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Osmosis - Explained in simple terms

Imagine a fibre glass hull as an exceptionally fine filter, when immersed in water the filter (the hull) allows water to pass through the skin of the hull to the interior. The process is so slow that as the water passes through the skin it evaporates internally without any incident. This is a fairly normal process, but at some stage this water begins to break down the residual chemicals in the laminate. The majority of laminates will have microscopic voids throughout the laminate, some of the voids are bigger than others, and these voids will vary from builder to builder, and even between each individual laminator. It is believed that most osmosis stems from these voids, where microscopic quantities of water start to hydrolyse (react with water) any stray chemicals that often remain in the laminate, particularly residues of catalyst. In this chemical reaction a completely new chemical is formed, the density of this chemical is such that it is too dense to escape through the very fine filter of the hull. This new fluid is hygroscopic (actively seeks water to combine with).
As more water combines with this new fluid the localised pressure starts to increase because the new fluid is unable to escape. This pressure is enough to raise blisters in the gel coat on the skin of the hull. It will be noted that when a large blister is pierced the fluid that emerges is no longer water. In very extreme cases these blisters, particularly if the initial voids are large and deep in the laminate, can create enough pressure to cause localised delaminating, although osmosis to this extreme is rare.
The process is not reversible once it has started, although it is thought that limiting the amount of time the vessel is afloat, hence laying up ashore can slow it. Halting the process completely is outlined later as a guide. Water temperature and salinity also play a part. Warm fresh water is likely to accelerate the process faster than cold seawater. Very few vessels suffer with osmosis to such a degree that the strength of the vessel is severely affected.
Generally speaking the development of blistering on the most hulls is quite slow, and from first indication of blisters several seasons could pass before any noticeable changes were visible. The most severe effect of limited osmosis, which is what I expect the majority of vessels will be prone to at some time or another, is not structural failure but loss of value. Mention the slightest hint of blistering and down goes the saleability and value.
As time goes by and more and more vessels in the marketplace have blisters or high moisture readings without any ill effect, perhaps the consumer will be more tolerant of the inevitability of the fact that most grp vessels have the potential to develop blisters, and those with limited blistering do not sink at their moorings!!!!

Moisture meters - How they work

Most surveyors when surveying fibreglass craft will use a moisture meter to indicate the moisture content of the hull. These meters register electrical conductivity in the hull, (working on RF frequency, one probe is a receiving aerial the other a transmitting aerial) the more moisture in the hull the higher the reading. The difficulty arises in that the blister fluid and water are both conductive. The moisture meter cannot differentiate between the two, and for correct analysis it is only the level of blister fluid that we are interested in. Any water will dry out on its own.
When a vessel is first lifted out of the water the moisture readings can be very high, gradually these readings will drop as the vessel dries out, it will reach a point when it no further reduction in readings takes place, this may take as little as 10 days in an inactive laminate, this residual reading is usually the one that can indicate the presence of blister fluid. The blister fluid does not dry or evaporate and no amount of forced extra drying or applied heat will have any long-term effect.
Unfortunately the development of blisters is not predictable, some vessels may indicate high moisture content, suggesting the presence of blister fluid, but will not develop blisters for many seasons if at all, others may have similar readings with blisters present. It is generally accepted that osmotic blisters will not be found with low readings.

Blistering and wicking

Wicking is where the individual strands of the fibreglass mat behave like straws and draw water along their length, in doing so they swell in size and wicking will quite commonly be identified by a very slight raised pattern of the original matting visible on the gel coat. Very often as the water dries out

the swelling diminishes and the pattern disappears. When looking at a gel coat without pigment, wicking is easily identified because the area affected will have many individual strands of fibreglass clearly visible with a white outline. This white outline is where the bond has broken between the resin and each individual strand.
Not all blisters are caused by osmosis, some will be found to be dry blisters, these may often appear in the gel coat and usually caused by aeration when the original batch of gel coat was mixed. These swell with water and raise localised rashes on the gel coat which disappear after a short time ashore and are obviously of no consequence usually.

Blisters caused by osmosis particularly at the outset may not be easy to find, as they may not be very numerous and will be quite small, having the appearance of small pimples, on average they may reach fingernail size (approximately 10 mm diameter), in extreme cases a may reach hand palm sized or larger when many blisters merge and combine making very large individual blisters, although this is a rare occurrence on modern craft, and probably would have been attended to long before it had reached this size. Serious delaminating would be a result of this extreme circumstance.

Preventing Osmosis

It is probably not possible - given the existing methods of construction and materials used - to absolutely guarantee that no fibreglass vessel will ever suffer from any type of deterioration caused by water ingress, and it is unlikely that any builder could confidently say this at present. Some resins and materials have far greater resistance to water than others, but at a price, and at present, it is thought that no resin including epoxy resin is guaranteed 100% waterproof for a lifetimes immersion in water. But it is possible to slow the process down.

Epoxy resins have exceptionally low water permeability, and if applied to a hull which has no evidence or sign of any chemical change in the laminate caused by hydrolysis, and provided it is applied to the correct specifications it will give many years of protection. Simple mathematics suggests that the longer the vessel is in water the more water it will absorb the higher the risk. By simply laying the vessel up ashore each season can possibly effectively double the number of years before any osmosis effects are present.
In my opinion many vessels undergo extensive treatment unnecessarily early, with the result in some cases, that the treatment is not totally effective and blisters reappear within four to five seasons. Some vessels even undergo treatment simply on the basis of high moisture readings, in my opinion this also is unnecessary and expensive!
If there is any indication whatsoever of chemical changes taking place in the laminate because of water ingress the application of epoxy coatings is not usually advised because the epoxy has the effect of sealing the problem in and speeding the process up, thereby causing all a deal of unnecessary work and expense.

Repairing Osmosis

The accepted practise nowadays in this country is generally to remove the entire gel coat by mechanical means, and then slurry blasting which removes the majority of the damaged laminate and blister cavities. The hull is then steam cleaned at regular intervals.
As the blister fluid is water soluble, this steam cleaning has the effect of diluting it and flushing the blister fluid away. More blister fluid will migrate to the surface to be cleaned away at the next steam cleaning session. Eventually using this method all of the blister fluid should have been removed from the laminate and regular checking with a moisture meter should confirm that the laminate is free from contamination. The water used in the steam cleaning has no long-term effect and will be found to dry out within hours.
Usually a minimum of seven to ten washes will suffice but it obviously depends on the individual vessel. Finishing off is usually just the process of re laminating any thin or weaker parts of the hull using epoxy resin and glass cloth, fairing the hull with epoxy filler and coating with adequate coats of epoxy finish. The exact process may vary from one builder to another. In North America where blistering is extremely prevalent, some repairers will attend to individual large blisters by digging out the deteriorated area, washing profusely and simply filling with epoxy filler.
Of course there are limitations to this as it is not feasible to attend to a large number of blisters in a localised area in this way, but reports on the limited method as above appear to be enthusiastic.

Time will tell!!!!

Conclusions

Technical advances and deeper understanding of the symptoms, prevention and cure are continually being made and new techniques and materials are being tried out on a continuing basis with the effect that what seems impossible now, might well be taken for granted in five years time.
The above information is given in good faith and based upon experience and personal opinion, and I am sure that other surveyors and technical writers may have different views, but this is how deeper understanding moves on.
Any interested party should seek further advice on any of the subjects raised above before committing themselves to any project or expense in connection with the above information.

The previous information should be treated as a guide for further investigation it is not intended to be a comprehensive guide for repair and diagnoses. Always seek professional guidance specifically for the vessel inspected before embarking on any preventative or curative works.

Sometimes a little is not enough, and sometimes, a lot may be too much. And always bear in mind that perhaps nobody knows everything when it comes to Blistering and Osmosis yet, it is still a degree of educated guesswork in many cases.....
No responsibility is accepted for any inaccuracies or mis-information in any of the above information.
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Further information

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