Penetrating Epoxies - Test Results

An Internet search for Penetrating Epoxies turned up the following suppliers: Rot Doctor (tm); Smith and Company (Clear Penetrating Epoxy Sealer (tm) - CPES (tm); BoatLIFE; Corrosion Control Products; and Sound Specialty Coatings Group, as well as many other firms. Many epoxy users also make their own.

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Being in the epoxy business, I've long wanted to add a penetrating epoxy to my product line. I began by purchasing some commercially available penetrating epoxies. I quickly discovered there are two approaches to penetrating epoxies. Some vendors offer a penetrating epoxy that is very rich in solvents while others offer a low solvent, low viscosity product. We evaluated each type and were very disapointed with the performance, quality (of the ingredients), and seemingly high price of these products (my own humble opinion here).

Let's begin with the solvent based products. At least one (if not all) contain more solvent than epoxy. How much solvent is in your epoxy? Most regular epoxies contain no solvents. Penetrating epoxies will list how much solvent they contain in several ways. Consider 10 ounces of a penetrating epoxy. The amount of solvent it contains can be identified in several ways. All the following convey about the same information: 30% solids, 70% VOC, 700 G/L (grams per liter), 6 lbs/gal VOC. This product is approximately 3 ounces of epoxy and 7 ounces of solvents. One of the third party products we tested was in this solvent range.

In an effort to formulate my own solvent based penetrating epoxy, I experimented with five different solvents (and combinations of each); 4 different kinds/brands of epoxies, and solvent concentrations ranging from 0% to 66%. I measured penetration (vertical 'suck-up') by placing wooden paint sticks, wooden tongue depressors, fiberglass cloth and strips of corrugated cardboard into my test solutions and measuring how far up the surface the mixture 'pulled'. Most tests were performed using 6 ounces of mixed product in 1 pint plastic containers. I also used ordinary cellulose kitchen sponges to simulate 'bad wood' and applied 1 ounce of my test mixtures to each sponge. The testing of the commercial penetrating epoxies was done as per their mixing/application directions.

I also poured small amounts of both third party, and my own test mixtures, into cups of water to observe their reaction to 100% damp surfaces. A resulting white compound (most likely extreme amine blush) or a non-hardening solution was taken as a failure. A 'clean' hardened mass below the water as considered a 'success'. All of the commercial products and several of my test mixtures were classified as failing this test. All but one formed a solid mass at the bottom of the container, below the water. The high solvent product I tested formed a 'skin' above or on top of the water.

My Observations:

1) Even a small amount of solvent noticeably increased epoxy penetration. Penetration improved slightly with increased solvent loading.

2) The solvents and solvent mixes generally performed about the same. Xylene seemed to provide the fastest cure and was easily obtainable at a local hardware store. It quickly become the solvent used in most of these tests. I paid under $10 for a gallon of xylene in an expensive local hardware store.

3) Epoxies with a lower initial viscosity before thinning, penetrated better (and were thinner) when solvents were added to them.

4) Even a small amount of solvent greatly affected the epoxy gel/set time. With only 10% -15% solvent the time it took for the epoxy to set (in a 0.5-1.0 inch thick layer inside an open wide-mouthed, pint container) increased from several hours (no solvent) to 1-2 days. The gel time was slower when using acetone instead of xylene.

5) The additional of solvent made the resulting block of epoxy very rubbery. At 10% this rubbery affect was minimal and slowly went away. At 15% there remained a bit of give to the epoxy blocks. At 33% the epoxy became a rubbery block. At 50% or better, the result was 'Jello' with or without a layer of unreacted solvent over the Jello-like epoxy. The 'Jello' took several days to form.

6) Above 50% solvent, there was not enough epoxy present to wet out (turn clear and stiff) the sample strips of fiberglass cloth.

7) After two weeks, only those cellulose sponges with concentrations of under 33% solvent were less than 'mushy'.

8) All the solvent epoxy mixtures performed much better when brushed on in the form of thin surface coats and outdoors in direct sunlight. I assume under these conditions much of the solvent managed to evaporate into the air instead of getting trapped (or including) into the reacting, crosslinking epoxy/curing agent mixture. Unfortunately these conditions are not typical in situations where penetrating epoxies are used.

My Recommendations

To create what I believe would be the best available penetrating epoxy, I would thin a good quality, low viscosity epoxy 10% with xylene. This would improve penetration of the epoxy upon porous surfaces. I might thin this epoxy as much as 25-33% if I was not overly concerned about the rubbery mass that would form, or if using it as a surface sealer (where much of the solvent will evaporate out of the mixture before the epoxy begins to gel). Warning the epoxy will decrease its viscosity and improve penetration. So too will warming the surface it is being applied to. As the object cools, the air in it will contract, helping to draw the epoxy into the object.
As a 'sealer',' 'primer', or 'undercoat' for paints or varnishes, epoxies have proven their worth. No special product is needed here. In my opinion, just about any epoxy, thinned or unthin, will perform this task in a satisfactory manner.

Pricing - how much should you pay?

What is a solvent based penetrating epoxy worth? My chemist/formulator told me he could provide a low end epoxy, thinned 60% with bulk purchased solvents for about $10 per gallon in volume (industrial solvents are cheap in drum units - ditto for low end epoxy resins). Let's think small and give him some wiggle room. Call his price $15 per gallon. Let's give that price a 300% mark-up to cover packaging (expensive!), labeling, marketing, overhead and profits for distribution and sales folks. This 300% is large, but not outrageous. This means that an end-user price of $45 per gallon in 1-2 gallon units is not unreasonable (although regular non-blushing marine epoxy can be purchased in 1-2 gallon units for as low as $33 per gallon). How much are you paying for penetrating epoxies?
What is a low solvent, low viscosity penetrating epoxy worth? Using the lowest grade resins and curing agents purchased in bulk, the cost could still be under (perhaps considerably under) $20 per gallon. With this type of penetrating epoxy, there is no cheap solvents blended in to lower the price. There is also nothing in the product to raise the price either.

Test it yourself

Before forming an opinion one way or another about penetrating epoxies, perform your own tests. Purchase or blend up your favorite penetrating epoxy. Put a few ounces of it in a dish or pan and observe it for several days. Pour and ounce or two on a kitchen sponge. Coat some fiberglass cloth with the mixture and allow to dry. Pour the product into a cup of water. After you've done these tests, then form your own opinion.

Conclusion

This site is not meant to discredit anyone's contributions to penetrating epoxies. It is simply the results of experiments and testing I performed in an effort to develop (and yes, sell) my own penetrating epoxy. I have decided not to do that. From what I have learned and observed, I could/would not take a solvent-free epoxy, thin it 10%, jack up the price, and sell it as a 'penetrating epoxy' to an unsuspecting public. Better to just share the 'how to' information my testing revealed. Please don't just accept my negative evaluation of penetrating epoxies. As stated above, test them yourself - see what happens when viewed "out in the open". Your observations, and the products you test, might be different from mine.

Penetrating epoxies are not the epoxy equivalent to penetrating oils or penetrating lubricants. The addition of solvents to epoxies greatly reduces their price and epoxy properties. Just calling something a penetrating epoxy, whether loaded with solvents or not, seems to greatly increase the price of the product and divert attention away from its epoxy performance/quality. But if you must 'penetrate,' use a low viscosity epoxy (our one commercial plug - we sell several epoxies from $33 - $100plus per gallon, including a low viscosity formulation, but satisfactory results will be obtained with most or all marine epoxies) and thin with xylene no more than 10%.

A Warning: In researching this topic I talked with other full time epoxy professionals both inside and outside the marine industry. I was graphically reminded of the health hazards and flammable nature of solvents. Use EXTREME care when working with them in engine areas, confined spaces, and in open flame heated work areas.

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