the already mentioned performance properties influenced by dispersing agents like color strength, mill base viscosity or storage stability, further performance drivers for automotive applications are of high concern.

For example, when looking at black automotive coatings, high jetness with a blue undertone is highly desired. To achieve best jetness with carbon blacks, the right choice of dispersing agent and an optimized additive level is crucial. Moreover, the choice of grinding resin, the overall compatibility between the pigment concentrate and the let-down as well as process parameters are keys to success for an impressive black.



Product group recommendations

- **To achieve best jetness and blue undertone with carbon black pigments:**
  Dispex® Ultra PX, Efka® PX

Advanced high molecular weight dispersing agents, especially CFRP based polymers, offer a proven solution here. With **Efka® PX and Dispex Ultra® PX** type dispersants it is possible to achieve best jetness in solvent-based and water-based coating systems.

Printing and Packaging Market

Product group recommendations

- **wb pigment concentrates and inks**
  Dispex® Ultra PX, PA, FA
  Hydropalat® WE
  Joncryl®
  Joncryl®/Joncryl® HPD
- **sb ink formulations**
  Efka® PX
  Laropal® A 81
- **UV curable inks**
  Efka® PX
- **wb ink jet**
  Dispex® Ultra PX and Dispex® Ultra PA

In the printing and packaging market for food preservation, one of the main selection criteria for additives is compliance with global food contact regulations like FDA, Swiss Ordinance, BfR, EU 10/2011 or GB 9685 (China).

With its Joncryl® product portfolio, BASF offers a wide range of polymer dispersions and resins for the printing and packaging industry. In water-based pigment concentrates and inks, alkaline soluble resins or resin solutions (Joncryl HPD) are used to stabilize pigments. However, in order to improve color strength and pigment stabilization, the use of dispersing agents like **Dispex® Ultra PX, PA or FA** grades is becoming more popular. In order to improve printability, ink transfer and shock stability of pigment concentrates in let-down vehicles, special products from our **Hydropalat® WE** series are used.

In applications where chemical resistance is of importance, polymeric dispersants like our **Dispex® Ultra PX and PA** grades are of high interest, as alkaline soluble resins do not give the required resistance properties.

To improve color strength combined with low viscosity and Newtonian flow behavior in UV-flexo formulations, polymeric dispersants like **Efka® PX** grades are well suited. In UV-offset formulations, a combination of polymeric **Efka® PX** dispersants with **Laropal® A 81** might be a further option.

In the growing market segment of ink-jet formulations, very low viscosities with excellent pigment stability combined with high color strength are required. Here, high performance dispersing additives like **Dispex® Ultra PX and PA** are best suited, whereas for solvent-based (glycol ether or ester based) or UV-based ink-jet inks our **Efka® PX** grades are available.

Pigment Preparations

Pigment Preparations

Pigment preparations are important products in the fabrication of paints and coatings. Various types of pigment concentrates exist as the requirements for their use strongly depend on the final application. In decorative paints and coatings as well as in industrial paints, a broad compatibility is essential to cover a large range of binder types and paint systems. Universal pigment concentrates for solvent- and water-based systems are mainly applied in decorative paints where they have to cover the whole range of different paint formulations. Specific concentrates, formulated with grinding resins and/or highly efficient dispersing agents, are more popular in industrial paints and inks.

A pigment preparation is a pigment which has undergone optimal dispersion to ensure that the best coloristic properties and the necessary application needs of the intended end uses are achieved. For an optimal formulation of the pigment preparation, the most suitable combination of formulation additives and further raw materials are applied, which ensures the best compatibility in the target application.

Pigment concentrates are concentrated, free-flowing, yet stable liquids in which the pigment particles are predispersed to an optimum level. Pigment concentrates have the following advantages in comparison to solid pigments:

- They are easy to add and simple to dose.
- No dust is generated.
- Optimum particle size distributions result in maximum brilliance and tinting strength.

BASF offers a number of readymade pigment concentrate ranges under its Luconyl®/Luconyl® NG and Sicoflush® trade names. Xfast® are innovative stir-in pigments eliminating the need for dispersion. Supplied in dry, granulated form, they can be added straight to a stirred formulation.

Pigment concentrates, if they are used as a prefabricated product in the paint and coating production, are required to be as universal and economical as possible.

Good to know

Different denominations like “tinters”, “colorant”, “stainer”, “shading paste” or “universal pigment concentrate” are used to describe products designed to give color to a paint. Often the distinction between the different terms is blurred. For this reason, some definitions are given below:

- **Tinters** are pigment concentrates used to adjust the color of a paint formulation. The amount of addition is up to 10% of the total formulation, so the possible influence of the concentrate on the quality of the final paint remains small.

- **Full Mixing Systems** are based on pigment concentrates suitable to produce complete paints by mixing with clear or pigmented (almost white) base paints. Here, up to 25% of these colorants have to be added. The quality of full mixing systems has to be higher because they have much more influence on the quality of the final paint.

- **"Universal" pigment concentrates** can be used with many different let-down binders. The meaning of "universal" can vary, however. For example, there are universal concentrates for solvent-based and aqueous systems for architectural paints. In industrial formulations, the term “universal” refers more to compatibility with many different solvent-based resin systems.

Pigment Preparations

Resin containing pigment concentrates (RCPC)

A grinding resin already provides sufficient wetting and dispersing properties and therefore special dispersing agents are added only to optimize the pigment dispersion. Due to various binder types used in industrial paints, incompatibilities can limit the use of a grinding resin.

Resin containing pigment concentrates (RCPC) improve both the production efficiency and the cost effectiveness of coating products. Used by numerous industrial paint manufacturers today, the concept has been proven effective around the world. The RCPC concept facilitates improvements in the manufacture of pigmented coatings or paints through the use of a single, integrated range of highly pigmented, resin-containing pigment concentrates. Formulated to be compatible with the major resins used to manufacture industrial and retail coatings, these concentrates still meet the specific requirements of paint end users.

Resin containing pigment concentrates that are based on Laropal® grinding resins and Dispex® Ultra or Efka® high-molecular-weight polymeric dispersants offer the following advantages over conventional pigment concentrates:

- Consistent color development - no flocculation
- Considerably lower resin content
- Significantly lower viscosities

These features result in the following benefits:

- Applicability in a very wide range of resin systems and solvents due to superior compatibility of the concentrates
- No flooding or floating
- Minimized influence on the finished product
- Suitability for today's modern computerized tinting systems, ensuring fast, economical manufacture and supply, as well as efficient small-order production

In resin containing pigment concentrates, two to four times more resin than dispersing agent is being used. This means pigment concentrates can be produced which, even in highly colored tints, give a final product with only 3% foreign resin or at most 10% of the total resin in the finished paint.

Resin free pigment concentrates (RFPC)

Especially for aqueous and universal pigment concentrates, it is common to formulate pigment concentrates without an additional grinding resin. The stabilization is done solely by the dispersing additive.

Resin free pigment concentrates (RFPC) generally show an improved compatibility with respect to the binder system.

A resin free concentrate requires a higher content of dispersant. This dispersant demand stems from the quality and effectiveness of the dispersant and the type of pigment, as the pigment surfaces vary strongly in their chemical and physical properties. The minimum dosage of dispersant to cover the whole pigment surface, however, is not enough to obtain a stable concentrate. In this case, the required quantity of dispersant to obtain a stable concentrate can effectively exceed the dispersant demand.

Universal Pigment Concentrates

Universal pigment concentrates can be used with many different let-down systems. The meaning of "universal" can vary, however. For example, there are universal concentrates for solvent-based and aqueous systems in the architectural paints market. In industrial formulations the term “universal” refers more to compatibility with many different solvent-based resin systems.

In architectural paints, universal pigment concentrates can be used to tint aqueous and solvent-based paints. This is achieved with "universal" dispersing additives which are often based on low molecular weight or oligomeric type dispersing agents (e.g. FAME products). They are also able to replace alkyl phenol ethyoxylate based surfactants (APEO) which have commonly been used to formulate pigment concentrates.

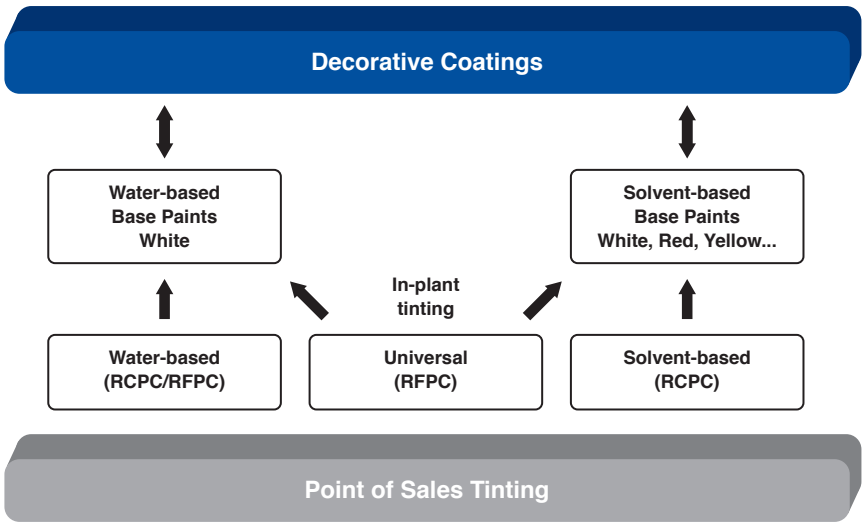


Figure 23:
Universal pigment concentrates can be used in solvent-based and aqueous base paints.

BASF experts have specifically selected a series of dispersing products which allow the paint and colorant producers to formulate label-free universal pigment concentrates and products that comply with the latest pro-environmental standards.

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