Amine Blush on Epoxy Floors and Walls

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Crown Tech Support: Series 3

"For knowledge, too, itself a power" Sir Francis Bacon

Some amine curing agents (used in epoxy floor and wall systems), when applied in cool ambient temperatures or in high humidity conditions, develop an undesirable "blush" - an oily appearance or a sticky substance on the cured epoxy surface. However, technology has advanced. Many customers now realize that "blush" is a result of using outdated product technology. Today, with improved products available, the window for application and curing is wider than ever before.

Unfortunately, in the concrete repair and polymer overlay business, there remains a large number of polymer manufacturers, specifiers and contractors who are slow to adopt the newest technologies. This can be harmful to our industry because customers expect superior results for the money they invest with us. In today's world, especially in the current economic environment, a solid technical background is critically important. The old ways are gone. Customers are more knowledgeable than ever before. As always, It is important to remember that the customer is both judge and jury when it's awarding contracts[1] and accepting the finished product.

The person who depends entirely on salesmanship, with shallow technical knowledge, is most likely to fail. Providing customers with successful solutions requires experience and an in-depth understanding of available products and advancing polymer technologies.

Background

Epoxy is one of the most widely used polymers in concrete construction material. Epoxies were introduced for commercial use nearly 60 years ago. Today, for application to concrete, epoxy still outsells all other polymers on the market. The reason for epoxy's outstanding performance is its compatibility with portland cement concrete (PCC).

During the sixties, epoxy formulations were straightforward. That is, the chemistry of each component was less complicated. The component "A" epoxy resin, and component "B" curing agent, sometimes called "hardener", were basically simple raw material formulas. As epoxy gained popularity around the world for concrete repair and protection, it became obvious that the existing formulations and raw material technology needed improvement. As technology started to evolve, it allowed new formulations to solve more problems, increasing use. Polymer researchers are continually creating improvements in epoxy industry standards, to solve more problems with improved formulas and applications. Today's manufacturers' formulations are very complex when compared to those of a decade ago. In addition, they are much easier to work with when it comes to application and curing. Formulations today provide greater advantages to the contractor for lower substrate temperature applications. They offer VOC free formulas, curability parameters and properties that benefit the end user.

Today's epoxy manufacturer must have knowledge beyond the chemistry of polymers. An in-depth knowledge of the concrete substrate is simply a requirement for success. For sustainability, the epoxy must create a monolithic attachment to the concrete. Obviously, a complete understanding of the nature of concrete is imperative. The manufacturer's responsibility goes far beyond making the product. They must be capable of creating products and systems

for specific uses, providing technical support literature, application instructions and specifications. Manufacturers must work in collaboration with the specifier on how to select the best systems for a specific application. Moreover, they must teach the contractor not only how to apply the product, but its limitations.

This paper addresses “blush”, a common surface defect that remains a problem for some epoxy manufacturers.

Epoxy Surface Defect: Amine “Blush”

To understand the blushing phenomenon you must see it first-hand. Blush is normally a surface defect that leaves an uncured portion of epoxy on the surface. The result is a dulling of the gloss, a haze, a sticky grease-like or oily substance. It can be very thin so that it just dulls the surface, with slight stickiness. Or, it can be thick and very sticky. Total thickness very seldom exceeds one mil.

Some formulas of epoxy have the potential to “blush” under certain conditions, during the uncured time, after application and before the tack-free stage develops. If blushing occurs, it can be very costly and time-consuming to correct. If undetected, or not removed before application of the next polymer, adhesion between the two polymer coats will fail. Warranty issues are a common problem when “blush” is not properly addressed before application of the next coat or overlay.

Causes of “Blush”

Blush is often called “amine blush”, “amine sweat”, “amine bloom”, and “amine carbamate”. The reason for blush is the exposure of the uncured mixed epoxy to high humidity, dew, and/or cold substrate temperature conditions. This reaction develops because of the surface exposure of the uncured epoxy to one or more of the above conditions. The primary amine, a hydrogen atom selects the easiest molecule to attempt the curing process, carbon dioxide (CO^2) and hydrogen (H). Typically, the unexposed atoms (below the surface) will cure with the epoxy resin as designed.

Simply stated, blush occurs because the amine portion of the curing agent partially reacts with the easiest source of CO^2 or H, even if it is only a gas. For the curing agent to react properly there needs to be a solid molecule, such as epoxy resin. Gas, or air, in the moisture thwarts the curing process of the exposed atoms and leaves a partly cured molecule residue. The degree of “blush” depends on the exposure condition during the polymerization stage, the epoxy reaction before the tack-free stage develops. That is,the time when the surface may be touched or walked on without leaving any indentation. Severe “blush” could also cause significant surface irregularities and may increase the amount of polymer topcoat required to complete the job.

When moisture is present on the substrate surface, the wet (uncured) epoxy may not cure, or only partially cure, creating a “blooming” condition. The “blooming” phenomenon will be described in a future white paper.

Caution!

If the epoxy product requires an induction period, it’s more likely that the product will “blush” if certain moisture or temperature conditions exist. These formulas typically contain excess amines to overcome blocking of all the amines by CO^2. Any amine molecules that are blocked become amine carbamate and cannot react readily with the epoxy resin to create a cross-link bond. Reducing the percentage of crosslinking of the system compromises physical strength and resistant properties as originally designed.

An “induction period” or “sweat-in time” starts after the “A” and “B” components have been mixed as directed. The mixed epoxy will stay untouched in the pail during the induction period. The time is typically up to 45 minutes before the product can be applied. The purpose of this induction is to allow the different materials in the mixed product to try to dissolve into each other or “smear” together. During this time the epoxy mass will start to rise in temperature as the chemical reaction develops. If VOC’s are present in the mixture, the heated epoxy will liberate them quickly into the air, as a mass in the container and while being applied as a thinner overlay.

When the induction is completed, potlife (working time) could be an issue. Some formulas have very short potlife and others up to an hour if solvents are in the formula. The induction procedure is time consuming, and makes project management very difficult. It also increases the cost of application labor and time to cure the product.

Removal of “Blush”

Some polymer manufacturers cite precautions on their literature regarding blush and guidance of its removal. The uncured polymer “blush”, is typically water soluble and should be relatively easy to remove. However, removal is time consuming and, as a result, costly. Removal is typically performed by pressure washing with water, sometimes requiring scrubbing the surface. Some formulas require detergent and hot water. In any event, the water used to clean the surface will become contaminated and it must be disposed of properly according to local, state (provincial) and federal codes.

Window for Recoat

Unfortunately, “blush” removal consumes time and it is critically important to comply with recoat standards. Most polymer manufacturers require the application of the next polymer within 18-hours or 24-hours depending on the temperatures of the environment. The concern is to achieve optimum adhesion to the previously applied polymer. The longer the time span between applying the next polymer overlay the greater the chance of insufficient adhesion between the coats. Serious concerns are related to density, dust, moisture and or CO^2 at the interface. The result can be incomplete cure at the interface or potential delamination of the floor or wall system because of poor adhesion. Missing the window of time for recoating may require a complete sanding and wiping of the surface to expose the cured epoxy, prior to recoating.

The curing agents that typically cause the blush phenomenon are known as aliphatic polyamines, amidopolyamides, and polyamides and many different mixtures of these materials. The formulas that use cycloaliphatic mixtures do not require an induction time and are ready to be applied immediately after mixing. These formulas seldom “blush”. Moreover, some rapid curing cycloaliphatic epoxy formulas that are 100% solids, are tack-free and ready for the next coat by the time an induction epoxy has been applied. Cost reduction is always a major issue, especially in a down economy. In addition, good cycloaliphatic epoxy formulas should comply as LEED® “Green”.

How to Avoid “Blush”

Avoiding “blush” starts with the correct product selection. Aliphatic amine and polyamide curing agents are the primary cause of “blush”. Higher tech polymer manufacturers have replaced these formulas many years ago in most products. They typically use cycloaliphatic formulas, which do not blush under normal and adverse conditions of use. These formulas provide good cures at temperatures above 40°F with excellent all-around properties and temperature resistance to 200°F, depending on the functionality and structure of the epoxy resin. If in doubt, ask the polymer manufacturer if their product will blush. On most projects, you cannot control the working conditions during application. Ask. Why take the financial risk?

Why Gamble?

Why take the chance of a product blushing by using outdated technology and possibly increasing your project cost because of extra cleanup between coats? It's interesting to note that epoxy costs are approximately the same for blushing vs. non-blushing formulations. A special relationship should be developed between the contractor and polymer manufacturer. It's called trust. To avoid problems such as blushing, discuss the application and cure conditions can be reviewed with the manufacturer's representative. The contractor needs to know the manufacturer is providing the right product for the job. The experience of both companies will provide sufficient knowledge to complete each project successfully. The customer benefits by having the project completed in a timely manner, in addition to being free of VOC's and LEED® "Green".

The Real Challenge

There are no cure-all products. Therefore, one of Crown Polymers' challenges is to assist its clients and customers in gaining knowledge. Crown's method for accomplishing this is to provide on-going educational programs and technical support for those who seek predictable, profitable, results. Crown actively seeks those who are willing to think differently about change as well as new thinking regarding sales and marketing strategies. We realize that companies that differentiate themselves from competitors by providing unique products and excellent customer service are those that become most valuable and respected. Crown Polymers clearly offers these competitive advantages.

Learning to Forget the Past and Look to the Future

Strategies that are worth taking advantage of today include: Improve the performance of your company by mastering a core competence[1] as addressed in this white paper. Knowledge is a competitive advantage. Become the local expert. Attend a Crown Polymers "Polymer Overlay College" A Hands-On Training Experience. Those who study and practice the concepts Crown advocates will be well-prepared to devise successful marketing and production strategies.

Contact us for the next available training class dates: 888.732.1270 or register on-line: www.crownpolymers.com/tech

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References:

1. *Dimmick Sr., Floyd: "Concrete Challenge, From Simple Install to Massive Resurfacing Project", Article published by CoatingsPro Magazine, January 2007; presented at NACE – CoatingsPro 2007 Conference, Orlando, FL January 2007.*