Subject: Underwater Epoxies 101 TechnicalNotes
Date: Sat, 24 Jan 2004 07:41:43 -0500
From: Paul Oman <p.oman@ix.netcom.com>
To: pauloman.pauloman.com@ix.netcom.com

COATINGS AND EPOXY NEWS FROM:

issue 0401
==========
PAUL OMAN ----- Progressive Epoxy Polymers, Inc.
MULTI VENDOR EPOXY SOLUTIONS - urethanes, fillers, NSF 61,
MIO, pipe wraps, low temp epoxies, barrier coats, and more!
home of: WET/DRY 700 (tm) Kevlar (tm) underwater epoxy paste

Frog Pond Hollow - 48 Wildwood Dr - Pittsfield NH 03263
To cancel or for questions email or visit our sites below:
info@epoxyproducts.com http://www.epoxyproducts.com
==========
INTERNET INDEX OF EPOXY WEB SITES - www.epoxyproducts.com/map.html
EPOXY CLEARANCE/DISCOUNT/OUTLET SITE - www.epoxyoutlet.com

Applying Epoxy Coatings Underwater and On Wet Or Damp Surfaces

By Paul Oman*

Underwater painting sounds like some sort of parlor trick, but there are actually a number of epoxy coatings ad repair products that can be applied to damp, wet, saturated, or submerged surfaces as well as used in environments of very high humidity. Typical work sites can include pits, sumps, underwater supports, boats, piers and pilings and all sorts of below grade structures. The ability to patch, seal, encapsulate, reinforce, and protect objects, in place and in wet environments, is a much more attractive option than the alternative which is usually demolish and rebuild from scratch.

Despite the obvious advantages of moisture tolerant coating/repair products, such epoxies are not widely known or understood. The concept of underwater painting remains out of the belief of most industrial and marine maintenance professionals. However, with a slowing economy and fewer replacement dollars available, in situ rehabilitation or repair of existing structures, be they docks, yachts, ships, or dams, is becoming more of a more likely option. In some cases the object might not be exactly underwater, just water saturated. An example would be an empty cement pit, manhole or sump that has contained water for many years. The cement is completely water saturated and will remain so for a very long time.

Epoxy Basics

First formulated in the late 1930s in the U.S. and Switzerland, epoxies can be considered a two-part, thermoset plastic. Mix two liquid components together, a heat producing reaction (known as ‘Exotherm’) occurs, and a hard product results. Some basic and general characteristics of epoxies are: 1) easy cure temperatures, generally from 5-150 degrees C; 2) low shrinkage; 3) high adhesive strengths; 4) high mechanical properties; 5) high electrical insulation; and 6) good chemical resistance.

With so much going for it, epoxies were produced as commercial adhesives in 1946 and as commercial coatings by 1947. The versatility of epoxies was further advanced with the early formulations of epoxies that could be applied in an uncured state to wet surfaces. These special epoxies have evolved from rather crude, unfriendly products into high performance, applicator friendly coatings.

Epoxy Curing Agents

The curing agent selection plays the major role in determining many of the properties of the final cured epoxy. These properties include pot life, dry time, penetration and wetting ability. Curing agents come in many different chemical flavors, generally based upon amines or amides. Amine based curing agents are considered to more durable and chemical resistant than amide based curing agents but most have a tendency to 'blush' in moist conditions. Blushing produces a waxy surface film on actively curing epoxy, the result a reaction with the curing agent and moisture in the air. Other potentially toxic chemicals within the curing agent can also be released in the same manner, thus amines are often viewed in light of these potential shortcomings. Amides, on the other hand, are more surface tolerant and less troubled by moisture. Fortunately for epoxy end-users involved with underwater applications, there is a small subgroup of non-benzene ring structured amines that maintain all the benefits of amines while removing the toxic leachability and moisture attracting properties of typical amines. These special polyamines form the basis for today's cutting edge underwater epoxies.

How Epoxies Work

The well known adhesion of epoxies is due to the strong polar bonds it forms with the surfaces it comes in contact with. On dry surfaces the bond between the surface and the epoxy displaces the air, which is a fluid. The same is true underwater. As on dry surfaces, the polar bond attraction is strong enough to displace the fluid, in this case the water, and produce an strong bond even underwater. Thus, painting underwater is, in theory, no different that painting above the water. The cross linking reaction of epoxies should be independent of the surrounding environment. Still most curing agents will react with water molecules rather than the epoxy base, resulting in a waxy film, mentioned above, known as amine blush. This makes them unsuitable for underwater application.

A WARNING: Always Test First (Cathodic Issues)

Epoxies bond to surfaces at the molecular level by tiny electrical charges. Sometimes in marine settings there can be pre-existing electrical charges in the underwater environment that interfere with the bonding mechanism of the coatings. Such electrical cells can be either intentional or accidental.

Active or passive cathodic protection systems, designed to protect against underwater corrosion, will produce electrical fields that disrupt coating bonding. Dissimilar metals in the immediate vicinity (identified or unidentified) will also produce stray electrical fields. Even chemicals and pollution in the water may be responsible for or enhance the voltage of existing underwater electrical cells. The problem is more often observed in dirty harbors, full of unidentified metal junk, and chemical/industrial waste. Even ongoing arc welding on a ship will produce electrical charges on and around the hull. Ships tied to dockside facilities with their own cathodic protection systems or sloppy electrical systems, can cause underwater coating bonding problems on conductive (metallic) surfaces. Generally there is no problem on non-conductive surfaces such as concrete and wood, or in fresh water.

The method to evaluate the application and bond of underwater coatings on conductive metallic surfaces in seawater is not in a bucket of harbor water, but under actual conditions. What bonds and works well at Dock A, may not work at Dock B or when tied up to Facility C due to identified or unidentified electrical charges at that site.

Almost without exception, bonding problems associated with 'underwater painting' are site specific and related to electrical cells formed in a conductive medium (seawater) on a conductive surface. Always test in the actual marine environment before committing to any underwater coating project.

If there is a problem, the epoxy will simple refuse to 'stick' to the surface. It is very obvious (and embarrassing). It often will not transfer off the brush, roller, or paint pad/glove..

A WARNING: Always Test First (Additives in Concrete)

Concrete structures, often commercial in nature, can sometimes have adhesion problems too. Commercial aquariums and swimming pools are examples. In some cases chemicals were added to the

concrete to speed curing, reduce air bubbles, etc. These chemicals, some perhaps silicon based, prevent bonding of the epoxies to the concrete. It is also possible (I don't have proof) that some pool/aquarium paints also contain stain or slime 'no-stick' chemicals that make underwater coating impossible. I know of commercial aquariums where some the underwater epoxies work fine and others where they don't work at all. The only safe thing to do is test before taking on such a project.

Epoxy Evolution

Three generations of apply underwater epoxies have emerged over the years. Each has pushed the technology window forward. The success of first generation epoxies was in their ability to be applied and cured underwater. The next generation moved these epoxies into true coating status, albeit with issues of user friendliness and chemical safety issues still to be addressed. The new third generation epoxies have addressed those issues successfully.

First Generation Underwater Epoxy Coatings
*Sticky, like Bubble Gum
*Knead the two parts together in hand-sized amounts and push on to the surface
*Potentially difficult to ship - may require haz-mat shipping (Corrosive Liquid -N.O.S.)
*May have short shelf life.

Second Generation Underwater Epoxy Coatings
*Good underwater adhesion
*True bonding instead of sticking
*Poor storage stability (heating required) - products tended to crystallize over time
*Toxic - MDA and possible solvents
*Haz-mat shipping required
*Problem bonding to cathodically protected surfaces

Third Generation Underwater Epoxy Coatings
*Stable storage - will not crystallize over time
*Basically Non-toxic, 100% solids (0% VOC), no MDA
*Non haz-mat - unregulated shipping
*Improved application on cathodically protected surfaces
*Easy application results in productivity increase

Underwater Epoxies in Action - A Recent (12/02) example in the user's own words.

Subject: Underwater Epoxy Repairs - Follow-up Report
From: Joy Sxxxx <bansheeboat@xxxxxxx.xxx>
To: p.oman@ix.netcom.com - Progressive Epoxy Polymers, Inc. www.epoxyproducts.com

Paul:
Remember me?
Joy Smith and her sunk boat in Papua New Guinea around Christmas time last year?

By the time I finally left my boat and got off the island, got to civilization and then found your website, in my desperate search for an air-shippable underwater epoxy, we had been marooned on remote Hermit Is., PNG for two months. Banshee sank on October 21, 2002, in three minutes, after hitting a coral head and was completely underwater for three days. There was a 6 ft. crack through the hull and a punched in hole about a foot in diameter. The damage was massive.
Leslie patched the hull with old Z-Spar Splash Zone and a piece of wood a villager shaped with an axe. We kedged it off the reef, winched it upright, and then the villagers built an underwater cradle of lashed together logs to support Banshee. We bailed with buckets during a very low tide at night. She floated. The inside of the boat was trashed, the electric/electronics destroyed, the engine unusable, lots of things stolen, and diesel oil, sandy sea water and ocean bottom rubble and mold covered everything. But the sailing rig survived.

However, it soon became apparent that the old Z-Spar patch would never hold for a 300 mile open sea voyage to Madang, PNG and dry dock for hull repair. As I told you when I wrote in December, the hull was steadily leaking, and we knew the temporary repair would not last much longer.

I was desperate to save my boat that has been my life for 32 years.

I bought your underwater epoxy, and you shipped it to Manus Is., PNG. I picked it up and returned to the remote island of Hermit-what a name!! Almost didn't make it back as a storm came up while we were in the open 26 ft. boat making it back to the island. 36 hrs in an open boat with heavy seas with local bush people and me! BUT I HAD THE EPOXY AND KNEW WE WOULD NOW SAIL BANSHEE OFF HERMIT.

The whole saga is a very very long story of an incredible three month ordeal for two women alone. I got back to Hermit in mid January, and Les and I applied your stuff according to your directions. We patched the hull inside and out as you said. By then, the leakage from the 10 year old Z-Spar Splash Zone was getting worse. However, your stuff stopped all the leaks.

After 3 weeks of working on the boat, we left Hermit for the voyage to Madang, PNG. Sailing the 300 miles with no engine, no electronics, no autopilot, no functioning life-raft, and very little food or water. There were very high winds and rough seas and then dead calms, and we only had wind and sails alone to get us across that ocean. YOUR REPAIR STUFF HELD!! The hull had a fierce pounding-but no leaks. WE MADE IT!! We were towed in at the entrance to Madang Harbor and collapsed in exhaustion.

If we had not had your epoxy - our boat which is our life would still be under water at Hermit. We owe a debt of gratitude to you. The boat was put up in a primitive dry dock, and we literally cut out the repaired hull with a diamond tipped saw. Your stuff eats sanding grinders! We are good at epoxy repair of hulls-thank goodness, because no one here knew anything. Before we had properly repaired big holes where thru-hulls had been removed by building up larger and larger layers of mat and roving with epoxy resin. Leslie is very good at that-having worked in a fiberglass repair shop. This was just a bigger job.

Ghastly work. We have pictures of the repair and the 6 ft. long crack and hole in the hull.

We are now safely sitting in an anchorage in Madang rebuilding, and rewiring with our very limited funds. We plan to leave Madang for Guam and employment in December....

Very thankfully,

Joy S. and Leslie B.,
US Yacht Banshee
Madang, Papua New Guinea

Manufacturer Notes

There aren't a lot of formulators/manufacturers making underwater epoxies. It is a small niche with generally limited sales. Often underwater repair jobs require as little as 1 quart of epoxy, or perhaps 30 or 40 gallons - not enough volume for many of the larger companies. Besides the small volumes, the cathodic bonding problems mentioned above require distributors to do a lot of handholding and pre-sale testing - simply a lot of extra work and effort put into problem avoidance. Also the epoxy raw materials are generally more expensive than other epoxy raw materials meaning a higher priced product or lower profit margins. It is easy to see why large coating companies would rather focus on high volume epoxies and leave the niche underwater market to the smaller specialty companies.

Closing

The underwater applied coating market remains a small niche within the much larger industrial and marine maintenance marketplace. Both first and second generation underwater coatings are still widely in use, primarily because of the conservative nature of the industry and the acceptance of less than user friendly underwater products. Too few users and potential users/applicators of underwater coatings are aware of the advances made in recent years. This is changing as the shift toward environmentally friendlier, and easier to use coatings are slowly causing the re-evaluation of old familiar products and the

introduction of new companies with new products that better meet today's expectations. The ability of a single product to be effectively used on dry surfaces, underwater, or on saturated or dripping metal/concrete surfaces, while being both environmentally and user friendly, represents a technology that will continue to gain acceptance. The savings associated with in-situ underwater repairs and coating projects is often easy to document, as are the potential benefits from even more ambitious applications of this maturing coating technology.

* Paul Oman - Progressive Epoxy Polymers, Inc.
48 Wildwood Dr. Pittsfield, NH 03263 603-435-7199 Fax/435-7182 info@epoxyproducts.com
www.epoxyproducts.com

Who Are We? Learn more about us at: www.epoxyproducts.com/pep.html

---
APPENDIX: Underwater epoxies (also regularly used on dry surfaces) offered by Progressive Epoxy Polymers, Inc. (in unit sizes as small as one quart) include:

1) Quick Fix 2300 - non hazmat quick setting epoxy paste (will work in cold water);

2) Wet Dry 700 - non hazmat epoxy paste with normal potlife and cure times; Our Wet Dry 700 epoxy paste is representative of the "state - of - the art" 700 series of new third generation underwater epoxies.

3) Corro Coat FC 2100 brushable, non hazmat epoxy coating with Dupont Kevlar ® and feldspar ceramic (also available in a cold water application version, but this version is hazmat and cannot be shipped by air). All are available for private labeling.

We also sell the original underwater epoxy - putty like "Splash Zone®" epoxy.

Our NSP 120 has passed DBA nuclear testing and is potable water approved (NSF 61 - under certain conditions)) - colors - blue, white, black. Can be applied underwater too!

Product sheets and MSDS at: www.epoxyproducts.com/datamsds.html

--

==========
PAUL OMAN ----- Progressive Epoxy Polymers, Inc.
Frog Pond Hollow - 48 Wildwood Dr - Pittsfield NH 03263
10-4 Monday-Thur EST 603-435-7199 VISA/MC/Discover
info@epoxyproducts.com http://www.epoxyproducts.com
Boating site: http://www.epoxyproducts.com/marine.html
==========

==========
PREVIOUS ISSUES:

Underwater Epoxies 101 - Tech Notes