Sunk with a paintbrush

Protecting surfaces under the water sounds challenging, but Paul Oman reveals the secrets of third generation paints that can be used underwater.

Underwater painting sounds like some sort of parlour trick, but there are actually a number of epoxy coatings and repair products that can be applied to damp, wet, saturated, or submerged surfaces as well as used in environments of 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 US and Switzerland, epoxies can be considered a two-part, thermoset plastic. Mix two liquid components together, and an exothermic (heat producing) reaction takes place, and a hard, cured product results.

Basic and general characteristics of epoxies are:

- **easy cure temperatures, generally from 5-150°C,**
- **low shrinkage,**
- **high adhesive strengths,**
- **high mechanical properties,**
- **high electrical insulation, and**
- **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 be 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, so 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 a strong bond even underwater.

Therefore, 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.

Creative colouring with underwater paints causes confusion for the squid population...