In-process calibration of temperature measurement points

Temperature measurements are the most common measurements in the process industry. In the food/pharma/biotech area not only the production process but also the steam temperature during sterilisation (SIP) must be measured and documented.

The increased requirements for process safety have led to an ever increasing number of measurement points in recent years. However, the accuracy of every measurement must be confirmed by regular calibration. In addition to the resulting costs, another critical issue is that the temperature sensors must be taken out of the process for calibration. To ensure that complete process documentation is available without any gaps, the calibration can only be performed during a production stoppage. In particular for continuous production processes, this can lead to significant costs when stopping and restarting production. Here, innovative solutions for lengthening the calibration intervals are needed.

Temperature measurements with Pt 100 elements have proven to be very robust and reliable. These sensors are very rarely replaced due to insufficient calibration results. In addition, the slope of the characteristic curve is largely specified by the production process. Ageing, for instance due to an increase in contact resistance, typically only generates an offset of the entire curve.

For temperature measurement points with average or low accuracy requirements, this opens up the possibility of significantly reducing the costs and in particular downtimes using a new calibration method and corresponding measurement equipment.

Summary

The required regular calibration of temperature measurement points only rarely discovers unacceptable deviations. The costs for calibration are disproportionate to the associated benefits. An in-process calibration can reduce the calibration costs for measurements with average or low accuracy requirements and can be performed without production stoppages. Even if conventional calibrations might not be fully replaceable by an in-process calibration, at least the intervals for a complete calibration can be lengthened.

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Principle of temperature calibration

For a calibration, the measurement device is compared with a reference sensor with a known, high level of accuracy.

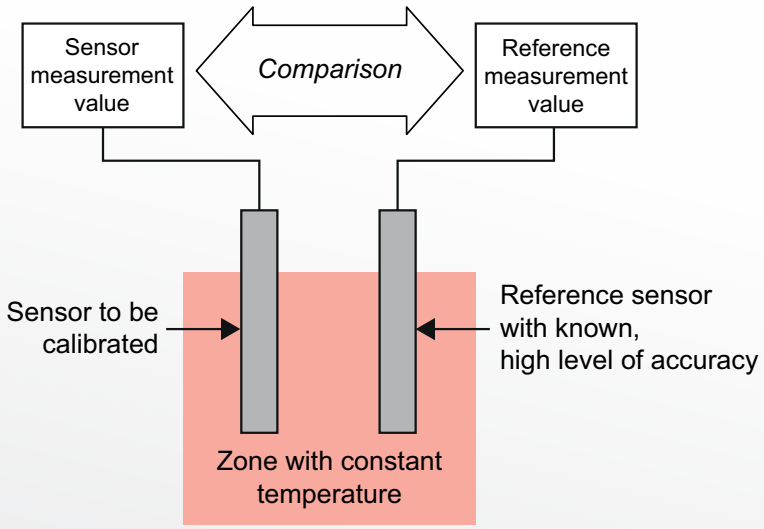

Figure 1: Calibration principle for temperature measurement equipment

For the calibration of a temperature measurement device, the challenge is to bring the sensor element and reference to the exact same temperature. The level of effort to achieve this depends on the required accuracy. Typically, special calibrators are used. Either the temperature sensors are removed and measured in the calibration laboratory, or the calibration is performed using a mobile calibrator on-site on the production floor. However, the measurement device must be taken out of the process in this case as well.

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New in-process calibration method

In the new calibration concept described here, the measurement equipment is designed so that the comparison between measurement device and reference sensor can be performed in process („in-process calibration“). The certified reference sensor is inserted into a special calibration opening in the device. The measurement device is designed so that both temperature sensors are then warmed by the process heat in the same manner.

This device concept can be realized for measuring inserts from a diameter of 4 mm. For this purpose, an inner tubular casing is integrated in the measurement insert that receives the reference sensor. The geometry is designed so that when the reference standard is inserted, both Pt 100 sensors are positioned very close to one another. Even smaller insert diameters are possible.

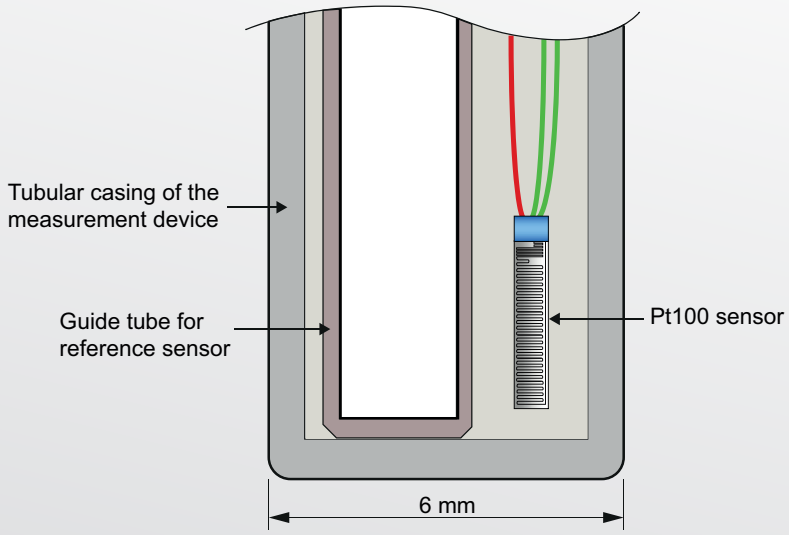

Figure 2: Tip of a measurement insert with additional calibration access

New in-process calibration method

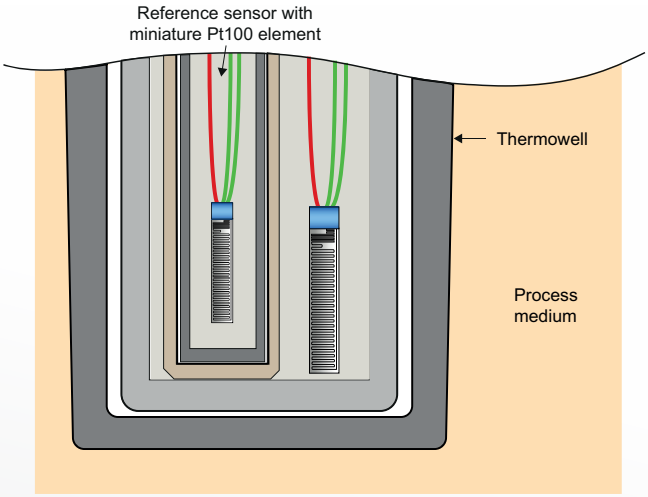

Figure 3 Measurement insert in thermowell with reference sensor inserted

An commercially available Pt 100 sensor with 1.6 mm outside diameter is used as a reference sensor.

A requirement for this calibration method is a production step with sufficiently constant process temperature for the comparison time of the sensors. Often, an operating point is particularly relevant for the process. Its temperature is a good option.

An example is the sterilisation with saturated water vapor (SIP). Temperature measurements for SIP monitoring are often only used for this purpose. Thus, the measurement accuracy is only relevant at the sterilisation temperature. At the same time, the accuracy requirements are not particularly stringent, as it is only necessary to ensure that the steam temperature is above the specified threshold.

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