My Thermometers Do Not Agree With Each Other?

Thermometer accuracy is critical for many reasons and in fact greater accuracy will likely improve your processes in many ways that most clients would never imagine.

At Scigiene we understand this and in fact we test every thermometer before shipping to ensure they meet stated tolerances. Yet on occasion we will have a clients contact us stating the thermometers they just bought are out of specification.

The question then arises: If we just tested them then how can they be out? There are several reasons this might occur.

1. They have failed under warranty (batteries are weak, or ???) We are happy to replace them if this is the case. But this is very rare because of our pretesting
2. While new if they have been in use for even a short period damage is possible. Please examine them for damage?
3. Has anyone tried to recalibrate them?

This last question leads to our most important comment.

If you are comparing them to certified thermometers its important to understand that not all certified thermometers are even as accurate as our pocket models and more critical to understand is the test method being used. Unless you have a precision calibrator (+/-0.01C) your calibration bath and certified thermometer themselves may be adding some deviance. We have seen accurate reference thermometers and pocket thermometers (both well within specification) read wildly out due to the use of a simple ice bath.

First note: Certified does not always correlate to high accuracy. When purchasing a certified thermometer, you should verify first the stated accuracy (you can buy reference thermometers that are +/-0.01C, +/-0.1C or even +/-1C) and then upon receipt verify this as per the stated test points on the certificate. Its also critical to understand the tolerance of the thermometer. If you buy a thermometer that has stated accuracy of +/- 0.5C but the certificate you have shows its 0.1 C at 0.0C, then you might need to be aware the tolerance for each use may be wider (factors affecting this are normal wear and tear on the thermometer and probe, temperature of the actual thermometer etc.) Using a lower accuracy certified thermometer (e.g., +/-0.5C) to cross validate an equal thermometer does not work due to errors introduced by the calibration method or the calibration chamber itself. See https://documents.scigiene.com/content/documents/Calculation-of-Stated-Thermometer-Accuracy1.pdf This paper reviews the proper statical methods for calculating stated errors/accuracy.

For example: an ice bath can typically vary from 0C by as much or more than 2C. So while ice baths might have been somewhat acceptable long ago to calibrate mechanical dial thermometers (+/-2.0C on a good day), ice baths only introduce variances greater than the stated accuracy of most digital thermometers. This creates problems for persons conducting the ice bath test. It is necessary to use highly accurate certified reference thermometers and a calibrator with a variance of less than 0.1C

So if cross validating in-use thermometers and other devices its also important that:

a. The Reference thermometer should be on a scale approximately 10X more accurate than the thermometers being certified SEE https://documents.scigiene.com/content/documents/Calculation-of-Stated-Thermometer-Accuracy1.pdf for an explanation of calculating accuracy to understand fully why.
b. The actual test method /calibration source must also be highly accurate. A precision 0.01C thermometer in an ice bath at 1.5C will read 1.50C and not 0.0C. Ice baths while a good simple cross check method is typically +/-2.0C and should not be used to calibrate or cross certify other thermometers with an accuracy of better than +/-2.0C. As with the higher accuracy Reference thermometer and the formula for calculating accuracies you will see that a proper calibrator is

necessary. Which calibrator and method will depend upon the accuracy of the devices being cross certified?

Infrared thermometers introduce a whole new set of potential problems. Firstly, its important to understand what an IR thermometer does.

1. It measures reflected IR light at specific wavelengths. Every material can have variable emissivity. We assume that most materials are between 0.95 and 0.97 for the default emissivity but this is not a perfect correlation and thus the reason that even the best IR thermometers (e.g., Our FI40P) still have stated accuracies far greater than a probe model.
2. With an I.R. thermometer we are measuring surface temperatures only. The internal temperature of a product even just mm's below the surface can differ by over 5C. Even surface probes will vary from internal probes for this reason. You should be able to do a good correlation on many products. But if you are testing steak on a grill the internal temperature could still be frozen while the IR reads cooked temperatures. Conversely a cooked product placed in a blast freezer will show higher internally for some time until it chills completely (ask us for dataloggers to help here)
3. Some models do have variable emissivity. This can be good if you know the emissivity but even if you do not you can adjust the emissivity to calibrate the IR to match an internal probe. Call us for more details on this process.
4. Other factors steam, frost, etc. can interfere with the IR reading. Our FI series use special ranges to minimize this but even then, its not 100%. So do not point an IR at boiling water or into a freezer as you open the door.
5. Like other thermometers the temperature of the thermometer can affect accuracy. But for IR's this can be further compounded by change in the shape of the lens as it heats or cools. When the IR units is cooling moisture can also condense on the lens creating further interference. Its best to allow the thermometer body to acclimatise to the ambient temperature for best readings.
6. Core temperatures of a product are more stable due to "Thermal Mass" but surface temperatures can change much more rapidly as they are in truth an average of the product and ambient temperature.

So, when using IR thermometers make sure you realize that the core and surface temperatures are likely different and compensate if necessary. Let the unit acclimatize and if you are testing a wide range of surfaces (carboard, foods, St. steel) you might find having several IR units all set for specific emissivity's will give superior trouble-free results. If all else fails just call us. At Scigiene we design IR thermometers, build IR comparators and certify and service them all. In fact, we offer 4 cost effective Calibrators for both Thermometers and IR thermometers.

Please review these helpful suggestions and your procedures and then contact us with details and we will be happy to help you improve your in-house thermometer validation program.

Sincerely

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