ARCOR® ® Epoxy Coatings & Rebuilding Materials

Technical Review - Product Overview

There are a lot of products for people to choose from when they are looking for epoxy repair compounds and/ or protective coatings. In recent years all of these choices have caused a lot of confusion in the maintenance world. We are continually asked to compare ourselves to this product or that one. Often it is very easy to draw a direct comparison for say our ARCOR 23231 to Belzona 1111, Chesterton 853, or Devcon's Titanium Putty. We can show laboratory test results proving that 23231 performs at a significantly higher level than these or any other product made in this category.
But we believe that it may be more helpful to alleviate much of the confusion by giving you, our customers, some general information about what actually goes into these products and how many of these ingredients interact to achieve certain properties. It is our hope that this will help you to be able to make more informed decisions when you are trying to choose epoxy compounds to solve many of your day-to-day problems or tackle even some of your more difficult unusual ones.

Resin systems:
First we should discuss the different resins systems available to us. The most commonly uses resin system is a simple Bis-A. Bis-A's were developed back the 1930's and were first used as adhesives in the aircraft industry. In fact during WWII epoxies were considered top secrete because their use on allied aircraft meant less rivets in the wings, meaning less weight, and meaning more bombs. In the 1950's it was discovered that if you added zinc powder into Bis-A resins, you could create a pretty good cold galvanizing process giving birth to the epoxy coating business.
While improvements were made to epoxy coatings through the years Bis-A resins remained the standard base material until the early 1980 when Bis-F resins were developed. The Bis-F resins produced a "tighter" molecule with additional bonding points along its backbone and reduced viscosity. This improved the finished products made from Bis-F's in the area of chemical resistance, wear resistance, and overall adhesion, all of the things that you basically want in an epoxy compound. The only drawback was that the Bis-F's were more expensive to produce and the tighter molecule was slightly more brittle.
It did not take long after the Bis-F's were developed before the Novolac resins came along. The Novolac resin produced a round molecule rather than the straight ones produced in the Bis-A's and F's. Again these contained more bonding points along the circle of this molecule creating very strong, very chemical resistant products. However, Novolacs are also very difficult to blend into finished goods. Even in their raw state, they are very tightly woven, creating very viscous, almost solid materials. When cured into a finished product, the tight molecule may produce a lot of internal stresses that can cause micro cracking and an orange peel look on the surface.
Also many Novolac based compounds require heat induction to obtain a near complete cure. Many companies now blend Novolac resins into Bis-A resins to add some enhancements in performance, mostly in the area of chemical resistance. Be careful when choosing a Novolac. Many companies are calling products Novolacs when there are 95% Bis-A and 5% Novolac.

It might surprise you to find out that the vast majority of the products that are offered on the market today, even the most well-known and expensive ones, are still using Bis-A resins as their foundation. We at ARCOR have a couple of our older lower end coatings that use Bis-A, but the majority of our coatings and all of our rebuilding compounds use either Bis-F's, Novolacs, or various blends of Bis-A, Bis-F and Novolac resins.

Fillers:
While pure resin systems are strong and have good properties that make them resistant to erosion, abrasion and corrosion, we have available certain fillers that can be added to produce even better results.

- **Ceramics:** Ceramics are the most commonly used filler in epoxy coatings used for abrasion resistance. Some companies even refer to some of their products as “ceramic coating”. The most common of these ceramics is a ferrous-silicate formed by the rapid heating and cooling of a sand and iron mix. It forms very hard and someone inert ceramic beads that are then sized through micro screens. These micro beads add a good deal of abrasion resistance to a finished product. They are readily available and very inexpensive.
  The drawback to these ceramics is that they are heavy and cause slumping of coatings on vertical surfaces. To compensate for this other thickening agents must be added which do not do anything to add to the performance of the product.
  ARCOR uses some ferrous-silicates, but also uses a variety of other abrasive resistant fillers including glass beads, zirconium beads and some very high end lightweight fillers that are several steps up the hardness scale from anything others use. Depending on the service that we are targeting, we will use these as standalone or blend them.

- **Fibers:** There are a variety of milled fibers that are available to epoxy manufacturers. Each of these fibers will contribute a different property to the finished product.
  The most common of theses is chopped up fiberglass. It adds tensile strength and increases flexural strength; however these fibers lack uniformity and leave many weak spots in the coating.
  ARCOR again uses a variety of fibers depending on our target use of the products.
  We only use those fibers which are milled specifically in a form that will add uniform and very specific performance properties throughout our product. Some of these are very common, while others are very unique to coatings such as raw Kevlar pulp.

Adhesion Promoters: On their own epoxy resin systems are considered to be good adhesives. And many companies rely exclusively on the properties of the resins for bonding purposes. But given time and money, anything can be improved upon.

- **Wetting Agents:** There are several ways to approach adhesion. The free radicals of an epoxy resins bond chemically by the exchange of electrons with another substrate. This bonding can be greatly enhanced by wetting agents that will “drive” the resins into a more intimate contact with that substrate increasing the bonding surfaces down to a molecular level.

- **Flow agents:** Flow agents internally push a coating to smooth it out and give a more uniform look to the surface. But when used in conjunction with wetting agents, they will also promote adhesion.

- **Organic to Inorganic Adhesion Promotion:** Epoxies are organic compounds and by nature bond more freely to other organic materials. Bonding to inorganic surfaces is one of those areas where there is room for a high level of improvement. There are a small variety of these promotion additives available. Unfortunately, they are very expensive and are used very sparingly by most manufactures or not at all.

- **Coupling Agents:** A large percentage of most epoxy compounds are made up of fillers. As we said before, many types of filler are added to improve certain properties. Some are added, to add weight, and some just to add inexpensive bulk. And while these fillers add certain properties, they can also create certain weaknesses with the matrix of the product.
  Most of these fillers are just encapsulated within the epoxy resin. Therefore each piece of filler creates a void in the system, dramatically reducing the internal tensile strength of the final product. The way to overcome this is to use coupling agents. Coupling agents are internal adhesion promoters. They create a bond between the fillers and the resins.
  ARCOR uses these coupling agents in every one of our filled products.

Air Entrapment: The one thing that we do not want mixed into any epoxy is air.
Air leaves voids, creates pin holes, and overall weakens the final product.

- **Degassing Agents.** During manufacturing air gets mixed into the product. Years ago some companies began using vacuumed mixing pots to eliminate this in the manufacturing process. This was a large help, but did nothing to eliminate "fluffing" while mixing in the field. Some companies still use this process and even promote it as an advantage over competition. The better way to accomplish this is to use degassing agents, which reject air entrapment while mixing.
  ARCOR always uses degassing agents, which helps to prevent air from getting into the products during mixing, both in the manufacturing process and in the field.

- **Air Evacuators:** Even with the use of degassing agents, some air can get mixed into the products, especially if mechanical mixers are used in the field. As stated above some of the entrapped air stays in the product creating weak spots. And some of this air will "bubble out" of the product, especially in thin coatings, leaving open trails behind it creating pin holes in the coating. Air evacuators will force the air up to the surface of the mixed product and out before gelling takes place. The flow agents mentioned above help to close in the trails left in this process eliminating many of the pinholes which are found in most coatings.
  ARCOR always adds air evacuators into every product.

Flexibilizers: As we stated above, as you go up the chain of epoxy basic epoxy resins, the increased functionality (number of bonding points on the molecule) which adds many positive properties, also increases internal stresses and brittleness. This brittleness will decrease the products impact resistance and in fluid flow environments will severely reduce its' resistance to cavitation. This is one of the main reasons that most epoxy manufacturers still use Bis-A as the basic foundation for their products. The lower functionality gives more flexibility.
ARCOR has pioneered the use of reactive flexibilizers, those which react within the cured matrix so chemical & heat resistance is not degraded. These flexibilizers significantly reduce the internal stresses of the higher functionality resins so that we can provide higher chemical & heat resistant products without sacrificing abrasion, impact, or cavitation resistance. In fact, we have used this chemistry to produce products with the greatest impact and abrasion resistance ever seen. And still others with the highest cavitation resistance also.