Comparing Transmission and Reflection Moisture Meters

Abstract

We found strange phenomena when tailoring and testing a reflection type NIR moisture meter **AK50** for our customer. Visilab's own background is in the reflection type moisture meters and this subject has not been studied by us before. These results are preliminary and of technical report level, not science. Wetting the board sample did not bring out an even drying curve as expected from theory but a rising peak and then a slow drying curve. This is contrary to general belief that transmission meters will deliver the correct total moisture content in all conditions. Those interested in this subject may repeat our studies with their own transmission and reflection moisture meters.

Results

The first picture (Fig. 1) shows a board of 240 g with coating on one side, measured with the transmission meter arrangement. The signal is not calibrated, the raw signal is scaled by 100.0 and the sampling rate is 5 Hz. Wetting is done with a manual spray and is not accurate nor repeatable. The first curve is after applying water on the uncoated side, second one for the coated side and the third curve for applying water on both sides, selecting a dry spot on the board initially for each case. The water film is always let to absorb for a few seconds then wiped

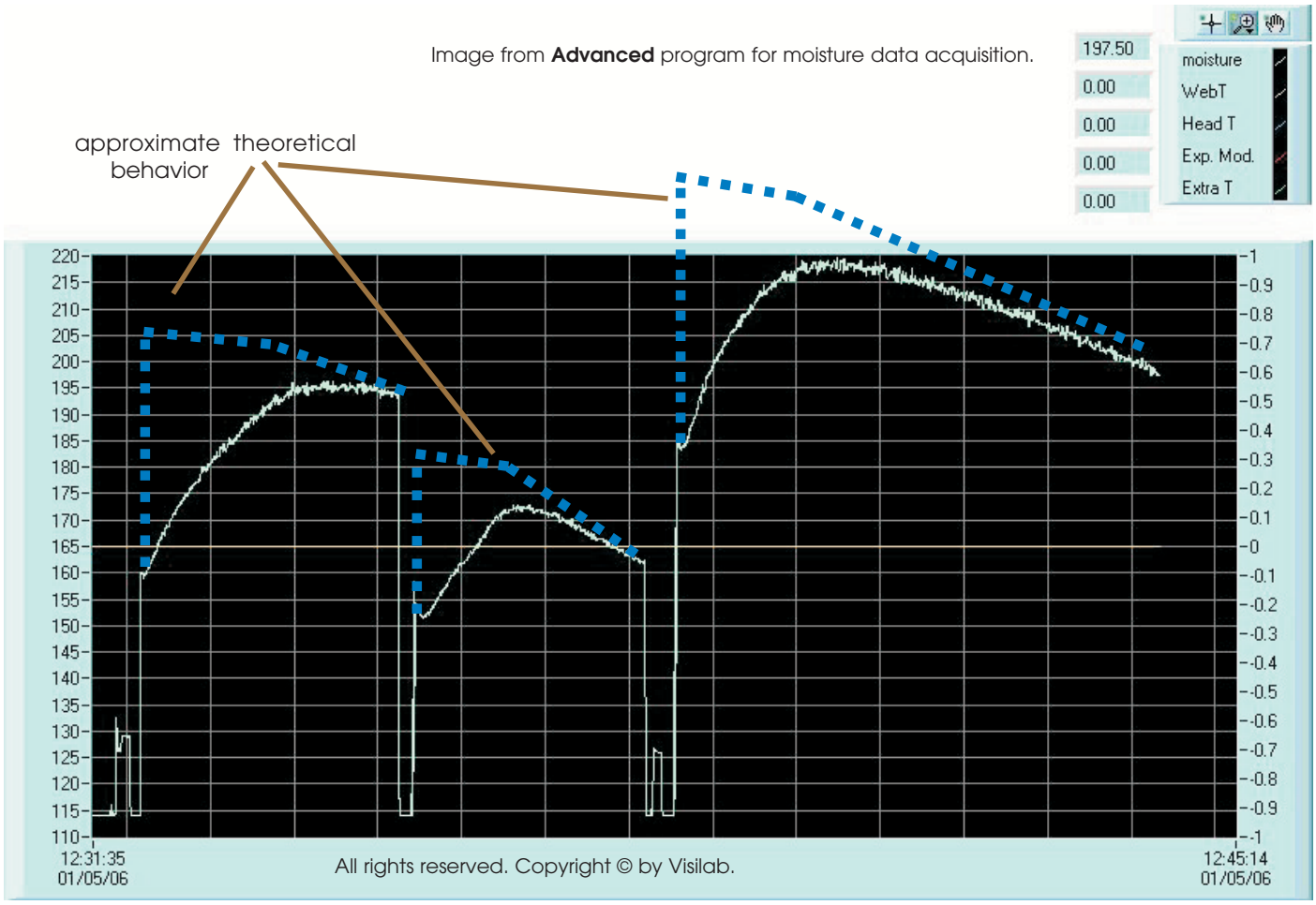

Figure 1. Wetting of single-coated board of 240 g. Transmission measurements done only.

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almost dry and introduced to the meter. The small peak at the left is the dry board at about 4% and at 20 %RH (reading about 129). This is for calibration purposes. The moisture jumps to 160 units (uncoated side wetted), rises slowly to about 195 units and slowly starts to dry out. The coated side is not able to absorb as much water as the uncoated side and drying of the surface removes most of water before it is able to enter the board. The peak value indicates the resulting total moisture reading at that time, being somewhat lower than originally at the time of wetting, due to drying. Drying occurs first only on one side then at both sides when the moisture wave has essentially reached the other side. This can be observed as a bend downwards in the curves. The theoretical transmission signals are marked with a broken line. **The resulting error in total moisture during the wetting process is significant**. If the total moisture at the time of wetting is 28 % the error at the beginning may be about 10 % in moisture. Very similar behavior has been detected with all boards tested, irrespective of their BW (>200 g).

Fig. 2 shows the results of a colour printing board (Colotech 220 g) performed with both methods. The first curve displays the transmission measurement which this time is crudely calibrated. The next two measurements are from a reflection measurement with wetting on the opposite side and the same side as the meter. More details are on the figure. The Fig. 3 shows a thin 80 g office paper with similar experiments done, refer to details in the figure.

Conclusions

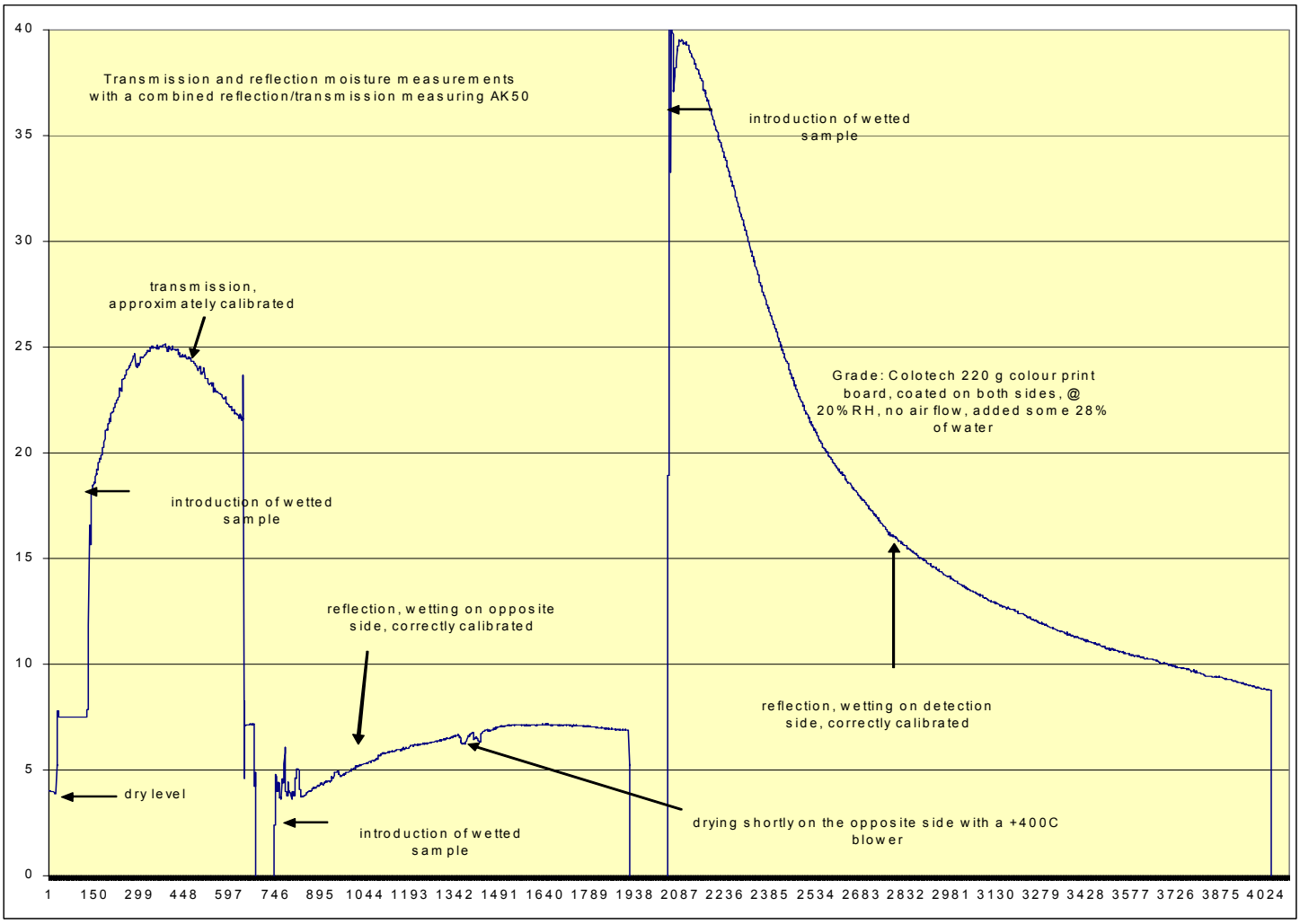

Figure 2. Wetting of double-coated board of 220 g. Transmission and reflection measurements done. A short drying experiment was conducted on the opposite side to see how much it will affect the reading. 4096 samples total with a spacing of 200 ms (5 Hz sampling) are displayed.

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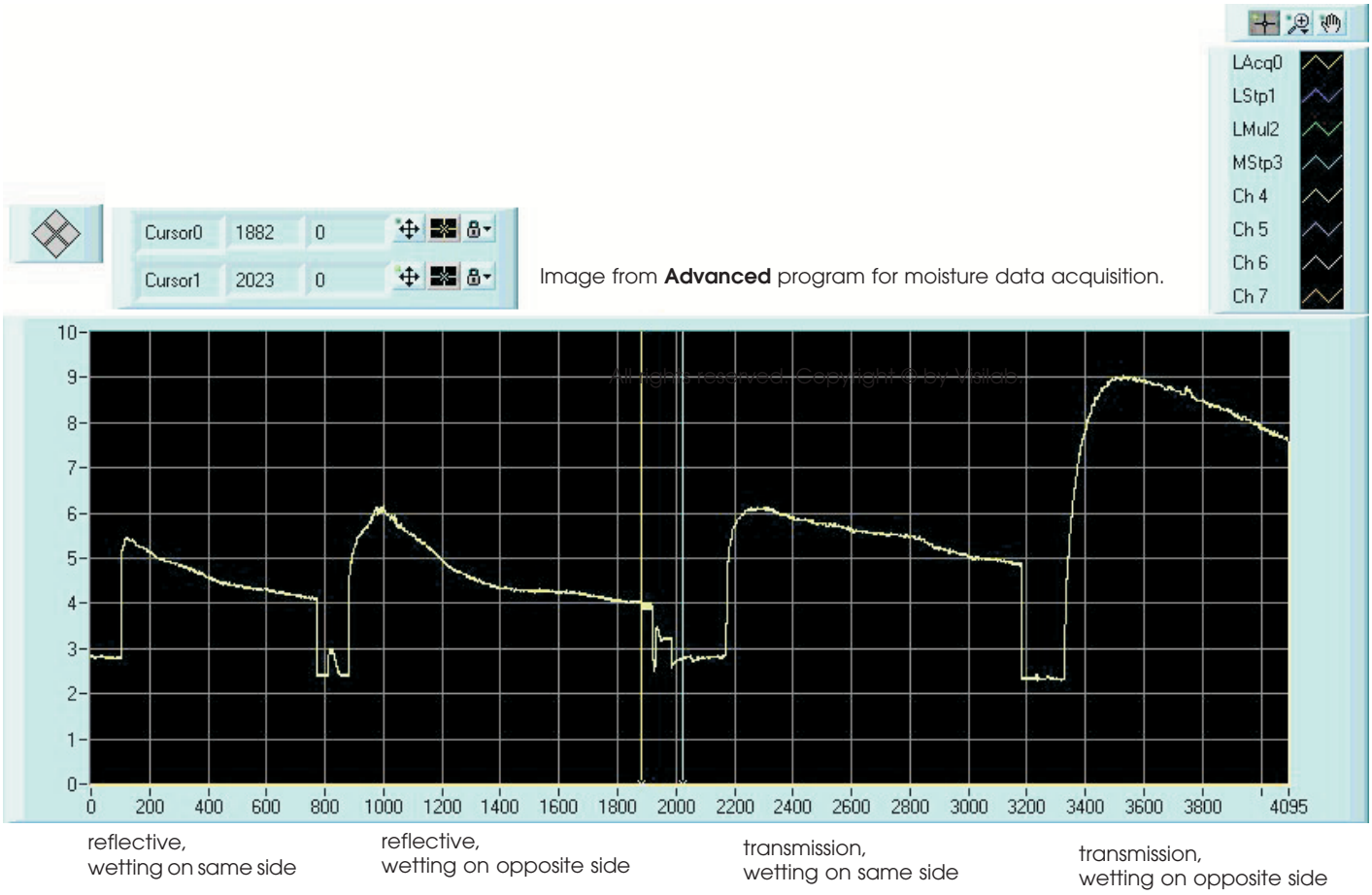

Image from **Advanced** program for moisture data acquisition.

Figure 3. Wetting of office paper 80 g. Transmission and reflection measurements done. The first curve is for reflective, wetting on same side, second is reflective with wetting on opposite side, the third is transmission wetting on detection side and the fourth is transmission with wetting on light source side. The amount of water is not accurately controlled. The calibrations are approximately correct. 4096 samples total with a spacing of 200 ms (5 Hz sampling) are displayed. The wetting is done by having a static sample and by spraying directly on the sample surface with no further treatment, while measuring at the same time.

The conclusions from these experiments are the following. The surface moisture behaves in a reasonable manner correlating to the surface moisture and responds quickly. The transmission moisture may be false with several percent. This has to be recognized while measuring fast PM and BM with the possibility of the web getting back moisture in the form of vapor around the process or by intention in a steam box. **If water has the possibility of creating a high-density layer on top of either surface, there is a possibility of getting significantly incorrect readings with the transmission meter.** This seems to apply to thinner paper grades as well.

We have no direct paper physical explanation for this phenomenon at this time. This report only proves that it is good to be cautious about total moisture results from a nir transmission moisture meter. This is especially important if the board is run through a violent process with steam boxes, infrared dryers, hot pressing nips etc. and then the web is measured. It may be possible to reach still new interesting results by applying powerful drying on one or both sides of the board which has a high moisture content. Without knowing the exact physical reason for this, we can not predict the behavior in that case.

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