Whitepaper

CONTAINING:

Why Use a Standard Platinum Resistance Thermometer (SPRT)?

An Industrial Platinum Resistance Thermometer (IPRT) can make an ideal working standard for temperature measurement and calibration. The most common type of IPRTs will have a resistance of 100 Ohms at 0 °C. Most IPRTs will be metal sheathed and the best performing will use a sensor with a coil of platinum wire that will have superior performance than the lower cost 'film' types. All Isotech IPRTs use coil type temperature sensors.

IPRTs are commonly constructed with a metal sheath, perhaps 3 – 6 mm diameter, in a range of lengths and are suitable for different temperature ranges. Whilst the standard, EN 60751: 2008 covers the temperature range to 850 °C, it is unusual to see working standards with a range higher than 660 °C.

EN 60751: 2008 specifies tolerances. At 0 °C for example, the tightest tolerance for a complete resistance thermometer is 0.1 °C while at 600 °C this increases to 3.3 °C.

With individual calibration using appropriate calibration standards IPRTs can be calibrated with uncertainties of 0.01 °C at 0 °C and 0.05 °C at 660 °C. Isotech would not offer an uncertainty lower than 0.01 °C for an IPRT due to the limitations of the sensing elements.

This level of uncertainty is suitable for many applications and IPRTs have benefits of lower cost and are more rugged than Standard Platinum Resistance Thermometers. IPRTs do require careful handling but are much more robust than SPRTs.

SPRTs can be calibrated to much lower uncertainties than the best IPRTs and Isotech can calibrate Primary SPRTs to uncertainties of 0.0001 °C at 0 °C and 0.002 °C at 660 °C.

When Lower Uncertainties are Needed

Primary SPRTs are constructed in such a way that the platinum wire coil is free to expand and contract without strain.

The flipside of the performance benefit is that the SPRTs are very fragile and require very careful handling. It has been said that if you can hear that you have put an SPRT down on a hard surface you have probably damaged it!

Primary SPRTs need the most care, secondary or working SPRTs whilst still needing care are less prone to mechanical shock and can still be calibrated to low uncertainties, typically 0.001 °C at 0 °C and 0.006 °C at 660 °C.

Water Triple Point Cells and SPRTs

SPRTs should be regularly checked in a Water Triple Point Cell. The temperature curve of an SPRT is more stable than the absolute resistance so users work with the ratio (W) of the resistance at a particular value to the resistance at the water triple point, R_{TPW}. The latest R_{TPW} value should be used and can be programmed into a suitable instrument. Checks at the water triple point also give confidence in-between calibrations and can help determine when an SPRT requires recalibration. For many laboratories, a two-year recalibration period is suitable but only with regular water triple point updates. There is little value in using a high quality SPRT without a water triple point cell.

Instruments

The Isotech range includes high accuracy precision thermometers which are ideal for use with IPRTs. For example, the Isotech millIK has a one-year accuracy of 0.004 °C at 0 °C and 0.007 °C at 660 °C. If we take typical best uncertainties for IPRTs of 0.01 °C at 0 °C and 0.05 °C at 660 °C and calculate the combined uncertainty (RSS) for the IPRT and instrument we get 0.0108 °C (10.8 mK) at 0 °C and 0.0505 °C (50.5 mK) at 660 °C. (A change of one mK is equivalent to a change of 0.001 °C).

If we take a Primary SPRT with an uncertainty of 0.1 mK at 0 °C and 2 mK at 660 °C and combine that with the uncertainty of the millIK we get a system uncertainty of 4 mK and 7.3 mK.

If we switch to a secondary SPRT (0.001 °C at 0 °C and 0.006 °C at 660 °C) it comes out at 4 mK and 9 mK so it would be pointless to use a Primary SPRT with a bench thermometer.

With a secondary SPRT there is an improvement over an IPRT - *but the full performance of the SPRT can only be achieved using a high specification instrument and with regular water triple point updates.*

Performance Summary

ITS-90 Sub Range 0 - 660 °C

	Thermometer only at 0 °C	Thermometer only at 660 °C	milliK only at 0 °C	milliK only at 660 °C	System Uncertainty milliK and Thermometer at 0 °C	System Uncertainty milliK and Thermometer at 660 °C
670SQ	0.1 mK	2 mK	4 mK	7 mK	4 mK	7.3 mK
909Q	1 mK	6 mK	4 mK	7 mK	4.1 mK	9.2 mK
935-14-95H	10 mK	50 mK	4 mK	7 mK	10.8 mK	50.5 mK

Thermometry Bridges

In order to make the best measurements with SPRTs it is necessary to use a thermometry bridge rather than a precision thermometer. Precision thermometers make potentiometric measurements. Bridges make ratiometric measurements; comparing the ratio of an unknown resistor to a known resistor. This measurement technique allows much lower uncertainties to be achieved, typically to less than 20 ppb. The world leading Isotech microK range of thermometry bridges includes models that are suitable for both secondary and primary SPRTs. In addition to thermometry bridges Isotech can also supply and calibrate reference resistors suitable for primary metrology and bridge calibration systems.

Help and Advice

If you need low uncertainty measuring systems we can help, contact us for free advice and consultation. We have proven solutions at all levels in temperature metrology, from high accuracy cost effective industrial measurements systems to the lowest uncertainty systems for primary metrology used by the world's leading National Metrology Institutes.

If you have any questions, if you need any advice, if you would like a free consultation then please get in touch