Blanes PRESSURE SOLUTIONS

C301: Temperature Calibration

1. "I don't need to calibrate temperature. My thermocouples and RTDs are primary elements and don't go wrong"

2. "I've got one, a Memocal".

3. "We've made our own oil/water bath with a certified sensor".

After you've been selling temperature calibrators for a while, you'll have heard all of these, and some more. What you want are some responses to these objections.

Why is customer using temperature instruments? First of all, if temperature has no effect on product quality or process efficiency, or isn't used to check on the wellbeing of plant components, then the question of temperature calibration may never arise.

Where temperature does have an influence, and temperature instruments are used, then there is a requirement for temperature calibration, so we will have objections to overcome.

#1: The same can be said, more truthfully, about deadweight testers, yet the same guy faithfully sends his deadweight tester in to be certified, so even if the statement were true, it's not a valid objection. You don't know it's right until its been checked.

Thermocouple science tells us that if we make a thermocouple with this and that material, there will be a voltage: temperature response that is tabulated by IEC. BUT - nothing in this life is perfect, and the materials WILL BE imperfect even when brand new, it's simply a question of whether they are within allowable tolerances. Was the finished unit adequately checked for compliance with the purchase specification, which will include tolerances on just about everything? That is a valid reason for doing a temperature calibration on a brand new unit.

Thermocouples drift with age, and the materials change under the influence of the temperature they are used to measure. That a valid reason for doing a routine temperature calibration on a unit in service.

RTD's consist of a resistance in a sensing probe. This is most often platinum. Platinum is very expensive. The resistance: temperature response depends on the purity of the material used. That is why there is a difference in the α coefficients of industrial and laboratory Pt100s. That is a valid reason for doing a temperature calibration on a brand new unit.

Next we need to look at the geometry of the sensor, often the resistance is made in the form of a coil, which may be supported or unsupported. Any bending or stretching or other physical deformation of the coil will change its resistance, which at any point is proportional to the cross-section. Going back to platinum, which is the commonest material used, you don't need to be a rocket scientist to work out that a thinner shorter resistance is going to be much cheaper than a thicker longer unit.

Such a delicate device is more susceptible to physical distortion which results in resistance changes. That is a valid reason for doing a temperature calibration on a unit in service.

That should take care of objection #1.

#2: So what is a Memocal, then? Look at the Jofra ASC300 which is similar. This can simulate the electrical response of a thermocouple or RTD. This can be used to check or calibrate a signal conditioner, transmitter or display, which should then be correct IF USED WITH A TEMPERATURE ELEMENT THAT IS WITHIN SPEC!

Every type of electrical temperature sensor has its own response, and they are all non-linear, thus it has always been recognised that one should check the signal conditioner to ensure the correct curve is in use.

Now we learned in point #1 above that the temperature sensors do drift with time, they are not stable. Analysis has shown that the temperature sensor is three times more likely to be the cause of a problem than the signal conditioner.

This means that a simulator, like the ASC300 or Memocal, is of limited use, and can never replace a temperature calibrator which generates a reference temperature.

There is yet another point to make here. The response of a temperature sensor as seen in the control room depends on just how the element is connected to the signal conditioner. The correct way of doing a temperature calibration is to apply a known temperature to the sensor, and see what comes out of the signal conditioner. This is a total calibration.

#3: The answer to this objection is "Has the bath been certified?". The probable answer is "I have a certificate for my temperature controller", in other words, NO!
You should have learned about conduction, convection and radiation, and that heat always flows from a hot object to a cooler one. Keeping any object at a uniform temperature is very difficult. Have you never been swimming in the sea and come across a cold patch?

Laboratory liquid baths are very expensively designed to evenly distribute the heat, and then are certified for use only with specific fluids, as viscosities different from the standard influence flow, and hence heat distribution.

Some people have even used kettles as calibrators. At what temperature does water boil?

The first person who answers "100ºC" will write out one thousand times – "Water boils when its vapour pressure equals the ambient pressure on its surface." On the Highveld, water boils at about 94ºC.

What we are saying above is that if an instrument workshop doesn't have a temperature calibrator such as the Jofra, it really needs to get one.

Dry block or liquid bath?

Which way should the customer go? It really depends on his needs. Both can probably provide the accuracy he needs.

Liquid baths can offer better stability, and hence better accuracy, than dry-blocks. They can accommodate multiple instruments–under-test. They can achieve lower temperatures than dry-blocks. On the other hand, they need a lot of power, are non-portable, they create a hazard with hot liquids, they may require fume extraction, they are expensive to fill (try 25 litres of silicone oil at a R100 per litre), they have a limited range dictated by the fill fluid in use, AND it takes a looooong time to change temperature.

Dry-blocks are in many ways the polar opposite to the above.

Liquid baths are ideal for the manufacturer of probes. He can use a separate bath, permanently installed, for each of his calibration points. He just moves his sensors from one to the next. This makes calibration very fast.

Dry-blocks are more suited to the instrument user. They are portable, wide-ranging, relatively quick in changing temperature, non-hazardous and require no fill, PLUS they have one advantage not yet discussed:- they can be automated!

Time gentlemen please!
Time is money.
Time is at a premium, they're not making any more.

In times of skill shortages, this is even more important.

Temperature change takes time. Heat flow is proportional to the temperature difference, which means that the closer we get to the setpoint, the slower the rate of change. The greater the accuracy, the greater the required stability, the greater the wait.

If we look at the Jofra CTC, which is the lowest specification unit in their range, we find that it takes 10 minutes to cool from 100ºC to 0. Compared to a liquid bath, this is real tortoise and hare stuff!

Then again, to go from 0 – 10 MPa on a deadweight tester takes a couple of seconds.

What we are getting around to is this:- a temperature calibration away from a manufacturer is going to take time. <u>This is why the automation capability of dry-blocks is so important.</u> The technician can be doing something else while the dry-block is changing.

Dry-block Specifications:

Dry-blocks have suffered from a lack of standardisation, but then we must remember that only some twenty years have passed since Jofra invented the dry-block. Different specifications meant different things to different suppliers.

There is now a standard guideline to calibrating dry-blocks, publication EA10/13 from the European Accreditation service. This defines the uncertainty budget for a dry-block calibrator. Use this publication as a checklist for comparing competing dry-blocks.