John Lilley & Associates Marine surveyors & Shipwright timber/grp

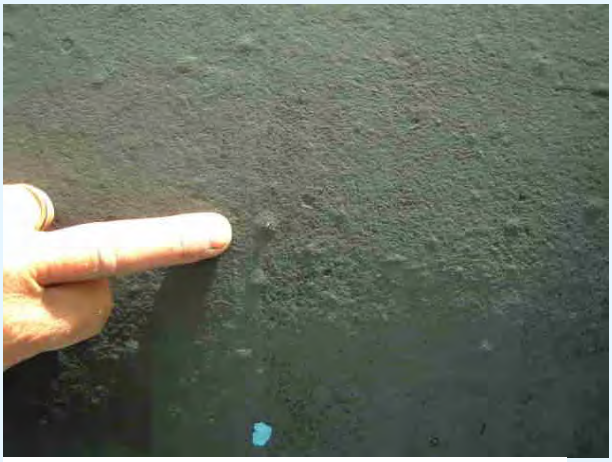
01258 837153 07963 011390 johnlilley@seasurveys.co.uk

**Osmosis**

A brief description of osmosis

If you can imagine the hull as a thick, but very fine filter, allowing water to pass through exceptionally slowly, because of the fineness of the mesh, it is so slow that the water evaporates away on the inside of the hull instead of dripping through. This action is normal, but at some stage, the water that is in the laminate starts to break down and dissolve the stray chemicals left in the lay up, these new compounds are much denser than the water that helped create them, and because the mesh (the hull) is so fine, they cannot escape. The majority of grp vessels have myriads of small voids throughout the construction; it is thought that it is these voids that become the starting point for initial breakdown into new chemicals.

More water continues to combine with them and increase their volume & density but as their escape route is blocked, they form blisters to make enough room, this slow process continues until they are released by gel coat removal and flushing all reaction chemicals away. In extreme cases the laminate can be forced to delaminate as the pressure of the blister fluid increases, when formation of blister fluid is deep within the laminate.



Moderate blistering, these average about 8mm dia, but can be as large as 13mm in advanced cases

The moisture meter indicates the presence of water and blister fluid, but does not differentiate between water and the blister fluid, the water dries out, but the blister fluid does not, therefore the reason for watching how the readings change. It is also not unknown for gel coat blisters to simply be caused by gel coat aeration bubbles when the original gel coat was vigorously mixed and applied, with the inclusion of air bubbles which subsequently show as small blisters as they become water filled. This type of blister is not usually of any consequence.

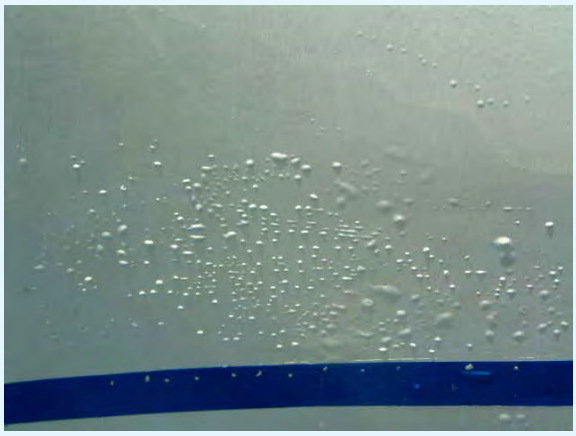
Before commencement of any remedial treatment, investigation into which type of blister is present is crucial to avoid unwarranted work.

It is often found that fully treating a vessel too early can be counter productive, just as epoxy coating a vessel that has high moisture readings can accelerate the breakdown within the laminate and possibly cause a vessel to develop blistering that otherwise may not have developed blisters for many seasons.

The development of blisters cannot be guaranteed simply based on a hull that has high moisture readings, and many vessels will continue blister free for several seasons but with continually high readings. It is not a condition that can be accurately forecast. The development of osmosis action is directly linked with the time spent afloat, store a vessel dry for 6 months out of 12 and it might be expected to double the time before treatment becomes necessary. Other surveyors & repairers may have differing views and the above is in my opinion only.

Wicking is where exposed ends of individual strands of glass fibre act like straws and through capillary action, draw water into the laminate. The strands of glass swell and show the pattern of glass matting through the gel coat. Epoxy coatings can prevent these being seen. It is not thought that this is structurally weakening to any great degree and will be present for many years before any structural effect is noted.

This is a necessarily simplified explanation only..



This is merely water beneath paint on resprayed GRP topsides, annoying but not a structural deterioration

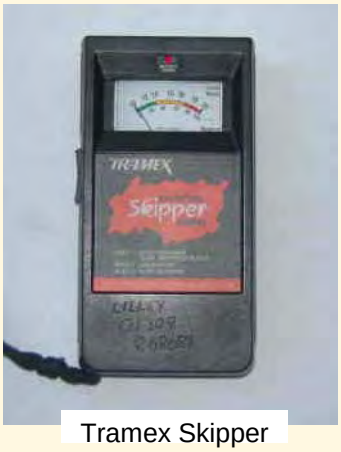
Mis-diagnosis is unfortunately far too common, as noted above, not all blistering is osmosis…….

John Lilley & Associates Marine surveyors & Shipwright timber/grp

01258 837153 07963 011390 johnlilley@seasurveys.co.uk

**Moisture Meter readings**

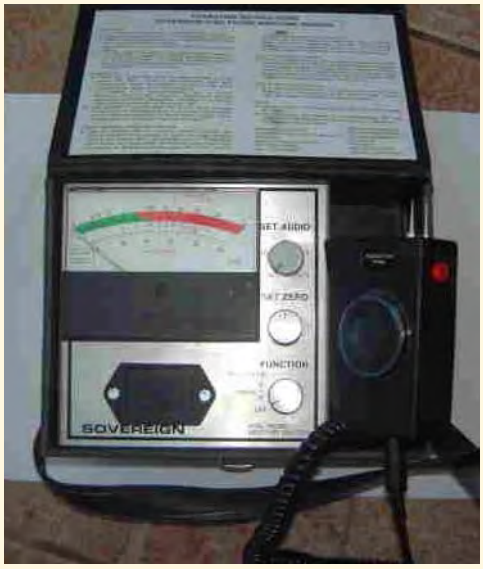
The most commonly used meters are the Tramex Skipper & the Sovereign. There are many other meters in use and these are just as reliable usually but the readings are not always easily compared to the two above. The Tramex has 3 selectable ranges of differing sensitivity and measures RF conductivity between two large pads. The display (similar to an analogue multimeter) is calibrated 10 – 20 on top side of the scale and 0 – 100 on the lower side of the scale i.e 10 on top is the same as 0 on bottom. and 20 on top is the same as 100 on lower side.




Tramex Skipper

Usually the most sensitive range (no.2) is used to indicate whether the hull is suitable for epoxy coating as epoxy coating is more successful the "drier" the vessel is. Usually epoxy coating will not be professionally suggested if the residual readings are above about 15 on top, 50 on lower using range 2. Range 1 starts where range 2 finishes, and range 3 starts approximately where range 1 finishes. Generally, a vessel that has residual readings less than 15 on top scale using range 2 is not likely to be suffering from any excessive degree of chemical activity in the hull.

A waterlogged skeg or rudder will often be off the scale on ranges 2, 1 and sometimes range 3, which does indicate high moisture content.




Sovereign Meter

The readings obtained on most vessels will usually be anywhere from the high end on range 2 through all range 1 and up to the bottom of range 3. which would be considered quite high.

The Sovereign meter only has 2 ranges, and the analogue scale is calibrated with various numbers but one of these is 1-100, which will be used by myself when referring to this in any survey. The drawback with this meter is that the only portion of the 1-100 reading that is used will be 0 – approximately 20 using the most sensitive range "A" Approximately 12 on the sovereign using scale A is equal to 15 (50) on the Tramex range 2..

Interpreting the readings should not be undertaken lightly. Internal bulkheads and engine bearers for instance will be picked up as very localised high readings when there perhaps is no underlying high laminate reading. Water tanks can also indicate high readings as will the presence of water in the bilges and of course, metal parts including keels. Spurious high readings will not be unusual in any vessel.

When a vessel has been recently lifted from the water, these readings will generally always be higher that those obtained after seven days ashore, and it will be impossible to accurately forecast what these readings will eventually settle down to.

Each vessel is different. For an accurate idea of what is happening to the laminate, a set of readings should be taken a short time after lifting, then another set, perhaps ten days later and note the changes. Any changes after that time will be less noticeable.

Any readings taken are basically reference numbers for comparison and do not represent any actual percentage of moisture content in the hull. Just occasionally, it can be found that a hull that has little or no "moisture" content will exhibit higher readings and when an area of topside is checked that is absolutely known to not be subject to any water absorption, this has a high starting reading which can be misleading regarding any areas below the waterline on the same hull as this start reading automatically gets added to the residual reading.

Epoxy coatings can also help give misleading readings and it would be unwise to carry out any invasive repair work based upon moisture readings alone. High moisture readings without any other visual or physical evidence, should, in my opinion, not be used as a basis for any costly works on a hull.

John Lilley & Associates Marine surveyors & Shipwright timber/grp

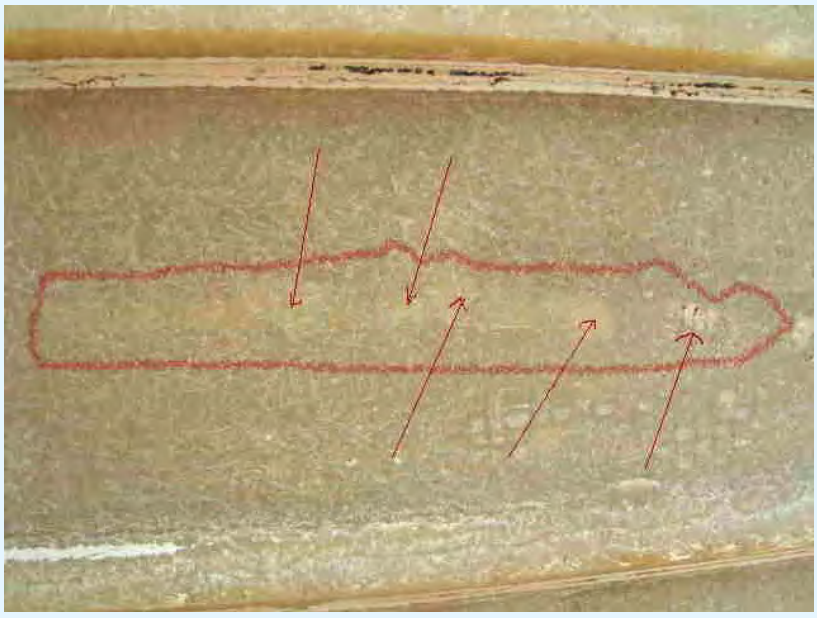
01258 837153 07963 011390 johnlilley@seasurveys.co.uk

**Drying problems**

Occasionally it has been found that in a minority of vessels, some from well known builders, when remedial work is undertaken for blistering, it proves impossible to reduce the moisture meter readings to a low enough figure to enable successful completion of works using normal established practices e.g. a minimum of six steam/pressure washes after gel coat removal and slurry blasting.

This, sometimes, has found to be a result of partial separation of the layers caused by resin starvation when originally constructed. Presently this cannot be successfully detected from normal sounding, non-destructive tests or visual methods, and although rare, I cannot guarantee that if and when any treatment is considered, this fault is not present. This fault is not easily cured as it can be a major headache trying to locate the underlying cause.

The only indicator is usually very high readings at the low parts of the hull, but this is where bilge water usually lays and gives these readings anyway. In extreme cases hammer testing can locate this, but confirming this fault requires core samples to be taken and not surprisingly, few owners would allow this.



Sandblasted hull but note the barely visible voids under the thin skin that will fill with water eventually if not opened up

Some vessels have hollow sections such as a keel section, which is completely sealed in for instance; some power vessels have structural tank type mouldings as part of the hull support below the waterline.

Eventually, these can partially fill with water and can go unreported for many years as it may not be possible to absolutely confirm with a moisture meter that water is present in them, for instance, when a vessel has been lifted immediately prior to survey and the hull remains physically wet. Even if the meter does suggest water is present, it should not be assumed as absolute as earlier noted, readings can be misleading for several reasons. There is only one sure way, and that would be to drain the area, either externally in the case of a hollow keel, or internally in the case of a structural tank type moulding. Generally drilling a drainage hole in a hull or mouilding should not present any structural problems subsequently provided care in placing the hole is taken. Obviously keep clear of internal bracing points, internal fluid tanks etc. The area can be made good by preparing externally by thorough abrasion and dishing with a grinder/sander. Plug with epoxy filler and overlay with glass cloth & epoxy resin. The problem remains then on where & how the water entered the area in the first place. epoxy coating problems

When a vessel has been epoxy coated at some previous time it is usually impossible to fully confirm the reason for the epoxy coating, or the standard of application of the epoxy coating.

There are one or two obvious reasons for epoxy coating including as a preventative application, a finish for comprehensive repairs for osmosis, an unwise finish for a vessel that is already on the process of some osmotic action, but unwisely thought by the owner as a way of preventing further deterioration and lastly and perhaps most seriously as a way of disguising the vessel that would be otherwise seen as having obvious visual signs of blistering by merely surfacing the exposed blisters flat and immediately epoxy coating without re-launching the vessel. In this particular case the blisters would not reappear until the end of the following season, giving the false impression that blistering has suddenly occurred, but is the result of perhaps attempts to mislead the buyer and surveyor.

In some cases, these works will be undertaken “professionally” at the owner’s expense by a boatyard, so it is always in the best interest of the interested party to make further enquiries regarding any epoxy coatings, as it is virtually impossible for a surveyor to absolutely describe and ascertain the laminate condition as regarding blistering in this case without wholesale removal of these “expensive “coatings.

01258 837153 07963 011390 johnlilley@seasurveys.co.uk

It might be wise to have written confirmation from the owner in these cases for the reasons of epoxy application, which would then place a legal obligation on the seller in the case of deliberate misleading statements.

In most cases it can be impossible to identify the particular reason for epoxy coating because without removal of the epoxy coating, which is not usually acceptable by either party, it is not possible to access large quantities of the underlying original gel coat. It is strongly recommended that whenever any epoxy coating has been identified under a finish of antifoul coats, the interested party make further inquiries as to when and where this coating was applied. Epoxy coatings are not a guarantee that the vessel will never develop blistering. Even epoxy coatings can fail and, if not applied correctly or thickly enough in the first instance will fail earlier then occasionally anticipated.

Other failure problems involve incorrect application such is applying in the wrong temperature, excess humidity at time of application, less then minimum hull preparation standard and obvious user problems such as incorrectly mixing. Another application fault that can be suffered by many non professionals is what is known as under cure where, the application temperature was suitable at the time but a sharp drop in temperature and an increase in humidity within a short time of the application halts the curing process of the epoxy which can never be fully restarted.

Any or all of these problems will substantially shorten the life of any epoxy coating. Moisture meter readings taken of some epoxy coated vessels will inevitably be high but it has to be ultimately that a degree of professional speculation as to what the cause of these relatively high readings would be. It is extremely rare to locate a vessel that has been epoxy coated and has negligible moisture meter readings despite this being the ultimate aim.

Epoxy coatings will also require renewal or reapplication at some stage, generally any time after 10 to 13 years might be an expected time for an epoxy coating deterioration (the epoxy coating starts to allow higher water ingress) Epoxy coatings themselves can also blister, this is not detrimental to the hull of the vessel but is caused by water entrapment between the epoxy coating and the hull.

In this particular case it has to be seen as a failure of the epoxy coating but not necessarily a failure of the hull structure. Unfortunately this can lead to high moisture readings merely due to the epoxy coating failure and not necessarily to a residual reading within the hull.

Perhaps now, it can be understood how difficult and ambiguous moisture meter readings can be.

**Epoxy coating suitability?**

This is an area where many yards and surveyors perhaps differ, it is generally accepted that in epoxy coating a vessel which has moisture readings beyond a certain point is an unwise procedure and ultimately a waste of time effort and money and, in some cases, can accelerate the course of any osmotic action within the hull if it is already present.

It is strongly suggested that whenever undertaking epoxy coatings in a non professional circumstance, it will be wise to gain some professional record of the readings obtained prior to epoxy coating for future reference and perhaps saleability as, as can be seen above there are some dubious reasons for epoxy coatings and it will be wise to have a record of precisely the reasons the epoxy coatings have been done and of the application details which will give any future purchaser a degree of confidence.

Voids beneath sandblasting easily seen

If the readings are considered by the surveyor at that time to be too high for epoxy coatings then, provided there is no serious blistering to the extent of weakening the structure and no evidence of delamination or other structural fault then, in my opinion, it is always best to leave well alone however, there are others who have differing opinions upon this but it has been found by experience in the past that carrying out any remedial work at the wrong time is often the cause of early failure of that new work, and in some cases the vessel would have fared better without any works carried out whatsoever as the development of blistering and associated faults can be extremely difficult to forecast with accuracy and some vessels that have a limited blistering at present may well go on for many seasons without any noticeable alterations to the hull.