Technical application Note 008-006-001, 2/15/2007

Sources of Error Measuring Dehumidifier Grains Depression

1. Manual Handheld Meter Measurements

1.1. Sensor Accuracy is <u>Critical</u>

Historically grains depression has been measured using handheld hygrometers and taking manual measurements. By measuring the intake and exhaust of the dehumidifier and taking their difference you can compute the grains depression. There are several factors affecting the accuracy of such a measurement. The accuracy of a handheld hygrometer may be +/-2% RH which at a typical exhaust temperature/humidity of 110F/15%RH translates into a range of 50.0 to 65.6 GPP

1. 110F 15%RH + 2%RH error = 65.6 GPP
2. 110F 15%RH – 2%RH error = 50.0 GPP

A typical dehumidifier input under similar conditions is 94F/32%RH. Factoring in the +/-2%RH accuracy of the handheld meter yields a range of

1. 94F 32%RH + 2%RH error = 81.6GPP
2. 94F 32%RH – 2%RH error = 72.9GPP

So overall the range of grains depression is from

1. 72.9-65.6 = 7.3GPP
2. 81.6-50.0 = 31.6 GPP

As you can see, what sounds like a very small error of +/-2%RH can translate into a very large error of +/- 12 GPP in the final differential measurement.

Further exacerbating the problem is that it takes approximately 10-20 minutes for temperature to stabilize and how many of you have been holding the handheld meter steady in the intake and exhaust for 10-20 minutes prior to taking your reading?

Fortunately, some part of the +/-2% error will be a “static offset” meaning that if you take two readings back to back of the same ambient conditions they will have the same “static offset” error and should be very close to the same value. Much like the speedometer in your car, if it reads high at 55 today it will likely read high at 55 tomorrow by a similar amount. And if it reads high at 55 it will likely read high at 65 by a similar amount. So in practice, if you are using the same meter to measure the intake and exhaust air the meter error will have a portion that is common to both measurements and will therefore be canceled out when you take the difference. Going back to the speedometer example, if your speedometer reads 2 MPH high at 55 and reads 2.2 MPH high at 65 then when you compute your speed differential it will be 10.2 MPH and the resulting error is only 0.2 MPH, not 2 or 2.2 MPH.

1.2. Sensor Placement on the Dehumidifier Exhaust is <u>Critical</u>

So we have seen that even small errors in %RH translate into very large errors in grains depression. Unfortunately meter accuracy is not the only source of error. Placement of the sensor in the exhaust air stream is an even greater source of potential error than the meter error. The air exhausting from the dehumidifier has a vortex around the perimeter of the exhaust where the exhaust air mixes with the ambient air. So a sensor placed near the outer edge of the dehumidifier exhaust may be seeing air that is a 50/50 mix (or worse!) of ambient air and exhaust air resulting in a measured grains depression that is not as good as the actual grains depression. Using the numbers above and assuming a 50/50 mixing of air, the actual verses measured numbers would look like this:

1. Actual is 110F/15%H = 57.8GPP
2. Measured = 102F/23.5%RH = 71.8GPP

The difference between actual and measured is 14 GPP, so if your actual grains depression should be 15 GPP the error caused by improper sensor placement could cut the measured grains depression to **<u>almost 0</u>**!

Note that sensor placement on the intake is not critical.

2. HygroTrac Sensor Measurements

2.1. Sensor Accuracy is <u>Critical</u>

HygroTrac sensor accuracy is conservatively specified as +/- 2.5%RH but in fact the RH sensor used in the HygroTrac sensor is calibrated to +/-2.0%RH. So the analysis we did above for handheld meters applies here as well. What is different though is that we are now using two sensors, one each on intake and exhaust, to make the differential measurement. So while we can count on at least some of the +/-2% error to be canceled out as “static offset” error in the case of the handheld meter method described above, the same is NOT true when using two sensors. So in the very worst case you really WILL see +/-2%RH resulting in +/-12GPP in the calculated grains depression.

Fortunately by selecting a “matched pair” of sensors for the differential measurement across the dehumidifier input and output you can achieve similar error results when compared to those achieved using a single hand held meter. A “matched pair” of sensors is two sensors that read the same under the same conditions so even though they may both be reading 2% high or 2% low the errors will cancel each other out in the final differential result.

To select a matched pair of sensors place all your sensors in an enclosed Tupperware container in ambient conditions that are similar to those of a typical drying job. Do not place in sunlight! Allow them to acclimate for 20 minutes and then view the sensor data on the web sorting the results by %RH. Select the two sensors that read closest to each other as your matched pair and use them for the dehumidifier intake and exhaust sensors.

2.2. Sensor Placement on the Dehumidifier Exhaust is <u>Critical</u>

What was true above for handheld meters applies equally to the HygroTrac sensor placement. Improper placement has been shown to result in very large error in the calculated grains depression. Sensors should be mounted as close as possible to the center of the exhaust and as close as possible to the face of the condenser. The further away from the center of the condenser you place the sensor the more mixing of air will result in an understated grains depression.

As stated above, placement of the sensor on the intake is not critical.

3. Conclusions

As you can see from the analysis done above, it is not the least bit difficult to accumulate errors from the sensor and the sensor placement which will result in a grains depression that is 0 or even positive! By following the recommendations regarding utilization of matched sensor pairs and proper placement of sensors these two sources of error can be minimized.