Temperature Calibrations (Thermocouple Edition)

It's well known that temperature is the most common process variable measurement. These measurements are performed by thermocouples (T/Cs), resistance temperature detectors (RTDs), filled systems, non-contact infrared thermometry and by other means.

Of these, the most common on-line measurements are by T/Cs and RTDs, either directly connected to the process control system or data acquisition system or indirectly connected by the use of a process transmitter.

Generally speaking the T/C or RTD being a primary element cannot be calibrated (adjusted). They're either working properly or not. They can be certified, if needed. This type of certification requires a device such as a temperature bath or "dry well" temperature calibrator. But, we're not going into that procedure here.

There are a few "gotchas" in temperature calibration when we're talking about T/Cs and RTDs. Each has its own problems, This article will focus on calibration of T/C instrumentation.

Thermocouples work on the principle that (EMF) proportional to the temperature difference between the "hot" junction where the measurement is made and the "cold" junction where the measurement is observed.

That brings us to the first potential problem. You can only find out the hot junction temperature if you know the cold junction temperature. In the old days, temperature calibrators were simple milliVolt generators. The technician could look up the EMF value for a given temperature, use a local mercury thermometer to measure the cold junction temperature, perform a little math (adding or subtracting the EMF for the cold junction value) and come up with the correct simulation value. A similar process could be used to make a temperature measurement.

Today's temperature calibrators all have what's called automatic cold junction compensation. They also do all the "looking up" of EMF values, etc. It makes it easy and usually quite correct.

If the instrument being calibrated also has automatic cold junction compensation and the calibrator's automatic cold junction compensation is active, you're in business. If this is not the case, you will calibrate in an error equal to the difference between ambient temperature and 0°C. That can be quite a lot. So, it's worth checking to see what's what.

A quick tip about this. If the calibrator has been moved from a relatively warm place to a cold place or vice versa, it may require some time for its cold junction compensation to stabilize for accurate performance.

By far the most common error in calibrating thermocouple instrumentation is the failure to use thermocouple extension wire that matches the thermocouple in question when connecting the calibrator to the instrument.

Why?

Because the calibrator is measuring a cold junction at its terminals. If copper test leads are used, the actual cold junction will be where the copper leads connect to the instrument. Whatever

temperature difference there is between these two points will be calibrated into the instrument as an error. If the two are really close together, it may be small, but why not do the job right? Also, many modern calibrators are designed to use miniature thermocouple plugs and jacks to connect, which makes it really easy to use the right materials.

If you think this is trivial, let me tell you that I have seen technicians connect a calibrator located in front of a control panel to an instrument located inside the panel with looooong copper leads. I'm sure that resulted in an error of 5-10°C. Considering that many processes have tolerances of 1-2°C, that's going to cost a lot of money.

So, two things to remember when calibrating T/C instrumentation: one, make sure automatic cold junction compensation is enabled on both the calibrator and the instrument, and, two, use thermocouple extension wire that matches the curve of the thermocouple to connect the calibrator to the instrument. **Today's smart temperature calibrators make the rest easy**.

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