Dry-Block Calibrators—
Understanding and Improving Dry-Well Calibrator Performance

Dry-well or dry-block calibrators are versatile tools for calibrating temperature sensor assemblies. They are portable, traceable, and satisfy the calibration requirements for most field temperature work. They also can be a source of calibration errors if not understood properly.

All dry-block calibrators consist of a heated block, and most are designed with one or more interchangeable inserts. The sensor that measures and controls the temperature is located within the block, not within the insert. While block and insert materials are carefully selected for thermal uniformity, small differences (and errors) are introduced.

Here are three specifications to be sure that you understand before you purchase a dry-well, and some tips on improving accuracy.

1. Accuracy
2. Stability
3. Uniformity

Accuracy: An expression of how closely a measured value agrees with the true or expected value of the quantity of interest. (NCSL glossary)

With respect to a dry-block, the accuracy statement is an expression of how closely the instrument's display temperature agrees with the actual temperature in the heated well. When a dry-block is calibrated in the lab, a high-accuracy reference thermometer, traceable to NIST, is placed in the heated well. The temperature measured by this reference thermometer is used to calibrate the dry-well's display so it matches the traceable standard.

Be sure your dry-block is calibrated by a lab that uses appropriate high accuracy temperature standards, and that can document traceability to primary temperature standards.

Stability: The tendency of an attribute to remain within tolerance. (NCSL glossary)

When a dry-well reaches its set point, there is some ± deviation as it maintains control. These temperature fluctuations around the setpoint can cause the well temperature to vary in the temperature block. You'll find this deviation expressed in the stability specification on a dry-block. Be sure to consider it when selecting a calibrator. Instability can cause spikes in temperature during your calibration and cause additional errors. Stability adds to accuracy in determining overall system uncertainty.

Uniformity: Temperature homogeneity of the heat source throughout the test zone. (Hart Scientific Temperature School).

Every dry-well has a vertical temperature gradient, which is the difference in temperature from the bottom of the test well to the top, and a horizontal temperature gradient, which is the difference in temperature from one calibration well to the next (in a multi-well block). The vertical gradient exists because the top of the test well is closer to room temperature than the bottom and draws the heat toward the room's temperature. Understanding this allows you to compensate by calibrating short stem probes by comparison at similar depths. Horizontal gradients, or hole-to-hole gradients, are caused by heat distribution of the temperature well and the thermal properties of the metal block. To reduce the effects of this error when making comparison measurements, use holes that are similar in size, in close proximity, and are equidistant from the heat source.

Probe/Insert Fit

Accurate calibration depends on having good heat transfer from the insert to the sensor. This transfer depends on a very close fit between the sensor and the insert–ideally only a few thousandths clearance. Select the proper size insert, or if your sensor has odd dimensions, have an insert custom made. Do not put oil or water into an insert well in an attempt to improve heat transfer. You risk ruining the insert and possibly the dry-block calibrator.

The bottom line on improving accuracy:

1. Be sure your probes fit your insert wells precisely.
2. Use a precision reference thermometer (you'll find a good selection on pages A137-A139 in this catalog).
3. When calibrating short stemmed probes, insert a reference thermometer to the same depth as the probe under test..

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