How to achieve consistent and reliable calibration of water baths

This guide outlines some simple techniques to help achieve consistent and reliable calibration of the water baths.

Probe position
The temperature probe used for the calibration must be supported so that it is held away from the sides and base of the tank. The general accepted distance is 15% of the dimension concerned, e.g. SUB AQUA 12 PLUS with working dimensions of 315/290/115mm (l/w/d), the probe should 48/44/18 mm from the sides and base of the tank.

Temperature uniformity
To ensure the specified uniformity of the water wait at least 30 minutes to take the reading after the bath indicates that it has reached the set-point.

Measuring equipment accuracy
Generally the accuracy of the thermometer being used to measure the bath water should be 3 times better than the measurement to be made; if the bath is to be set within ±0.5°C, the thermometer accuracy will need to be ±0.17°C at the temperature of interest. Example: the Digitron 2024T has quoted accuracy of ±0.2% of reading ±0.1°C. At 70°C this gives ±(0.002 x 70 +0.1)= ±0.24°C which would mean that half the error budget has been consumed by the measuring instrument. When you add in other sources of error (e.g. probe position), the total error could easily exceed ±0.5%

Length of Probe
Ensure that the probe is set deep enough into the water, the larger the thermal mass of the probe the more of it must be immersed in the water e.g. a standard 6mm x 250mm PT100 stainless steel probe would unsuitable for calibrating a 2L shallow bath as it would be impossible to make sure that enough of the probe is submersed in the water. At least 50mm of the probe would be required to be submersed in the water, but there would be no perceptible improvement by submersing more than 100mm of the probe in the water.

Calibration equipment stabilisation
The temperature probe will take some time for the reading to match the actual temperature of the water. By installing the probe before the bath has got to temperature this will eliminate any lag because the bath will be far slower to stabilise than the probe. Ideally the probe should be kept in the bath thought out the calibration.

Room temperature
Calibrations should be performed in an area where the ambient temperature is controlled to a consistent temperature (e.g. 23 ± 2°C). The difference in temperature between the water and its surroundings can affect the calibration readings particularly if a large probe with most of its body out of the water is used. By controlling the temperature of the room, it will not necessarily eliminate any errors but they will at least be consistent.

Also calibrations should not be performed in areas where there are excessive air movements. As an example, setting up a calibration close to an air-conditioning unit (ACU) the periodic blasts of cold air from the ACU will upset the stability of the bath and cool the exposed probe resulting in an unstable temperature reading.