When it comes to boats, WEST SYSTEM epoxy is unbeatable at keeping liquids out. It makes sense that it would work just as well at keeping liquids in. If only it were as simple as turning a boat inside out.

Building tanks with WEST SYSTEM® epoxy

Wood/epoxy composite tank guidelines

By Patrick Ropp

Builders have successfully constructed tanks for potable water, sewage, gray water, ballast and diesel fuel tanks and a limited number of gasoline tanks using WEST SYSTEM epoxy since the early 1970's. The regulatory environment has evolved within the last thirty years and has placed safety restrictions on various aspects of tank building, specifically potable water and gasoline.

U. S. Coast Guard (USCG) regulations, Food and Drug Administration (FDA) regulations, American Boat & Yacht Council (ABYC) standards, and insurance restrictions should be carefully considered by anyone, professional and homebuilder alike, planning to build a composite tank. Tank construction material and construction processes have been investigated thoroughly over the years, and the lowest grief option is choosing a certified tank from a manufacturer. Certified fuel tanks have already been tested in accordance with strict fire and flame regulations, and have proven themselves in the field. Certified potable water tanks have been made to minimize or eliminate extractives.

While professional builders are bound by tough USCG regulations and ABYC standards regarding tanks, backyard-boat builders have the option to follow or disregard them. However, if the builder decides to sell the boat, the federal regulations become applicable because he/she has built the boat for the purposes of sale. A good reference for individuals building boats for their own use and not for sale is Safety Standards for Backyard Boat Builders, COMDTPUB P16761 3B, available from. USCG Headquarters or its web site. *(See resources at the end of this article.)*

Before using Gougeon Brothers' products in tank construction, we advise that customers review the relevant federal, state and local safety regulations, standards, and recommended marine practices, as well as contacting their insurance carriers for restrictions. A wood/epoxy diesel fuel tank may be an uneconomical choice if insurance premiums increase or if state licensing/federal documentation problems are encountered.

Wood/epoxy tank construction

Once the epoxy leaves our shipping dock, Gougeon Brothers cannot control how the epoxy will be used. Some customers will use, and have used, the epoxy to build all types of tanks. For those who decide to proceed with making tanks, here are some guidelines to help make the project as successful as possible. The key to a durable tank is a thick, well-cured epoxy coating. To minimize long-term performance problems, we recommend the following:

1 Coat all interior surfaces with 5 or 6 coats of rolled epoxy

The inside of the tank should be treated similar to the outside of a hull. We recommend a minimum of 20-mil coverage, which is five or six rolled coats of epoxy, for all interior surfaces of tanks. This is similar to the coverage recommended as a "barrier coat" for the exterior of a hull. After it is rolled on, brush the epoxy out to minimize any entrapped air. Install surge baffles to minimize free surface effect, using generous fillets and giving them the same 5-6 coats of epoxy as the rest of the tank interior.

Any tank openings, such as fill, vent, inspection or clean out, should be oversized and also receive 5-6 coats of epoxy. We recommend that fasteners be epoxy bonded in place to secure any hardware to the tank or in the construction of the tank *(See details of hardware bonding in the WEST SYSTEM User Manual & Product Guide.)*

2 Use a slightly resin-rich/ hardener-lean epoxy mixture

Carefully metered resin/hardener ratio is **critical** to any epoxy's performance. In all projects, with one exception, we recommend dispensing and mixing epoxy at the target ratio within our acceptable range. Tank building is the exception to the rule. When mixing epoxy for tank coatings, we recommend a resin-rich/ hardener-lean mixture at the outer limits of the acceptable range as shown in Table 1.

This is because excess *resin* in epoxy is less likely to adversely affect the physical properties of cured epoxy than excess *hardener*. When excess hardener is in the epoxy matrix, it cannot fully react with the resin and will become suspended in the mixture. Because amines (in the hardeners) are water soluble, they can potentially leach out and cause odd tastes, contaminates in the liquid, and porosity in the epoxy film, among other performance defects. The maximum resin-rich ratios noted in Table 1 are at the end of acceptable ranges for

Resin/Hardener Combination	Weight Ratio		Volume Ratio	
	Target	Max Resin-Rich	Target	Max Resin-Rich
105/205	5.1:1	6.16 :1	4.7:1	5.68 :1
105/206	5.3:1	6.35 :1	4.7:1	5.58 :1
105/207	3.5:1	4.16 :1	3.1:1	3.69 :1
105/209	3.7:1	4.13 :1	3.1:1	3.50 :1

Table 1—Maximum resin-rich ratios

WEST SYSTEM epoxy. These ratios should not be taken any farther from the target. These maximum resin-rich ratios meet specification to obtain a properly cured epoxy film and to minimize extracts leaching out of the epoxy. When using 300, 301 or 303 Mini Pumps, one way to obtain the resin-rich/hardener-lean ratio within the acceptable range is to dispense the following:

Epoxy Combination	Pumps Resin	Pumps Hardener
105 Resin + 205 or 206 Hardener	**6**	**5**
105 Resin + 207 or 209 Hardener	**7**	**6**

3 Mix thoroughly, using a double-pot method

We recommend using a double-pot mixing method when building or coating tanks. Completely thorough mixing of epoxy is difficult to achieve when resin and hardener are pumped and mixed in one container. A film of resin or hardener will cling to the bottom or side of the container leaving areas of unmixed or under-mixed components. This can be readily seen when tinted epoxy is mixed together.

To ensure thorough mixing, first dispense and mix resin and hardener in one container, carefully scraping the sides and bottom. Scraping is key because it incorporates the majority of the single components into the mixture. Second, transfer this mixed epoxy into another clean mixing container. Use a new stir stick to mix a second time. This transfer will eliminate any clinging unmixed material and additional mixing will assure thorough cross-linking of both components.

4 Post cure at an elevated temperature

Post cure at a minimum of 120° F for 4 to 8 hours (after the epoxy has cured at room temperature and can no longer be dented with your thumbnail). You can use a temporary oven or radiant heater to apply an elevated temperature post-cure. A high-wattage incandescent or halogen light bulb can raise the temperature in a tank high enough to do the job. This is often the only way to do an integral tank. However, watch the fire hazard as some light bulbs can get hot enough to cause the epoxy to char or possibly ignite.

5 Scrub cured epoxy thoroughly with water

Scrubbing with water and a scouring/abrasive pad, such as 3M's Scotch Brite™ pad, removes any surface contamination, specifically any potential amine blush that may form on the surface. Amine blush is water-soluble and can be removed with tap water. The scrubbing action agitates the surface to help removal. Solvents don't normally remove the amine blush because of its water solubility. So leave the lacquer thinner, acetone, vinegar, alcohol, and other solvents in the storage bin, and use water. After scrubbing, rinse again with water and dry with paper towels.

Considerations for holding tanks and gray water tanks

Sewage holding tanks are Type III marine sanitation devices (MSD) and are regulated under Title 33, Code of Federal Regulations Part 159 (33 CFR 159)-Marine Sanitation Devices. A Type III MSD is considered a certified tank if it (1) is used solely for the storage of sewage and flush-water at ambient air pressure and temperature, and (2) prevents the overboard discharge of treated or untreated sewage or any waste derived from sewage (33 CFR 159.3, 159.12a, and 159.53). Type III MSDs may not be labeled. For Coast Guard Inspected vessels, the Type III MSD must also comply with 33 CFR 159.97. For the specific tank construction, make sure the internal surfaces are very smooth and that all burrs or wood splinters are removed so they don't cause anything to cling to the surfaces. This should help allow the tank to be cleaned efficiently.

Type I and Type II MSDs are more complex systems and are beyond the scope of this article; refer to the Code of Federal Regulations for guidance.

We know of no federal regulations or other standards regarding the manufacture of gray water tanks. Use the above general guidelines for construction and you should not have any problem using WEST SYSTEM epoxy.

Considerations for potable water tanks

We have adopted the broad policy of not recommending epoxy for drinking water tanks because of regulatory and safety issues. The potential problems outweigh the benefits. To date, none of Gougeon Brothers' epoxies meet FDA regulations or any other drinking water certified approval. The major long-term concern with any plastic water tank is extractives leaching out in the water. Off-ratio, poorly cured epoxy can release extractives, as noted above. In the fabrication of water tanks and food handling equipment, the successful use of epoxy requires thorough mixing and adequate elevated temperature post-cure to assure the maximum cross-linking and cure of the polymer. These process controls are not always possible with the home-built tank. Unfortunately, neither Gougeon Brothers, Inc. nor any certification agency can verify the level of quality control exercised in the fabrication of the tank.

What about the builder who weighs the risks and decides to go ahead against our recommendation? For the homebuilder it is a personal choice. If you build a potable water tank, follow the general guidelines noted above; in addition, you may want to install an in-line filter to help remove any

possible extracts and odd tastes. Professional builders should understand, again, that there are no formal approvals (awarded or pending) for Gougeon Brother's epoxy products for use in potable water tanks. Where certification is required, it is usually application specific. We have looked at the 2000 Title 21 of the Code of Federal Regulations, Part 175.300 (Food and Drug Administration, HHS) and found that the testing is specific for end-use conditions, container sizes, and frequency of use. If you have a specific design/use in mind, it may be appropriate to contact the American or Canadian agency to identify their requirements. As with many things, the care used in the construction of the tank is the key to the overall quality.

ABYC also has a section dedicated to the general installation of potable water systems; the specific standard is H-23-Installation of Potable Water Systems for Use on Boats.

Another great agency to get information from regarding potable water coatings is NSF International, The Public Health and Safety Company. They are dedicated to testing and issuing certifications of various coatings and materials for public health and safety. See their web site to find current products that meet their various standards.

Considerations for fuel tanks

Fuel tank building is a controversial area. There are several USCG regulations and ABYC standards governing fuel systems. Because of gasoline's lower flash point, higher volatility and combustibility, gasoline systems are more regulated than diesel fuel systems. These regulations are very specific and contain stringent requirements for the fill systems, vents, installation, testing and labeling.

The USCG regulatory information can be obtained at USCG Headquarters and at each Coast Guard District's Boating Safety Division. The guiding regulations for gasoline tanks in recreational boating are contained in Title 33 of the Code of Federal Regulations, Part 183.501 through 183.590. The regulations may be found online at no charge or obtained for a nominal fee from the Government Printing Office. The ABYC standards for gasoline systems are found in Standard H-24-Gasoline Fuel Systems and H-25-Portable Gasoline Fuel Systems.

Although the USCG doesn't publish any regulations for recreational boat diesel fuel systems, ABYC publishes a written a standard, Standard H-33-Diesel Fuel Systems. It would behoove customers to obtain a copy to ensure all safety precautions and recommended practices are followed.

Conclusion

All types and variations of tanks have been successfully constructed with WEST SYSTEM Brand epoxy and used in the field with great results. However, Gougeon Brothers does not condone or recommend that certain tanks be built because of various issues noted above. In our testing, various epoxy combinations have proven to be resistant to various liquids, including gasoline, diesel fuel, motor oil, potable water, sea water, sewage, gray water, etc. Regarding gasoline specifically, some epoxy combinations are more resistant than others. With the increasing use of alcohol and other high-tech additives, we are unsure how the epoxy will resist them in the future. We do know that many types of alcohol vigorously attack epoxy; we can only conclude that gasoline with a higher percentage of alcohol may break down an epoxy coating over a long period of time.

Before building gasoline tanks and potable water tanks, do your homework and take into consideration the information above. The resources and various agencies noted should help you make informed decisions regarding tanks and whether or not you should build your own. The final decision rests on the builder, and it is vital that you make sound, educated choices. As always, please contact the Technical Staff if specific questions arise.

References and Resources:

American Boat & Yacht Council
3069 Solomons Island Road
Edgewater, MD 21037-1416
phonel: 410-956-1050
fax: 410-956-2737
info@abycinc.org
www.abycinc.org

Food and Drug Administration:
5600 Fishers Lane
Rockville, MD 20857-0001
www.access.gpo.gov/nara/cfr/waisidx_00/21cfr175_00.html

Government Printing Office
Code of Federal Regulations:
Superintendent of Documents
Attn: New Orders
PO Box 371954
Pittsburgh, PA 15250-7954
Customer Service: 202-512-1803
Internet access
Fuel Tanks:
www.access.gpo.gov/nara/cfr/waisidx_00/33cfr183_00.html
Marine Sanitation Devices
www.access.gpo.gov/nara/cfr/waisidx_00/33cfr159_00.html
Fuel tanks for USCG Inspected Vessels (d GT):
www.access.gpo.gov/nara/cfr/waisidx_00/46cfr182_00.html

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Recreational Boating Safety
Safety Standards for Backyard Boat Builders, COMDTPUB P16761 3B
www.uscg.mil/d8/mso/louisville/WebStuff/comdtpubp16761_3b.pdf ■