The term “osmosis” was coined in the early 70s to describe the blistering found on many GRP boat hulls and is now in common usage. The osmotic process probably does occur within the blisters but is not the only process involved and is not the full story.

A GRP (glass reinforced plastic) boat hull is a matrix of (usually) polyester resin reinforced with glass fibres, built up in layers. The final laminate will have an approximate ratio of 30% glass to 70% resin. This laminate is not homogeneous; that is even within a well-built GRP hull there will be small voids, air pockets and micro-cracks within the resin matrix and at the interface between the resin and the glass fibres.

Water can diffuse into, and through the gel coat and the laminate (the polyester not the glass fibres) as water molecules, not a liquid. A boat hull can absorb a maximum of approximately 2% water in this way. Water may pass slowly through a GRP hull in this way and disperse in the bilges as water vapour. The moisture content of a new hull will slowly increase during the first few seasons that she is afloat. The moisture content will similarly reduce slowly when she is out of the water.

As mentioned previously there are various small voids within the laminate. The water molecules can collect and condense within these. Within the GRP laminate and the micro-voids are various water soluble components. These are solvents, by-products and unreacted constituents from the manufacturing process.

The water within the micro-voids is able to dissolve and chemically react with these components. This process is known as “hydrolysis”. “Hydrolysis” will continue with the voids enlarging. A dissolved solution is formed, the main ingredients being, acetic and hydrochloric acid and glycol. These products give “osmotic fluid” its characteristic vinegary smell and greasy texture.

The glycol in particular is “hydroscopic” (water absorbing). Once this is released in the voids it will accelerate the rate of water absorption into the laminate. This process will now continue and will not be reversed by simply taking the boat out of the water. Moisture content will drop slowly if left ashore but will rise again fairly rapidly when the boat is immersed again. The various hydrolysed products cannot pass through the polyester gel coat / laminate but the water molecules can.

As this process continues, at some point the concentration within the voids will become greater than the concentration of the water the vessel is floating in (sea water). At this point the “osmotic” process occurs and more water is drawn in.

The interface between the glass fibres and the resin matrix can also be broken down. The binder used on the glass fibres (particularly emulsion bound mats with polyvinylacetate binder) are water soluble. This can allow liquid water to pass along the fibre bundles, producing some swelling at the fibre ends and the characteristic “wicking” or “fibre-aligned blisters”.

As this continues the voids are increased in size by “Hydrolysis” and the pressure within is increased by “Osmosis”. At some point the pressure may become too high for the surrounding material to support and a blister is formed.

This all sounds fairly alarming, however it is important not to over-react. Many boats are used for years in this condition and at this stage the processes are chemical with very little loss of mechanical strength of the laminate / hull. Many boat hulls may take 10 - 20 years or longer to reach this stage.

As this process continues, moisture continues to be absorbed, the laminate break down accelerates and more blisters are formed. In time some larger blisters may develop within the laminate as well

as those more commonly occurring between the gel coat and laminate. At this stage, treatment will be required (See later).

Diagnosis of the “osmotic” condition and the decision as to what level of treatment, if any, is required and when, is made by considering a number of factors.

- The hull gel coat surface is visually examined for signs of blisters or wicking.
- The liquid content of any blisters is examined and tested.
- The moisture content of the hull is gauged using a moisture meter.

With regard to moisture meters, these are only one tool and have their limitations. A diagnosis based on meter reading alone is flawed. Relatively high readings on older hulls in particular is not necessarily an indication of “osmosis” or poor laminate condition.

At the other extreme, a visual examination revealing extensive gel coat and deeper seated blisters may be all that is necessary to produce a diagnosis of “osmosis”.

To determine the full extent of the defects and therefore the detail of the complete treatment required, it will be necessary to examine the hull laminate after the gel coat has been removed. In some cases additional laminate repair may be required prior to epoxy coating the laminate (see treatment).

As noted earlier there are a number of factors associated with “osmosis”. The treatment process has to deal with all these factors. Simply “drying” the hull and covering with an epoxy paint system will not work.

The laminate does have to be dry, however the removal of just water from the laminate will not result in a long lasting treatment. The contaminants and components dissolved in the water also have to be removed. As noted earlier some of these are hydroscopic (water attracting) and in general are large molecules. These have to be removed from the laminate when still in solution within the water.

Simply drying or forced drying using dehumidifiers and/or heat lamps will tend to remove the water but leave many of the contaminants behind. For this reason steam cleaning and washing the hull surface is important.

The gel coat, although not 100% water proof, is still a very effective water barrier and will not allow the passage of larger molecules such as glycols. For this reason the gel coat has to be removed. This is most effectively achieved by the use of a “Gel Peeler”. This removes a controlled thickness of gel coat and / or laminate leaving an even, smooth surface.

The surface left by the “Gel Peeler” however has several problems. Firstly the very smooth surface does not promote drying well and doesn't provide a good abraded surface for a good mechanical bond for the epoxy coating. In addition the “Gel Peeler” will not remove softer material within the blisters deeper than this smooth surface. For these reasons the peeled surface should be “grit blasted” after peeling.

As the aim of the treatment is to remove the contaminant from the laminate along with the water, it is best to initiate treatment, peeling and drying shortly after the vessel has been lifted ashore after a sailing season. If left ashore for some time (a winter say) before initiating treatment, some of the water may have been removed and it will be more difficult to wash out the contaminants.

Once peeled and blasted it's important to wash out the contaminant from within the laminate. This is best achieved by repeated steam cleaning or hot pressure washing. Initially this will probably be on a daily basis and then less frequently for a period of several weeks. It is necessary to monitor this process with both moisture meter readings and using litmus paper to assess the PH of the surface water.

When the surface is found to be neutral, a few days after washing, the drying process can commence. At first this can simply be air dried but the hull will eventually need to be heated to reduce the surface moisture content to a very low level, 50 or below (Tramex scale 2) 5 or below (Sovereign scale A)

At this stage coating can commence. The exact specification, over-coating, application procedures etc will be determined by the product used and the manufacturer’s specifications. However in general a solvent free epoxy system, applied by roller, with four to five coats giving a total application thickness of approximately 1mm, is a summary of what is required.

Most solvent free epoxy systems require to be applied and cured in controlled temperature and humidity conditions. For this reason generally applications should be carried out inside a workshop