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STOP THE ROT

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Specialty Sealants for Marine
and Architectural Applications

WOODEN BOATS AND WET WOOD

Wood holds water in two basically different ways. First, wood has microscopic open spaces, both inside and between the hollow fibers. Just like a sponge with all its holes or a towel with all the spaces between its fibers, any amount of water may be held, from barely measurable to damp to dripping wet.

Water held in this manner will eventually evaporate entirely when the wood is out of the water. The wood would not, in theory, shrink at all when water held in this manner evaporated.

Wood also consists mainly of cellulose, and cellulose is a kind of very high-molecular-weight sugar, and has lots of chemical groups called hydroxyl groups. These will readily form a weak chemical bond (called a hydrogen bond) with water molecules. The cellulose fibers change their diameter (and so the wood swells) as more or less of the cellulose molecules form bonds with water. The bonding mechanism is fairly weak, and its strength varies with temperature and the humidity (water concentration) in the air and the excess water in the wood. Thus, these two mechanisms overlap in their action.

Kept out of the water but in the air near a body of water (where the humidity is perhaps 40% average) the wood will dry out and shrink as the wood approaches an equilibrium humidity (10%-30%) with the air. This process starts soon after wet wood comes out of the water and ends in 2-6 months.

If the evaporation is stopped or dramatically reduced at some point in the middle of the process, when there is still some excess water in the wood but before most of the excess water is gone and the wood begins to lose water primarily through dehydration rather than evaporation of excess water, there is little shrinkage and the wood tends to hold its shape and humidity.

When the wood first comes out of the water it dries out faster on the surface than internally, because the water evaporates off of the surface faster than it can diffuse from the inside to the surface (the difference in evaporation and diffusion rates is at least a hundred to one).

In the first week or two after the boat comes out of the water, our Clear Penetrating Epoxy Sealer can be applied to the wood. It will penetrate the drier outer layer of the wood, since the alcohol in the solvent blend is capable of dissolving the water diffusing out from within. Once cured, the rate of water diffusion out of the wood is dramatically reduced, and the wood surface is impregnated with an epoxy resin and capable of bonding to polysulfide seam compounds and epoxy paints. If the seams are caulked with a two-component polysulfide rubber and an epoxy moisture diffusion barrier paint is applied, the wood will not absorb more water when the boat is launched and the seams will not force out the rubber. Further, when the boat is next hauled out, little if any water evaporates out of the wood (and that primarily off the inner surfaces where water loss can easily be controlled). The seams will therefore not open hardly at all, unless the boat is kept out for a long time and the below-decks area is open to dry air.

It is therefore possible to use modern high-performance compounds to stop the slow degradation of wood by excess water and mechanical stress.

For new boat construction or the restoration of old wooden boats which have been out of the water for quite some time, the first step (after removal of decomposed material) is to very thoroughly saturate the wood with Clear Penetrating Epoxy Sealer. The excess volume in the wood (especially near the surface or up the endgrain) which might otherwise hold excess water is now plugged up with epoxy resin, although not so thoroughly that the wood cannot breathe as much as it needs to. When a moisture diffusion barrier epoxy paint is applied to the outside, the wood absorbs virtually no water from immersion, and the wood is stable. Small variations in wood dimensions due to air humidity are readily accommodated by the two-component polysulfide rubber seam compound.

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WOODEN BOATS THAT GO IN AND OUT OF THE WATER

Wooden boats that are continually in the water have traditionally been designed so that the wood swells, absorbing the maximum possible amount of water, and the planks develop a water-tight seal either against each other or by compressing a caulking compound between the plank edges.

In many circumstances wooden boats are left in the water for a portion of each year, and removed for the remainder of the year. Under these conditions the wood has many months to dry out, and there is considerable shrinkage of the hull planks. When the boat is first put back in the water it may take a few days for the planks to swell and develop a seal, which is not always as good each time. During these few days the boat may leak like a sieve requiring constant attention to the pumps to prevent disaster. This regular expansion and contraction not only slowly loosens fasteners but slowly loosens and wears away the surface fibers of the wood, requiring constant attention and maintenance to ensure the vessel remains serviceable and trustworthy.

There is a way to take advantage of modern coating and sealant technology in order to eliminate this regular expansion and contraction of the wood, loosening of fasteners and slow degradation of the wood.

The basic principle is this: since the boat is out of the water for many months we recognize that the wood will dry out. Since we want to stabilize the wood we observe that it is easier to keep the wood dry in the water than it is to keep it wet out of the water. We therefore apply a moisture barrier coating on the outside of the hull below the water line.

The rate of water diffusion through the coating is far less than the rate at which moisture can diffuse through the wood and evaporate off the inside of the hull. Assuming the bilge is painted and kept reasonably dry, the humidity of the planks of the hull will reach an equilibrium with the humidity of the air, which is of course far less than (perhaps a thousandth of) the humidity of the water.

The key item that makes this work is to use a flexible, water-proof synthetic rubber bonded to each edge of each plank below the water line to allow the hull to "work" while maintaining a water-tight seal between each separate piece of wood and each other. We must allow for the inevitable slight motion of parts of the boat while sailing, and when in the water there will of course be some slight swelling of the wood due to the water splashing about.

Boats with naturally tight seams should have a

small vee-groove (perhaps 1/4" by 1/4" for 3/4" thick planks) cut on each edge of each plank. Lapstrake hulls will require an external fillet, perhaps a 1/4" radius, at the point where each plank overlaps the next. Hulls with significant space between the planks should have the seam filled with rubber. For deep seams with old caulking compound present, the seam should be reefed (cleaned out) to a depth of approximately twice the width, at a minimum.

In all cases the wood surfaces to which the rubber seam compound is intended to bond must be clean. This may involve cutting the seam clean with a rotary saw, running a folded piece of 60-100 grit sandpaper back and forth in the seam, or merely scraping the wood clean with the reefing tool.

Once the wood is clean, the first step is to brush Clear Penetrating Epoxy Sealer (Fast Version) in the seams. This primes the wood, ensuring excellent adhesion of the rubber to the wood.

The second step is to apply the rubber compound so as to fill the seam volume. To begin this step, first calculate the amount of rubber required for the job. Measure the depth and width of the average seam in inches, the total length of all the seams and multiply. That is the total volume in cubic inches. Divide by 231, and that is the required volume in gallons. Seam width and depth in centimeters times total seam length in centimeters divided by 1000 is required volume in litres.

For lapstrake hulls with a fillet of radius 1/4" or about 6 millimeters, the theoretical cross-sectional area is about .008 square inches, but one must allow more for waste in forming the fillet; perhaps twenty to fifty percent more than the theoretical calculated amount, whereas for other types of seams only perhaps ten percent waste in caulking the seams will be experienced. For a vee-grooved seam of 1/4" width and 1/4" depth the area is 1/32 square inch, and the seam volume is then 1/32 cubic inch per lineal inch of seam.

In order to complete the second step one mixes the rubber base with its curing agent and then forces the compound into the seam, either with putty knife or similar tool, or by packing into empty caulking tubes and then applying a bead, using a conventional caulking gun.

It is critical that only high quality, two-component polysulfide rubber be used for the seam compound. This is the only material which will hold up in this application and yet will bond to both epoxy coatings and antifouling paints.

The third step is to apply a High-Build Epoxy barrier coat over the entire hull, caulked seams and all. In this manner a water proof seal is formed.

The final step is the application of antifouling paint below the water line, and the bootstripe and hull paint above the water line.

The caulking of seams should ideally be done on the entire hull, but at a minimum should extend a few planks above the water line.