Choosing and Using Moisture Meters

Written by Nigel Clegg

A good moisture meter is an essential tool when inspecting and treating glassfibre laminates, but have you ever thought about what a moisture meter actually tells you?

Moisture meters determine moisture content by applying a high frequency signal between two electrodes held against the laminate surface. As moisture content increases, the electrical capacitance measured between the electrodes rises, and is interpreted by the meter to indicate a value on it's display.

Whilst this technique gives a useful indication of moisture content, the spacing of the two electrodes and the thickness of any gelcoat has a significant influence on the readings given. As a general rule, the gap between the two electrodes dictates the depth to which moisture can be detected in a laminate, (i.e. the larger the gap, the greater the depth of signal), with sensitivity dropping off rapidly beyond this point.

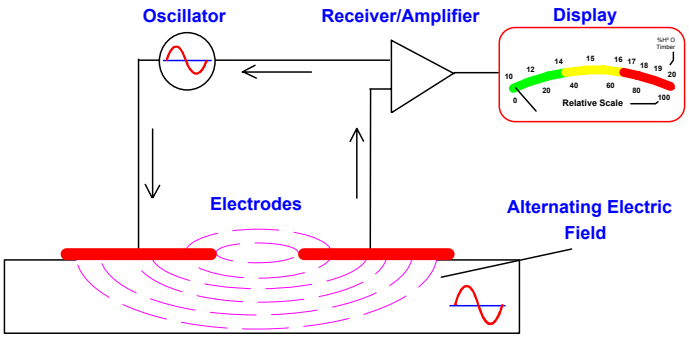

Fig 1. Schematic of a Typical Electronic Moisture Meter

This is an important (and often underestimated) factor, as the moisture we are looking for is most likely to be found within the core of the laminate itself, rather than in the relatively dense gelcoat.

Having been concerned by the number of stories circulating about false readings, a simple test was devised to determine the real effects of gelcoat thickness on moisture meters.

To carry out this test, a series of polyester 'Test Shims' were cast between sheets of plate glass, using Scott Bader's isophthalic gelcoat resin (in clear and white). The resin was allowed to cure for a month, following which the shims were measured using a micrometer to determine their exact thickness.

As it was found impractical to produce shims of less than 0.5mm thickness, a number of 0.1mm thick Xerox overhead projector acetates were used for taking smaller measurements, and for adjusting the 'gelcoat' thicknesses to the exact sizes required. (These acetates were found to have the same dielectric properties as an equivalent thickness of clear gelcoat).

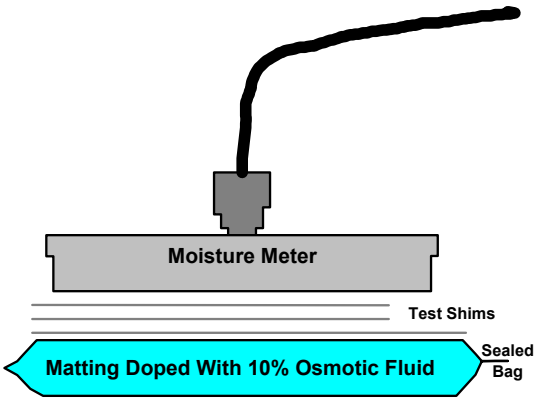

Fig 2. Test Method Used To Compare Instruments

A dummy laminate was also prepared, using two layers of chopped strand matting, doped with 10% by weight of an imitation osmotic solution, (comprising 10% Acetic Acid, 20% Propylene Glycol and 70% distilled water). The doped matting then was sealed into a thin polythene bag to prevent evaporation during the test, and placed on a thick piece of known dry laminate.

A series of response curves were then plotted for each of the most popular moisture meters by inserting shims between each meter and the dummy laminate, progressively increasing the effective gelcoat thickness. To avoid confusion, the figures quoted in the graphs relate to percentage of full scale deflection, rather than using the manufacturers indicated moisture content.

The actual test scores quoted in the summary are the maximum thicknesses of clear gelcoat through which the instrument would indicate 50% of full scale deflection when using the dummy laminate, and

are extracted from the graphs below. Readings taken when using white gelcoat shims were found to be approximately 10% higher throughout.

Ideally, a moisture meter should be able to detect moisture regardless of it's depth within the laminate, although in practice this would be almost impossible to achieve. Nevertheless, the quantity of moisture introduced into the dummy laminate was quite substantial, and should have been enough to ring alarm bells on all of the instruments tested. In practice, some instruments proved to be far more effective for detecting this moisture than others, particularly as the test 'gelcoat' thickness was increased.

Despite it's modest appearance, the Irish built Tramex Skipper proved to be by far the most sensitive moisture meter tested, and displayed the most useful response curves. When using Scale 2 (most sensitive), the Skipper indicated 'off scale' until the gelcoat thickness was increased to just over 3 mm, and was still showing a 50% deflection at 10 mm. When using the less sensitive Scale 1, full scale deflection was still recorded at up to nearly 1mm gelcoat thickness, falling to 50% at 3mm. (See graphs)

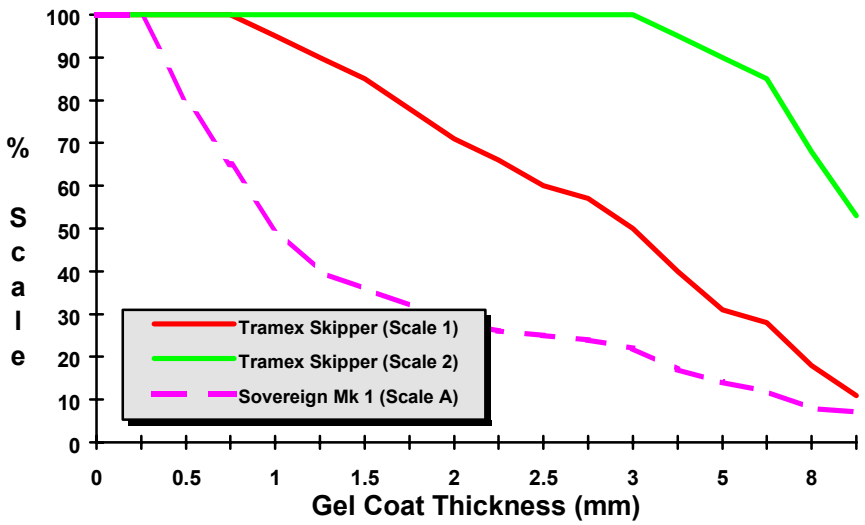

Fig 3. Tramex Skipper Response Curves

The Skipper is a very easy instrument to use, and needs no setting up before use, although the scale can sometimes be rather difficult to read when working underneath boats. There is, however, a warning bleeper fitted to the meter, which is pre-set to sound at 50% deflection on all three scales. This is helpful when taking measurements from inaccessible areas, as it quickly signals any unusually high reading.

The third scale provided on the Skipper was not used, as the manufacturers only recommend this for use on wet timber.

The Protimeter Aquant Plus 2 was also found to be quite sensitive, and like the Tramex displayed good sensitivity to moisture deep within the test laminate. The meter was used both with and without the supplied Field Concentrator, which provides a useful increase in sensitivity by effectively shortening the distance between the two electrodes.

Using the same 50% of scale benchmark, the Aquant recorded figures of 8 mm with the Field Concentrator fitted, and 2.5mm without.

The Protimeter is also quick and easy to use, and has a very useful 'Hold' feature when the push button switch is released, although the bar graph type display provided by a string of sixteen identical red LED's gives very little 'feel' for moisture content, and needs to be improved. A small moving coil meter as fitted to the other instruments would be ideal, although even changing the LED's to a red yellow green 'traffic light' type display would be a great help.

Nevertheless, the display is quite easy to read when working in dark corners, and is also supported by an adjustable warning sounder.

Of the four instruments tested, the two Sovereign meters were found to be the least sensitive, with a score of only 1 mm gelcoat thickness at 50% deflection on Scale A. This is rather disconcerting, as the Sovereign has established itself as something of an industry standard, and is very widely used by both boatyards and surveyors.

This limitation is almost certainly due to the very close spacing of the two electrodes, which at 2.5 mm is actually less than the thickness of some gelcoats. Sovereign do recognise this problem, and they

provide a compensation graph with the instrument, although this is of little help if the gelcoat thickness is unknown.

The large moving coil meters are, however, a delight to use, and the remote scanning heads are easily handled when taking measurements from confined or inaccessible areas. It must also be said that the Sovereign does work well on GRP hulls where the gelcoat has been totally removed, as the texture of exposed laminates tends to be fairly consistent, and the question of gelcoat thickness does not arise. Given the adaptability of the remote scanning head design, I would not be too surprised to see an alternative made available at some stage.

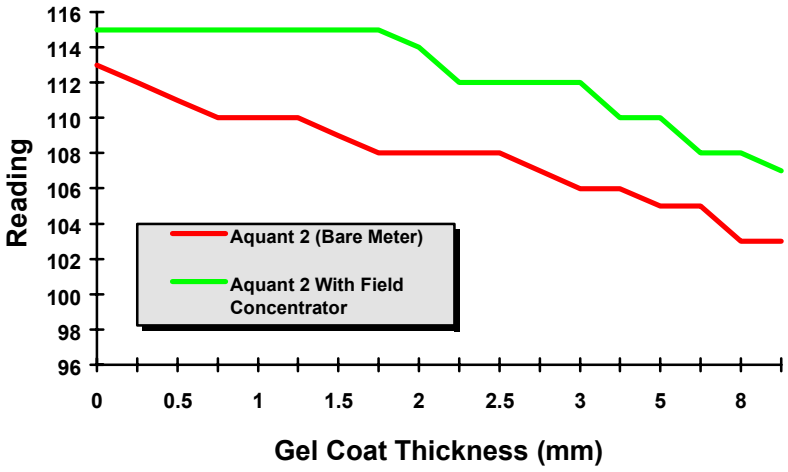

Fig 4. Protimeter Aquant II Response Curve

Both the Mk1 and Mk2 versions of the Sovereign were included in this test, and were found to give almost identical results. It had also been planed to test the popular Novanex instrument, but unfortunately the company appears to have ceased trading, and no samples were available from their distributors, Elcometer Ltd.

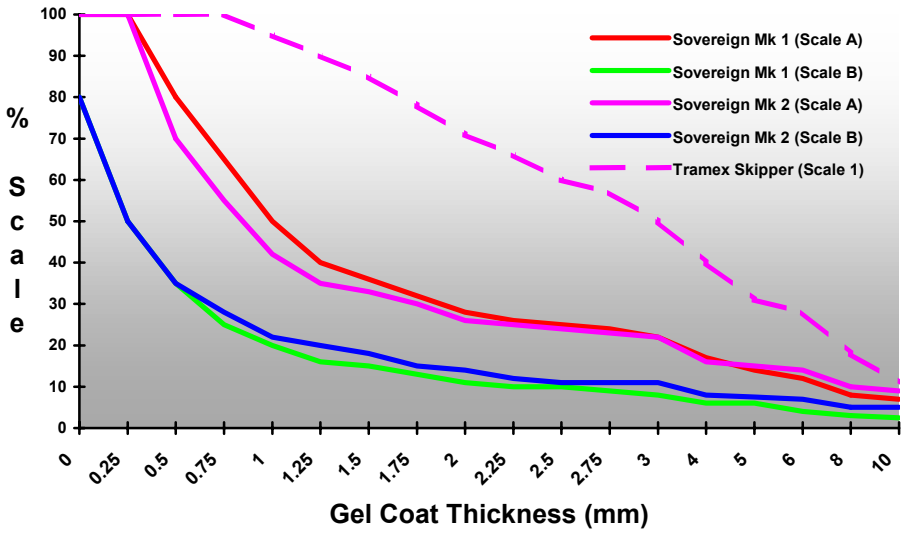

Fig 5. Sovereign Mk 1 and Mk2 Response Curves

Having read these test reports, it should be clear that no electronic moisture meter can provide an absolute measure of moisture content, although they do provide useful indications subject to certain limitations.

It will also be seen that there is no direct relationship between moisture content and laminate condition, so it would be most unwise to recommend osmosis treatment on the basis of high moisture meter readings alone. So what should we be looking for?

Remember that if the laminate is wet, but is otherwise in sound condition, moisture readings should start to fall noticeably within a few days of lifting. The danger signs are persistently high readings which do not fall appreciably within two or three weeks of lifting, indicating that moisture is being retained by laminate breakdown products. ***No amount of heat or dehumidification will overcome this problem.***

Likewise, moisture readings taken from laminates prepared for full osmosis treatment should fall quickly as soon as the washing phase has been completed. Persistently high readings indicate that laminate breakdown products are still present, and must be removed by further washing.

Moisture Meter Summary

Instrument	Electrode Spacing	Test Score (Max. Gelcoat Thickness for 50% of Full Scale Deflection)	Price Inc. VAT
Protimeter Aquant Plus 2	20 mm Approx. with field Concentrator fitted	8.0 mm with Field Concentrator 2.5 mm Bare Meter	£270.25
Sovereign Mk 1	2.5 mm	1.0 mm (Scale A) 0.25 mm (Scale B)	Included for reference only.
Sovereign Mk 2	2.5 mm	0.85 mm (Scale A) 0.25 mm (Scale B)	£349.95
Tramex Skipper	24 mm	10.0 mm (Scale 2) 3.0 mm (Scale 1)	£239.50

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