BYK

TECHNICAL INFORMATION

SOLVENT-FREE AND SOLVENT-BORNE FLOOR COATINGS

FL-TI 1

A member of ALTANA

Contents

Introduction

All around the world, liquid polymer coatings are becoming an increasingly popular finish for floors. While they were previously only found in warehouses and production halls, they can now be found in shopping centers, schools and hospitals. More recently, these coatings have also become available to end customers, whether for decorative purposes in bathrooms or for recoating the old screed in the garage.

Epoxy resin systems are by far the most commonly used floor coating. The success of this technology is predominantly based on the fact that these floor coatings are quick to install, easy to clean and very resistant.

As the systems have begun to gain popularity in commercial sectors, the production of the coatings is being subjected to increasingly strict regulations, for example in relation to volatile organic compounds (VOC). For this reason, it is becoming increasingly important to develop formulations that contain little to no solvents. However, solvent-free systems are much more difficult to handle during manufacturing and application processes, due to their high levels of inherent viscosity and reactivity.

For this reason, a variety of additives are now used to simplify the handling of the systems and enable consistently reproducible results to be achieved.

Suggested additives for the floor coatings market can be found in the "Additives for floor coatings" (FL-AG 1) brochure or at www.byk.com/en/markets/floor-coatings.

Note

To ensure the best appearance and full functionality, please open in Adobe Acrobat.

Different floor systems and their properties

	Penetrating primer	Primer filler for leveling out unevenness	Self-leveling coating	Top coat/sealant (clear or pigmented)
Film thickness	0.2–0.3 mm	1–6 mm	1–3 mm	0.06–0.1 mm
Yield	≈ 0.1–0.2 kg/m^2 (depending on the substrate)	At 1 mm: 0.8–1.6 kg/m^2	At 1 mm: ≈ 1.5 kg/m^2	≈ 0.1–0.6 kg/m^2
Application/function	Sealing the substrate, binding loose particles and improving the adhesion of subsequent coatings	Sealing pores and leveling the surface	Mechanical and chemical resistance, visual appearance, anti-static properties, slip resistance	Abrasion and scratch resistance, UV stability, visual appearance, slip resistance
Systems used	Low-molecular epoxy systems	Solvent-free systems based on epoxy or polyurethane resins	• Solvent-free systems based on epoxy or polyurethane resins • Methacrylate systems • Aqueous epoxy resin formulations	• Epoxy- and polyurethane-based solvent-free systems • Polyaspartic systems • Methacrylate systems • Aqueous epoxy or polyurethane systems • Aqueous acrylate systems (1-pack)
Requirements	• Good substrate wetting • No foam bubbles • Good penetration into the substrate	• Good substrate wetting • Low viscosity • Good storage stability • No foam bubbles • Good leveling	• Good substrate wetting • Low viscosity • No flooding/floating of pigments • Good storage stability • No foam bubbles • Good leveling	• Good substrate wetting • Low viscosity • No flooding/floating of pigments • Good storage stability • No foam bubbles • Good leveling • High transparency in clear systems

T. 01

Viscosity reduction and/or pigment stabilization

Due to their high solids content and inherent viscosity, floor systems have a tendency to stabilize foam and have poor leveling properties. Many resins that are used in this sector also have poor pigment wetting properties. This can often lead to pigment separation, Bénard cells or color fluctuations. On large surfaces, it is particularly important to look out for Bénard cells, as they are a sign of poor pigment stabilization and are caused by turbulence, settling of the pigments/fillers and the increase in viscosity. Controlled flocculating and deflocculating wetting and dispersing agents can be used to prevent this.

These additives are particularly suitable for use with highly filled primers or leveling primers. These coatings frequently contain lots of fillers and require good penetration properties. For epoxy and polyurethane coatings, products such as **BYK-P 104 S** are ideal in this case. This product family creates a positive effect with regard to the color stability and improves flooding/floating.

Rub-up test used to check for possible color differences

Highly filled, self-leveling top coatings and roller coatings require excellent pigment stabilization of inorganic and organic pigments and a higher level of gloss.

The best results are often provided by additives with amine pigment-affinic groups. Nevertheless, these additives have a tendency to react with epoxy resins and are therefore not storable in these coating systems.

By developing **DISPERBYK-2151**, BYK has created an innovative additive that is highly efficient thanks to amine groups, but also has excellent storage stability in epoxy systems due to the encapsulation of these groups.

With **DISPERBYK-2152**, BYK is able to offer a product that, as a 100 % active substance, contains no volatile components or solvents and is therefore ideal for AgBB-compliant coatings.

DISPERBYK-2155 and **BYK-9076** have proven to be ideal for use in self-leveling polyurethane coatings. **DISPERBYK-2155** also has a tin-free variant named **DISPERBYK-2155 TF**.

BYK-9076 exhibits very strong viscosity-reducing properties, which allows it to be used in primers. Due to its highly amine character, the processing time should always be checked when used with aliphatic polyurethane systems.

The choice of wetting and dispersing agent is critical for achieving reproducible results during application. The strong viscosity reduction can facilitate defoaming and improve the leveling properties of floor systems.

Storage stability

In floor coatings, it is particularly difficult to avoid the settling of fillers/pigments. One reason for this is the high amount of high-density fillers. Furthermore, the systems are subjected to temperature fluctuations and vibrations during transportation and storage, which can increase settling. To prevent this, rheology additives can be added to the system. However, doing so must not have a negative impact on parameters such as leveling and defoaming/air release.

To achieve this, products are used that give the system pseudoplastic or thixotropic flow properties.

If a system has thixotropic flow properties, the overall viscosity is already significantly lowered by low shear forces, giving the material very good application properties. The increase of viscosity after application takes place after a delay. This ensures good leveling of the coating and a good air release.

Additives that create a pseudoplastic flow behavior are also suitable for use in floor systems. The use of these products also brings about a reduction in the viscosity through shear. The rebuilding of the structure takes place immediately after the shear stress ceases to be applied. Therefore, a very low yield point must be ensured for this application. Only then can sufficient air release and good leveling occur.

To ensure good storage stability combined with good defoaming and leveling properties, it is important to select a kind of additive that precisely complements the rest of the formulation components and additives.

Liquid rheology additives

The **RHEOBYK-410** range is based on modified ureas, which have been dissolved in various carriers. When incorporated into the coating system, extremely small crystalline particles are formed. These crystals use hydrogen bonds to form a three-dimensional network structure and create a thixotropic flow behavior. The additives in this class can be used independently of the chemical composition and the solids composition of the system, if the polarity is compatible with the additive. The formation of this network structure means that using additives such as **RHEOBYK-7410 ET** prevents pigments from settling. The efficiency is not affected by the addition of the amine hardener.

RHEOBYK-430 can also be used to prevent the settling of solids in highly filled systems. This urea-modified polyamide generates a pseudoplastic flow behavior that prevents the settling of solids during storage and after application.

Powder rheology additives

Additives in this class are made up of clay, the surfaces of which have been modified to make them suitable for use in systems with varying polarities. They are delivered in powder form and can be added to a suitable carrier (e.g. solvent or reactive diluent), ideally in a pre-mix (also known as a "pre-gel"), in order to exploit their full potential. There are also "preactivated" types which can be incorporated straight away. Examples of these additives include products from the **CLAYTONE** range. In an idle state and with no shear forces present, the system builds a three-dimensional network, which allows the viscosity to increase. This network can be destroyed by the use of shear forces, leading to a reduction in the viscosity. After the shear forces have subsided, the viscosity is then rebuilt after a delay.

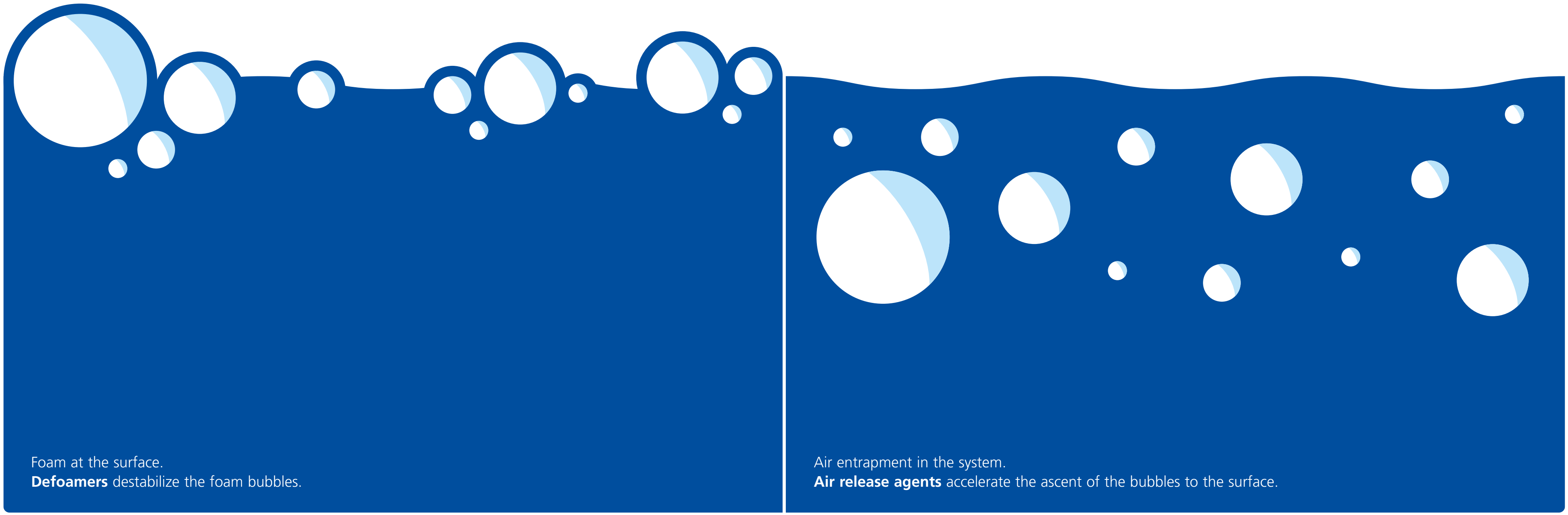
Products from the **GARAMITE** range can be incorporated directly in the formulation. Even low additive quantities and low shear forces during incorporation are enough to achieve a very efficient increase in viscosity.

Further positive properties of **GARAMITE** products include a low tendency to form dust, as well as the high bulk density.

Defoaming/air release

We often hear about "defoamers" in connection with removing gas bubbles from a liquid coating by using an additive. The term "air release agent" is also commonly used. These terms are closely linked to one another, and both additive classes are necessary in order to remove gas bubbles from a coating. "Air release" entails the foam bubbles contained in a liquid film combining to form larger foam bubbles. In doing so, the ascent rate increases in accordance with Stokes' law. "Defoaming" is when the bubbles have reached the surface, the lamella of the bubbles is destabilized and the bubble bursts.

Comparing defoaming and air release

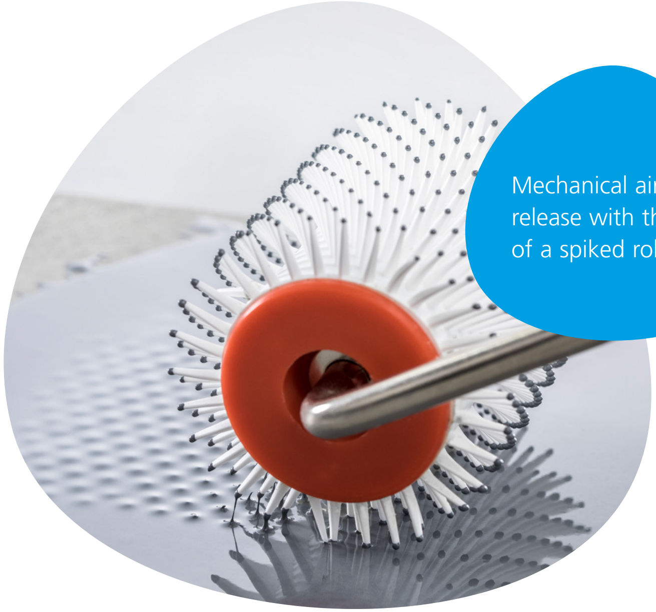


G.01

In practice, it is not possible to make a precise distinction between the additive classes of "defoamer" and "air release agent" as they tend to carry out both functions to a degree. Therefore, for simplification purposes, only the term **"defoamer"** will be used in the following section.

Foam is one of the greatest challenges in floor systems. There are many reasons why this is the case. First of all, material viscosities tend to be high, making it difficult for the foam bubbles to ascend in the film. In addition, a high filler content introduces air, which adheres to the solid particles and is only released from these particles later on, for example due to insufficient dispersal. Moreover, in the case of solvent-free systems, it is not possible to use solvents such as xylene to reduce the viscosity and support the defoaming process. Often, the foam bubbles only reach the surface when the viscosity has already increased significantly and the foam bubbles can no longer burst, or after a bubble has burst it is no longer possible to ensure sufficient leveling. This often means that, for example, self-leveling floor coatings appear to be free of foam on the day of application, but then foam marks or pinholes appear a few days later. Reaction foam in PUR-based or polyaspartic systems is caused by the reaction of the isocyanate with water or moisture, and is generally only visible in the form of pinholes once the system has cured.

Example of good and insufficient defoaming in a floor formulation



Mechanical air release with the aid of a spiked roller

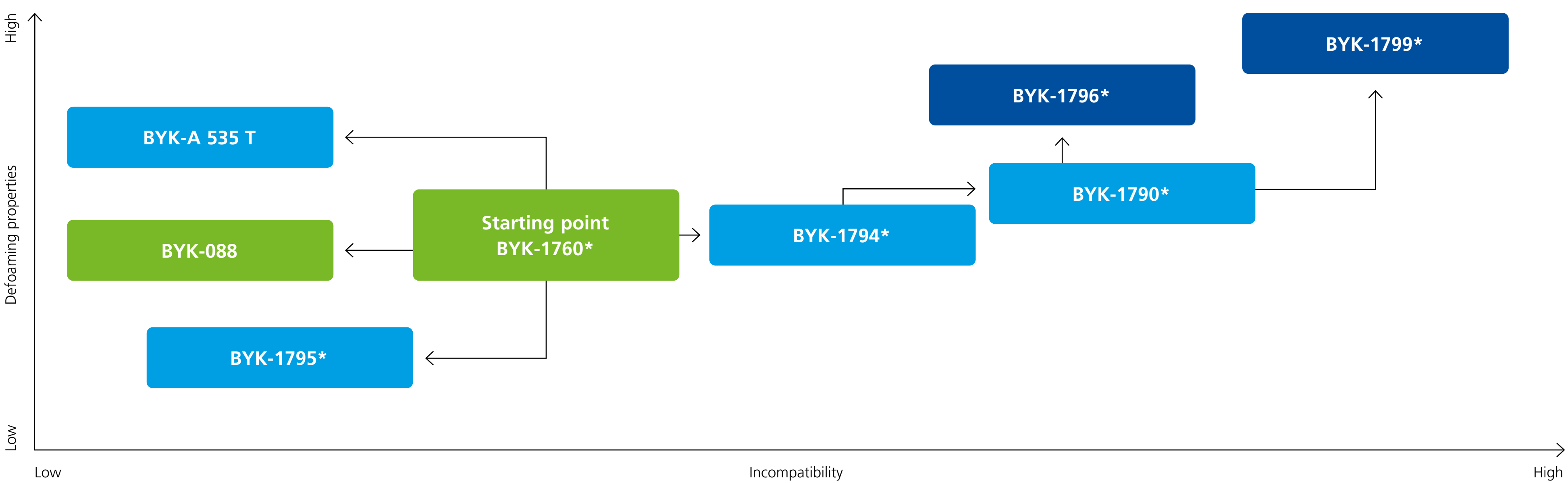
This is why it is recommended to add the defoamer to the millbase, even if this is being processed under vacuum. It is often the case that the defoamer quantity is distributed across different production stages, as otherwise the strong shear forces will cause it to be too compatible with the system and it will lose its efficiency. However, depending on the compatibility of the defoamer, it is important to ensure that it is processed for a sufficient incorporation time, as otherwise undesirable effects, such as cratering, can arise.

Selection criteria for defoamers

Requirement	Defoamer selection
Pigment concentrate or co-grind	Medium-strength defoamer, silicone-free (optional)
Non-pigmented system	Compatible defoamer
Primer	Primary effect of substrate wetting additives: the better the wetting, the faster the air displacement/defoaming
Roller coating	Low coating thickness, high air incorporation, therefore medium-strength defoamer in very low dosage, recommended: Combination with a surface additive, such as **BYK-3550** (reduces negative side effects e.g. catering)

T.02

General overview to help select a defoamer



Polymer/silicone defoamer · Polymer defoamer · Silicone defoamer · * 100 % non-volatile matter or active substance

G.02

Optimization of the surface

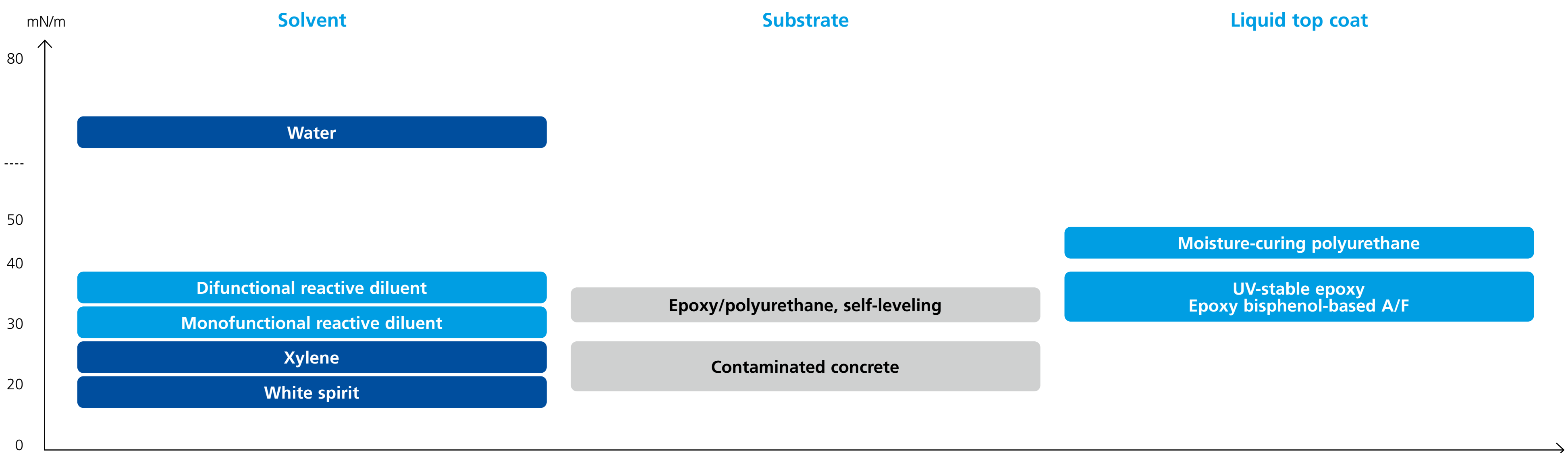
Surface defects affecting the appearance and protective function of the floor coating often emerge during and after application. Typical surface defects include:

- Poor substrate wetting (caused by contaminated concrete)
- Cratering
- Formation of Bénard cells, flooding/floating
- Trowel marks

A fundamental factor in all defects of this kind is the different **surface tension** of the materials involved and the resulting interfacial tension differences. These differences can be caused both by processes taking place during curing (cross-linking reaction, settling of the fillers) as well as by the application process itself (contaminated concrete or application equipment, dust, droplets of perspiration).

Figure G.03 illustrates common surface tension differences that can occur when using different floor coating systems.

Surface tension differences between different raw materials



G.03

To avoid surface defects and ensure sufficient wetting, additives are used to influence the surface tension of the coating system in a targeted manner. Usually these products are additives based on **polysiloxanes** (silicone) or **polyacrylates** (acrylate additives). If considerable surface tension differences between the coating system and substrate need to be balanced out, **polysiloxanes** are the preferred solution. They can significantly reduce the surface tension of the liquid coating system and are therefore used to improve the substrate wetting, or as an anti-cratering additive.

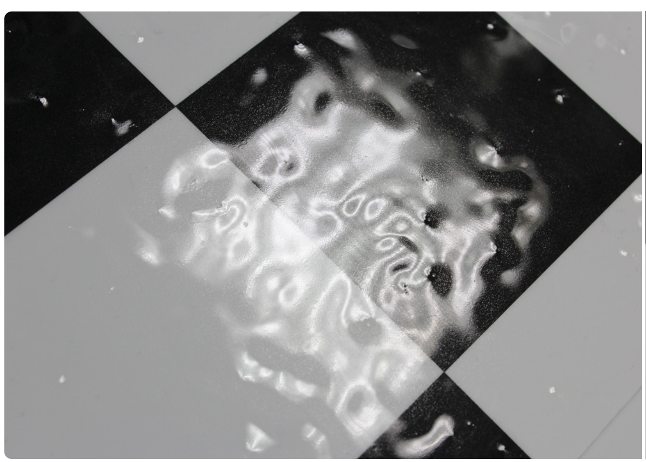
In floor systems it is best to use polysiloxane-based additives that have a specific incompatibility with the coating system and therefore also have a defoaming effect (e.g. **BYK-320**).

Moreover, silicone additives can optimize the surface of the cured coating film, improve cleanability and make the surface more resistant to scratching. In this regard, it is important to check the impact on the surface slip, so that no unwanted slip is introduced to the surface.

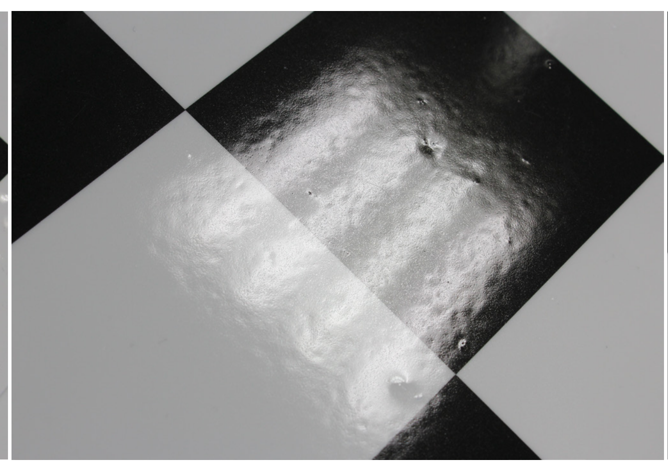
Additives from the polyacrylate class can also be used. Polyacrylates are capable of balancing out surface tension differences. Compared with classic polysiloxanes, however, polyacrylates cause less of a reduction in the surface tension and also do not increase the surface slip. They are therefore predominantly used to improve leveling. The **BYK-3550** additive is particularly recommended for floor coatings. Even though it is based on polyacrylate chemistry, it strongly reduces the surface tension, similar to a polysiloxane-based additive. In the cured coating film, this additive has barely any effect on the surface slip, unlike many polysiloxane-based additives.

Optimum combination of defoamer and surface additive

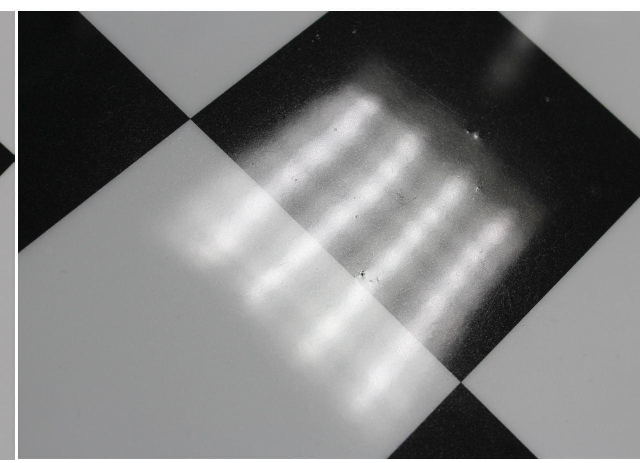
Control



No optimum combination of defoamer and surface additive, too incompatible



Optimum combination of defoamer and surface additive



Troubleshooting for floor coatings (1/2)

Carbamate formation (amine blushing)

At low curing temperatures (below 10 °C), some hardeners tend to bring about a chemical reaction with the carbon dioxide and the moisture from the air, forming carbamates, which no longer participate in the hardening reaction. In this scenario, a mat, sticky film often develops on the surface of the floor. This will not provide good adhesion for the next coating layer. This surface defect can sometimes occur in isolated spots. Large marks often develop, especially in poorly ventilated or cold zones on the floor. In such cases, it is important to check the suitability of the hardener for use in cold ambient temperatures. There are hardeners that have a stronger or more reduced tendency to form carbamates. Silicone-based surface additives can significantly reduce the formation of carbamates. This takes place primarily through the formation of an interface at the surface, which impedes CO_2 diffusion into the coating.

Fish eyes

Fish eyes are individually occurring, large, round surface defects that can also be circular. Fish eyes are often caused by defoamers/air release agents that are too incompatible, or by low shear forces when incorporating these additives. More compatible defoamers/air release agents or improved incorporation conditions for defoamers can solve this problem.

Trowel marks

Trowel marks occur where there are localized surface tension differences when processing the system during the curing stage. These are often only visible once the surface has cured. They can be reduced by using products such as **BYK-320** or **BYK-3550**.

Settling

High-density fillers and pigments have a tendency to form sedimentation in epoxy systems. Sometimes this phenomenon occurs only after the low-viscosity hardener has been incorporated during processing. Additives based on modified ureas (e.g. **RHEOBYK-7410 ET**) can provide an effective protection against settling even at very low concentrations of 0.1–0.3 %. Special organophilic phyllosilicates such as **GARAMITE-7305** can remedy the problem without any significant reduction in gloss.

Troubleshooting for floor coatings (2/2)

Leveling problems

Leveling problems can be caused by an inhomogeneity in the surface tension at the interface with the air or by pseudoplastic rheological behavior. In the first case, silicone-based surface additives such as **BYK-320** or **BYK-333**, as well as polyacrylates such as **BYK-354** or **BYK-3560** can help. In the second case, a considerable improvement can be achieved by using viscosity-reducing wetting and dispersing additives **(BYK-9076, BYK-220 SN, DISPERBYK-111)**, especially in highly filled systems. Some rheology additives (e.g. pyrogenic fumed silica, polyamides, hydrated castor oil derivatives, simple organophilic phyllosilicates) with a strong pseudoplastic character can also cause leveling issues in high dosages. In such cases, the use of additives based on modified ureas **(RHEOBYK-7410 ET)** are recommended for adjusting the rheological properties.

Flooding/floating and Bénard cells

Both phenomena are an indication of poor pigment stabilization. The insufficiently stabilized pigments can have a tendency to separate horizontally or vertically. Controlled flocculating **(BYK-P 104 S, BYK-220 SN)** or deflocculating wetting and dispersing additives **(DISPERBYK-2152, DISPERBYK-2155/ DISPERBYK-2155 TF, BYK-9076)** can effectively prevent these defects.

Reducing the surface slip (anti-slip)

If the surface slip of a floor coating is too high, it can cause accidents. In such instances, high doses of silicone additives should be avoided. Standard practice is usually to sprinkle the surface with silica sand, carborundum or rubber granulate – however all these measures produce a highly structured surface. A homogeneous and not too slippery surface can be achieved using anti-slip wax additives such as, for example, **CERAFLOUR 970**.

FL-TI 1 02/2024

Click here
for your
local contact

BYK-Chemie GmbH
Abelstraße 45
46483 Wesel
Germany
Tel +49 281 670-0
Fax +49 281 65735

info@byk.com
www.byk.com

A member of ALTANA