BYK

APPLICATION INFORMATION

ADDITIVES FOR ACRYLATE APPLICATIONS

TS-A 9

A member of ALTANA

Contents

Introduction to acrylate applications

In this brochure, "acrylate applications" refers to polymethyl methacrylate (PMMA) solutions in monomeric methyl methacrylate (MMA) that typically contain about 20 % PMMA. This resin solution (often called "syrup") is mixed with fillers such as ATH (aluminum trihydroxide) or quartz (silica sand) and then cured at ambient or elevated temperatures using a peroxide initiator. To achieve special decorative effects, pigments (white or colored) as well as different types of flakes are also used in addition to the filler.

Different objects can be produced with acrylic syrup such as high quality bathtubs, sinks, and other sanitary equipment. Slabs and plates are other products with excellent abrasion resistance for various uses.

The right choice of additives can improve the acrylic syrup processing and quality of the final parts in many ways:

- Reduced air entrapments
- Improved mechanical and chemical resistance
- Reduced syrup viscosity, allowing higher filler loads
- Less settling and floating of filler, pigments, and flakes
- Pigment stabilization, no flocculation
- Accelerated curing reaction and more homogeneous curing
- Reduced monomeric methyl methacrylate emission

For additional information on additives and technical topics, please contact us:
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Note

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

Examples of typical acrylate applications

Air release additives

Air is easily incorporated into the acrylic syrup during mixing operations and while fillers and other solid particles (pigments, flakes) are being dispersed. If these air bubbles are not completely removed from the system before curing, such air entrapments will negatively affect the optical and mechanical properties of the final parts.
A vacuum is often used for air release. Additives are very helpful in accelerating this process and minimizing the time necessary to remove the air.

Air release additives work in three steps. **Step 1:** By reducing the interfacial tension between the acrylic syrup and the solid particles (filler, pigments), the air from the particles is displaced into the resin solution. **Step 2:** Substances which stabilize the air bubbles are displaced by the air release additive. As a result, smaller bubbles coalesce to form larger bubbles and larger bubbles rise to the surface faster because of their higher buoyancy (Stoke's law).
Step 3: Air bubbles break when they reach the surface.

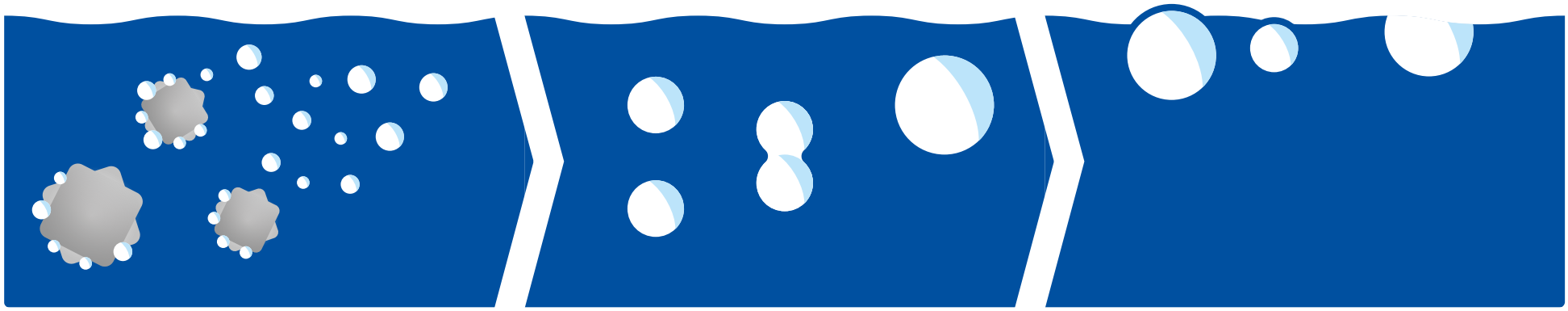
Air release additives

Product	Recommended for	Dosage
BYK-390	All types of acrylic systems	0.3–1 % on syrup
BYK-1790	All types of acrylic systems, especially for food contact applications*	0.3–1 % on syrup
BYK-A 515	All types of acrylic systems	0.3–1 % on syrup

* For the use in food contact applications please check the food contact sheet.

T. 01

Air release additives work in three steps



G. 01

Improvement of mechanical and chemical properties

Filler particles are usually only mechanically embedded in the acrylic resin matrix, and filled parts typically break at the filler/resin interface under mechanical stress. Coupling agents strengthen the interface between the filler particles and the acrylic resin by forming chemical bonds, which in turn significantly improves the mechanical and/or chemical properties.

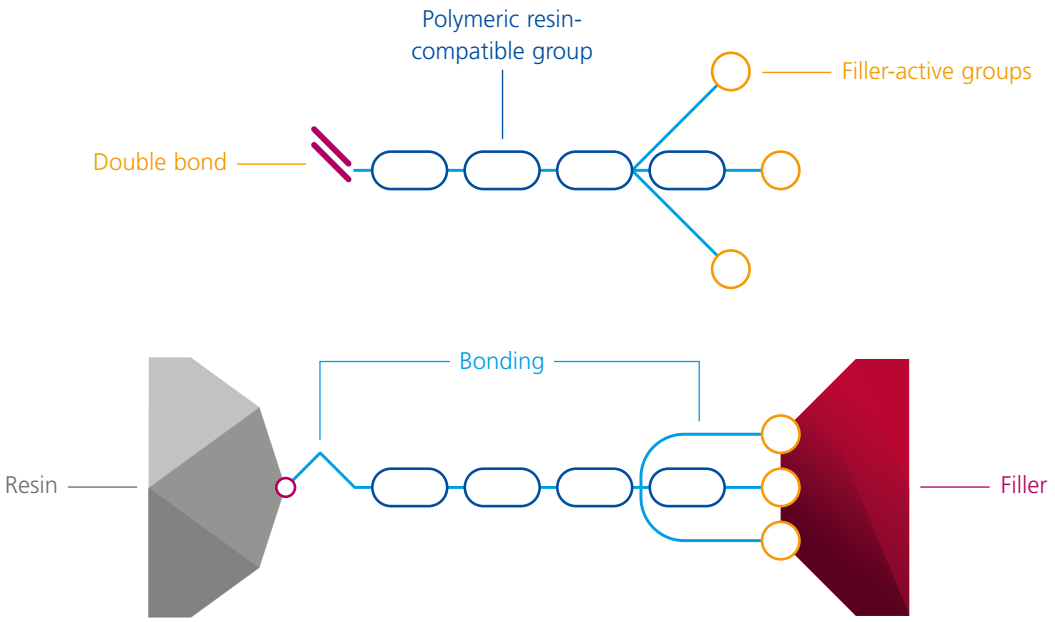
Using these coupling agents, for example, can increase flexural strength by a range of 10–50 %. Chemical and water resistance is also significantly improved particularly in quartz-filled systems. G. 03 shows the results of a hot water immersion test.

Coupling agents

Product	Recommended for	Dosage
BYK-C 8000	Quartz and glass flakes	0.5–1.5 % on syrup
BYK-C 8002	ATH	0.5–1.5 % on syrup

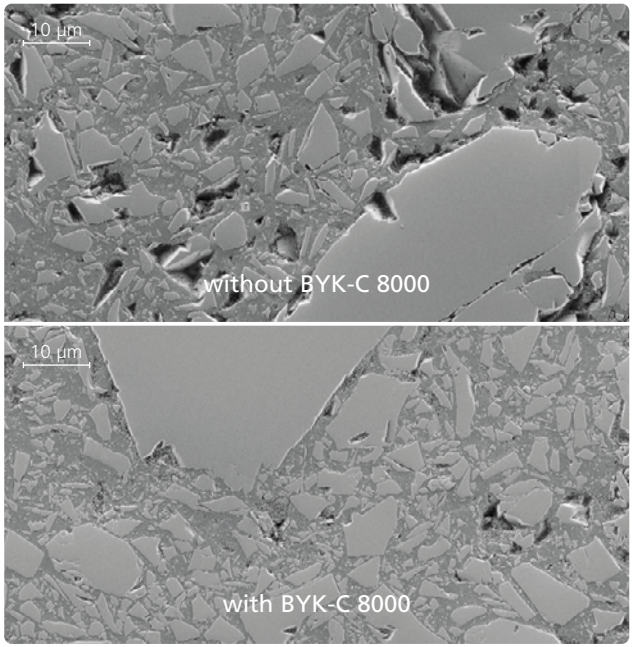
T. 02

Mechanism of coupling agents



G. 02

Hot water immersion test (200 h)



G. 03

Viscosity reduction

The quantity of filler in a highly filled acrylic system should be as high as possible, but at the same time, viscosity must be low enough to guarantee problem-free handling and processing. Wetting and dispersing additives can be very helpful to combine high filler loads with low viscosity. These additives adsorb onto the filler surface and minimize the interaction between the polar particles, which results in a much lower viscosity.

Wetting and dispersing additives for viscosity reduction

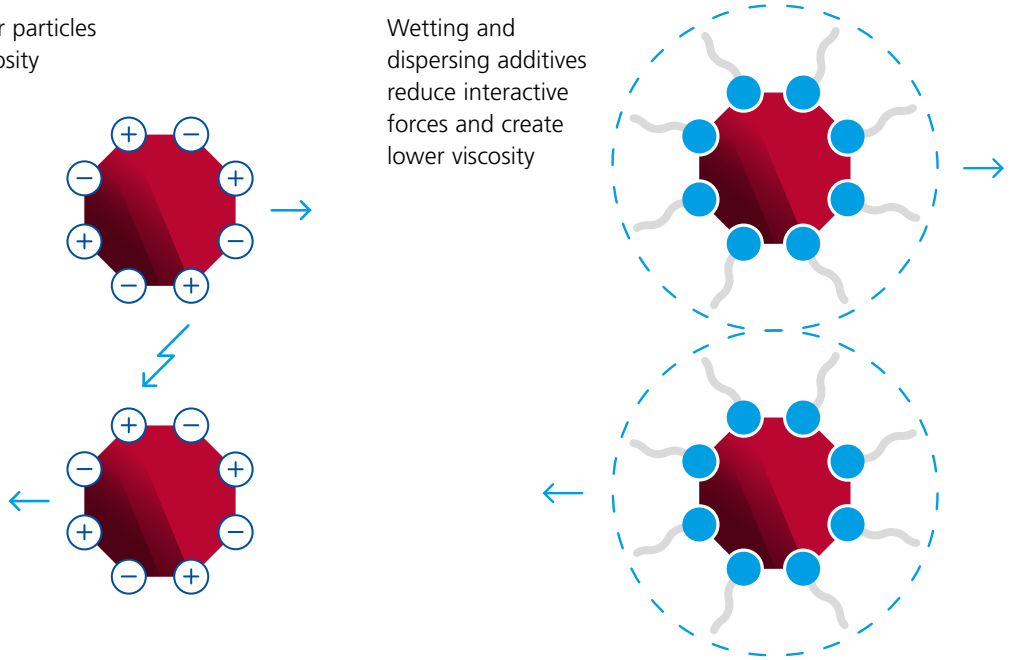
Product	Recommended for	Dosage
BYK-W 969	ATH, silane-treated silica sand	0.3–1.5 % on syrup
BYK-W 980	Silica sand	0.3–1.5 % on syrup

T. 03

Mechanism of viscosity reduction

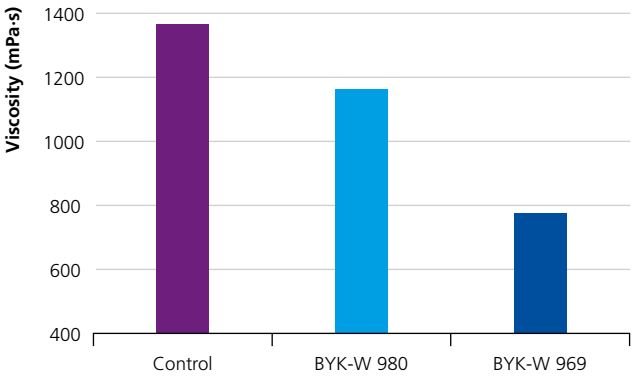
Interaction of filler particles leads to high viscosity

Wetting and dispersing additives reduce interactive forces and create lower viscosity



G. 04

Viscosity reduction in an ath-filled acrylic system



Syrup: 20 % PMMA in MMA; Filler load: 60 % ATH
Additive dosage: 1 % based on filler

G. 05

Anti-settling/anti-floating

In acrylic casting systems, viscosity should be low in order to obtain good flow in the mold. Consequently, many systems face settling (sedimentation) or floating problems with the solid particles (filler, flakes). Achieving good flow properties while experiencing no settling or floating issues requires the use of specially developed wetting and dispersing additives or coupling agents that support such behavior.

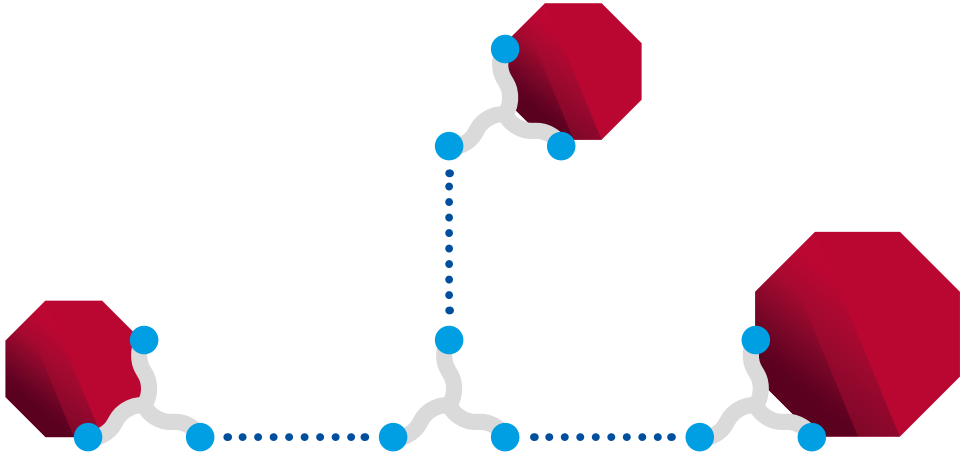
These multifunctional additives adsorb onto the particle surface and form bridges between several particles. This network structure very effectively reduces settling and floating.

Wetting and dispersing additives to prevent settling and floating

Product	Recommended for	Dosage
BYK-C 8002	ATH filled systems	0.3–1 % on syrup
BYK-P 105	All types of acrylic systems	0.3–1 % on syrup

T. 04

Mechanism of multifunctional wetting and dispersing additive



G. 06

Anti-floating

G. 07

Pigment stabilization

Many applications require pigmentation of the acrylic syrup to achieve an optimum appearance. White pigments (titanium dioxide) are often used, but colored pigments (inorganic and organic) are also utilized for special decorative effects. Pigments tend to agglomerate with each other, with other pigments, or with the filler particles. Such flocculation negatively affects color homogeneity, color shade, and hiding power.

Flocculation can be minimized by using appropriate wetting and dispersing additives. These additives stabilize the deflocculated particles and prevent reflocculation. A stable and uniform color effect is thus guaranteed.

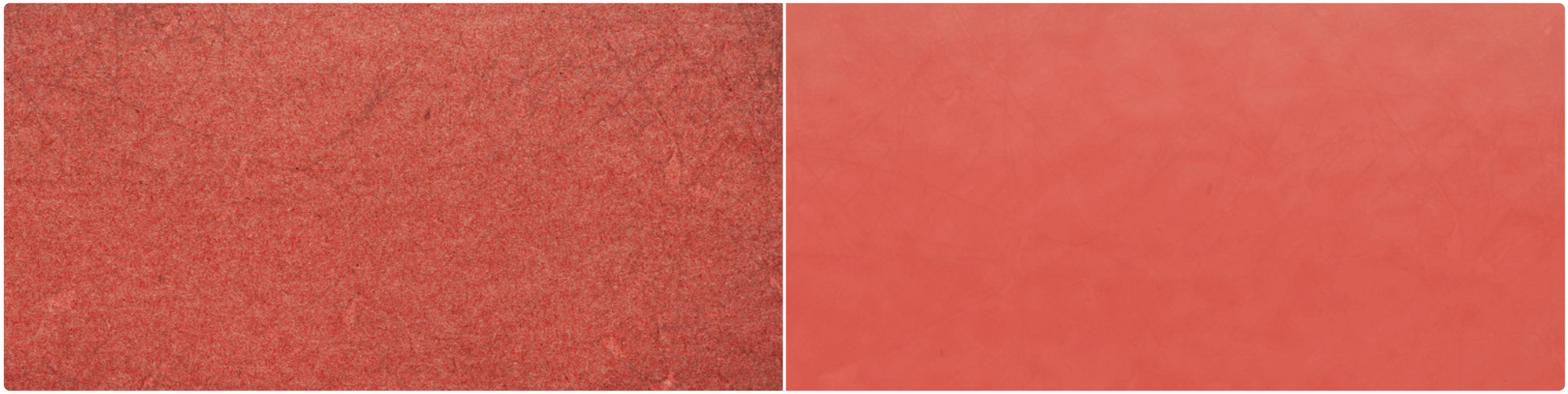
Additives for pigment stabilization

Product	Recommended for	Dosage
BYK-W 940	Fillers and inorganic pigments	1–5 % on pigment/filler
DISPERPLAST-1142	All types of fillers and pigments	1–10 % on pigment/filler

T. 05

Additive dosage strongly depends on the particle size of the pigments. Small particles with a larger specific surface area require higher amounts of wetting and dispersing additives than coarser particles with a smaller specific surface area.

Pigment stabilization with wetting and dispersing additives



G. 08

Acceleration of curing reaction

Curing of the acrylic system can be accelerated with Ca^{2+} ions. Dry $Ca(OH)_2$ or a suspension of $Ca(OH)_2$ in methyl methacrylate (MMA) is usually added to the syrup/filler mixture for that purpose, but both forms have their disadvantages:

Suspension of $Ca(OH)_2$ in MMA:
- Difficult handling of dry $Ca(OH)_2$ to produce the suspension
- Agglomeration and sedimentation of $Ca(OH)_2$

Dry $Ca(OH)_2$:
- Difficult to handle (corrosive)
- Difficult to dose materials in powder form
- No homogeneous distribution in the mixture
- Moisture and CO_2 absorption leads to reactivity change over time

Using $Ca(OH)_2$, either in powder form or in suspension, presents handling difficulties and can also lead to an inconsistent curing situation. This may negatively impact the quality of the final parts.

BYK-2616 is a CaO paste with 74 % CaO and is the better way to accelerate acrylic syrup curing:
- Pumpable paste
- Dust-free handling
- Fine particles in a very homogeneous distribution
- Fast acting due to large specific surface area
- Excellent storage stability

Overall, BYK-2616 facilitates accelerated curing that is consistent and homogeneous and enables the production of high-quality final parts.

Curing accelerator

Product	Recommended for	Dosage
BYK-2616	Ambient temperature curing acrylic systems	0.5–2 % on syrup

T. 06

Suppression of MMA emission

A typical acrylic syrup contains about 80 % monomeric methyl methacrylate (MMA), which has a high vapor pressure of 40 hPa and evaporates quite easily. Therefore, a considerable amount of MMA can be detected in the workplace when an acrylic syrup is exposed to air.

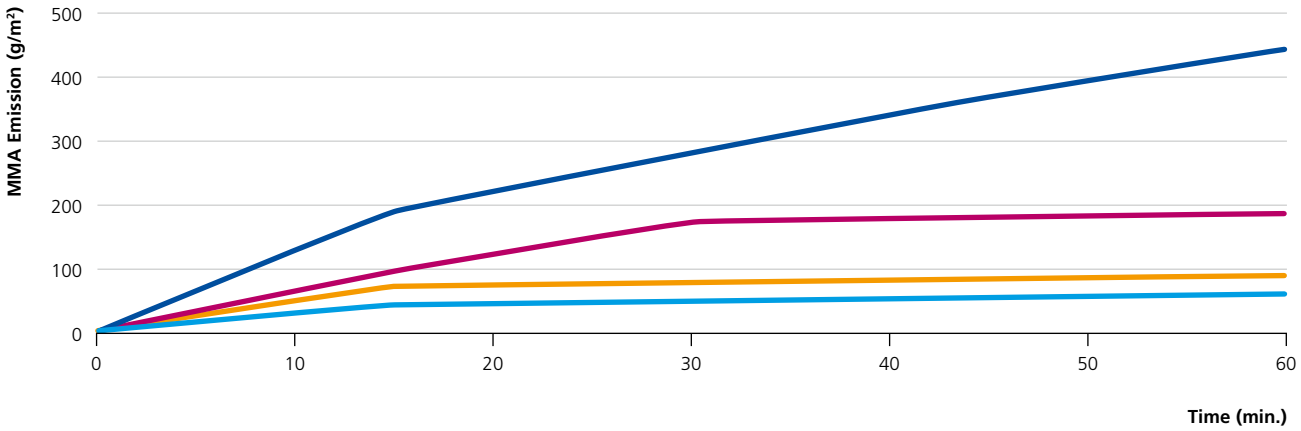
To avoid the unpleasant smell of MMA and protect the workers, the MMA emission should be as low as possible. Emission suppressants such as BYK-S 782 can reduce the MMA emission substantially; a reduction of more than 80 % is possible.

Emission suppressants

Product	Recommended for	Dosage
BYK-S 782	All types of acrylic systems	0.5–1.5 % on syrup

T. 07

MMA emission of a filled acrylic system



BYK-S 782 based on resin: 0 % 0.5 % 1 % 1.5 %

G. 09

Syrup: 20 % PMMA in MMA; Filler load: 60 % ATH

Summary of additive recommendations

Additive recommendations for acrylate applications

Effect	Product
Air release and defoaming	BYK-390 ● BYK-A 515 ● BYK-1790* ○
Improvement of mechanical and chemical properties	BYK-C 8000 ● BYK-C 8002 ●
Viscosity reduction	BYK-W 969 ● BYK-W 980 ○
Anti-settling and anti-floating	BYK-P 105 ● BYK-C 8002 ○
Pigment stabilization	BYK-W 940 ● DISPERPLAST-1142 ●
Acceleration of curing reaction	BYK-2616 ●
Suppression of MMA emission	BYK-S 782 ●

● First recommendation ○ Second recommendation T. 08

* For the use in food contact applications please check the food contact sheet.

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