Additives for Acrylate Applications
Additives for Acrylate Applications

Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Acrylate Applications</td>
<td>2</td>
</tr>
<tr>
<td>Air Release/Defoaming</td>
<td>3</td>
</tr>
<tr>
<td>Improvement of Mechanical/Chemical Properties</td>
<td>3-4</td>
</tr>
<tr>
<td>Viscosity Reduction</td>
<td>4-5</td>
</tr>
<tr>
<td>Anti-settling/Anti-floating</td>
<td>5</td>
</tr>
<tr>
<td>Pigment Stabilization</td>
<td>6</td>
</tr>
<tr>
<td>Acceleration of Curing Reaction</td>
<td>6</td>
</tr>
<tr>
<td>Suppression of MMA Emission</td>
<td>7</td>
</tr>
<tr>
<td>Summary of Additive Recommendations</td>
<td>7</td>
</tr>
</tbody>
</table>

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

Examples of Typical Acrylate Applications
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 Mechanism

![Figure 2](image.png)

**Step 1**

**Step 2**

**Step 3**

### Air Release Additives

<table>
<thead>
<tr>
<th>Type of additive</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYK-070 Silicone/polymer combination</td>
<td>0.3-1 % on syrup</td>
</tr>
<tr>
<td>BYK-A 515 Silicone-free polymer</td>
<td>0.3-1 % on syrup</td>
</tr>
</tbody>
</table>

### Improvement of Mechanical/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.

### Mechanism of Coupling Agents

![Figure 4](image.png)
Hot Water Immersion Test (200 h)

![Hot Water Immersion Test](image)

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. Figure 5 shows the results of a hot water immersion test.

**Coupling Agents**

<table>
<thead>
<tr>
<th>Coupling Agent</th>
<th>Recommended for</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYK-C 8000</td>
<td>Quartz and glass flakes</td>
<td>0.5-1.5 % on syrup</td>
</tr>
<tr>
<td>BYK-C 8002</td>
<td>ATH</td>
<td>0.5-1.5 % on syrup</td>
</tr>
</tbody>
</table>

**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.

**Mechanism of Viscosity Reduction**

![Mechanism of Viscosity Reduction](image)

Wetting and dispersing additives reduce interactive forces and create lower viscosity.

**Wetting and Dispersing Additives for Viscosity Reduction**

<table>
<thead>
<tr>
<th>Additive</th>
<th>Recommended for</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYK-W 969</td>
<td>ATH, silane-treated silica sand</td>
<td>0.3-1.5 % on syrup</td>
</tr>
<tr>
<td>BYK-W 980</td>
<td>Silica sand</td>
<td>0.3-1.5 % on syrup</td>
</tr>
</tbody>
</table>
Viscosity Reduction in an ATH-filled Acrylic System

Additive dosage: 1% based on filler

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.

Anti-floating

Anti-settling

Wetting and Dispersing Additives to Prevent Settling and Floating

<table>
<thead>
<tr>
<th>Additive type</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTI-TERRA-204</td>
<td>Multifunctional wetting and dispersing additive 0.3-1% on syrup</td>
</tr>
<tr>
<td>BYK-C 8002</td>
<td>Coupling agent with multifunctional groups 0.3-1% on syrup</td>
</tr>
<tr>
<td>BYK-P 105</td>
<td>Multifunctional wetting and dispersing additive 0.3-1% on syrup</td>
</tr>
</tbody>
</table>
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. 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.

Additives for Pigment Stabilization

<table>
<thead>
<tr>
<th>Additive type</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYK-W 940</td>
<td>Multifunctional wetting and dispersing additive 1-5 % on pigment/filler</td>
</tr>
<tr>
<td>DISPERPLAST-1142</td>
<td>Deflocculating wetting and dispersing additive 1-10 % on pigment</td>
</tr>
</tbody>
</table>

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)$_2$
- 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

<table>
<thead>
<tr>
<th>Additive type</th>
<th>Recommended dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYK-2616</td>
<td>Suspension of CaO 0.5-2 % on syrup</td>
</tr>
</tbody>
</table>
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 BYK-S 780 and BYK-S 782 can reduce the MMA emission substantially; a reduction of more than 80% is possible.

MMA Emission of a Filled Acrylic System

![Graph showing MMA emission over time with different suppressants](image)

BYK-S 782 based on resin: 0% 0.5% 1% 1.5% figure 17
Syrup: 20% PMMA in MMA; Filler load: 60% ATH

Emission Suppressants

<table>
<thead>
<tr>
<th>Suppression of MMA emission</th>
<th>BYK-S 782</th>
<th>BYK-S 780</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended dosage</td>
<td>First recommendation 0.5-1.5 % on syrup</td>
<td>Alternative to BYK-S 782 0.5-1.5 % on syrup</td>
</tr>
</tbody>
</table>

Summary of Additive Recommendations

Additive Recommendations for Acrylate Applications

<table>
<thead>
<tr>
<th>Additive Recommendations for Acrylate Applications</th>
<th>First recommendation</th>
<th>Second recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air release/defoaming</td>
<td>BYK-A 515</td>
<td>BYK-070</td>
</tr>
<tr>
<td>Improvement of mechanical and chemical properties</td>
<td>BYK-C 8000 BYK-C 8002</td>
<td></td>
</tr>
<tr>
<td>Viscosity reduction</td>
<td>BYK-W 969</td>
<td>BYK-W 980</td>
</tr>
<tr>
<td>Anti-settling/Anti-floating</td>
<td>BYK-P 105</td>
<td>BYK-C 8002</td>
</tr>
<tr>
<td>Pigment stabilization</td>
<td>BYK-W 940 DISPERPLAST-1142</td>
<td></td>
</tr>
<tr>
<td>Acceleration of curing reaction</td>
<td>BYK-2616</td>
<td></td>
</tr>
<tr>
<td>Suppression of MMA emission</td>
<td>BYK-S 782</td>
<td>BYK-S 780</td>
</tr>
</tbody>
</table>
Products and Applications

BYK Additives

Product Range Additives:

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

BYK-Chemie GmbH
P.O. Box 10 02 45
46462 Wesel
Germany
Tel +49 281 670-0
Fax +49 281 65735
info@byk.com
www.byk.com/additives

BYK Instruments

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

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

BYK instruments – the complete solution for the coatings and plastics industry.

Application Areas:

Coatings Industry
- Architectural Coatings
- Automotive Coatings
- Industrial Coatings
- Can Coatings
- Coil Coatings
- Wood & Furniture Coatings
- Powder Coatings
- Leather Finishes
- Protective & Marine Coatings

Plastics Industry
- Ambient Curing Systems
- PVC Plastisols
- SMC/BMC
- Thermoplastics

Printing Ink Industry
- Flexo Inks
- Gravure Inks
- Inkjet Inks
- Silk Screen Inks
- Offset Inks
- Overprint Varnishes

Paper Coatings
- Impregnation
- Coatings

Adhesives & Sealants

Construction Chemicals

Pigment Concentrates

Raw Materials for Manufacturing
Release Agents

BYK-Gardner GmbH
P.O. Box 970
82534 Geretsried
Germany
Tel +49 8171 3493-0
Fax +49 8171 3493-140
info.byk.gardner@altana.com
www.byk.com/instruments

ANTI-TERRA®, ATEPAS®, BYK®, BYK®-DYNWET®, BYK®-SILCLEAN®, BYKANOL®, BYKETOL®, BYKJET®, BYKOPLAST®, BYKUMEN®, DISPERBYK®, DISPERPLAST®, ISAROL®, LACTIMON®, NANOBYK®, SCONA®, SILBYK® and VISCOBYK® are registered trademarks of BYK-Chemie.

AQUACER®, AQUAMAT®, AQUATIX®, CERACOL®, CERAFAX®, CERAFLOUR®, CERAMAT®, CERATIX®, HORDAMER® and MINERPOL® are registered trademarks of BYK-Chera.

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 issue replaces all previous versions – Printed in Germany