Hygienic temperature measurement with thermowells

Combining maximum accuracy and ambitious hygiene standards time and time again presents a challenge to measuring solutions in biotechnology and pharmaceutical industry. The use of hygienically designed thermowells has proved itself over time for temperature measurement.

The measurement of temperatures is probably the most common measurement task across all branches of the process industry, with the use of resistance thermometers being the most common method of measurement. Resistance thermometers make use of the physical effect that temperature changes in metals cause the electrical resistance to change. The changes in pure metals are particularly significant. It is an additional benefit if the material is corrosion-resistant and shows minimal signs of ageing. Temperature sensors, known as measuring resistors, are therefore often produced from platinum (Pt100).

The traditional method of temperature measurement is invasive, that means the measuring sensor, consisting of a Pt100 element and thermowell, is installed through a bore hole in the container or the pipe directly into the media to be measured. But applications in the food, biotechnology and the pharmaceutical industry require a hygienic product design and process connection. This is the only way that contamination of the media can be avoided.

Invasive or non-invasive?

The German manufacturer LABOM has supplied its patented clamp-on solution as a non-invasive alternative for hygienic measurement of pipelines for many years. The measuring device is fixed to the outside of the pipe using a sleeve. The measuring sensor does not penetrate into the pipe, rather measures the temperature of the pipe wall, and which can be mounted in the running process without drilling and welding. This saves the user time and costs and he can nevertheless reliably record whether a specific temperature has been reached in the pipe. The clamp-on method is very handy, for example for monitoring vapour sterilisation processes, in which a minimum of 120 degrees Celsius must be reached in the process pipe. If this temperature is measured at the outside wall, the operator can be sure that in the pipe it already has been exceeded. This makes it easier provide the proof of the sterilisation temperature.

Hygienic temperature measurement with thermowells

If maximum accuracy and simultaneously short reaction times are required, then an invasive measurement continues to be the method of choice. This is the case with biotechnology applications, for example, in which a minimum of 54 degrees Celsius must be reached in a bioreactor to manufacture an artificial insulin for diabetes patients. The product would be destroyed if the temperature rises above 57 degrees, what can happen very quickly. In this case, a thermometer needs to react very quickly to temperature changes to ensure that the process can be regulated successfully. This accuracy can only be achieved with invasive measurements. Special thermowells are used to ideally harmonise this measurement procedure with the hygiene requirements.

Thermowells are made of thermally conductive material and separate the temperature measuring device from the media. If the pipe is pressurised or an aggressive media affects the material of the measuring device (e.g. by corrosion), the thermowell also helps to protect the measuring device from damage.

Photo 1: LABOM's GA2730 resistance thermometer is available with different cases.

The thermowell reaches through the wall of the pipe into the media. The thermometer's Pt100 measuring sensor is inserted into the thermowell and thus records the temperature of the media without being in direct contact. Instead, the thermally conductive material of the thermowell transmits the temperature to the measuring sensor. Stainless steel thermowells are used in hygienic processes. A preferably low surface roughness and an appropriate design ensure that the thermowell does not interfere with the systems cleaning procedures.

Hygienic temperature measurement with thermowells

No drilling and sealing

Once the thermowell is installed in the process, measuring sensors and measuring devices can be replaced relatively easy without interrupting the process. Crucial with the issue of hygienic process reliability is the question: How does the thermowell enter the process? The thermowell is welded to the pipe through a bore hole in the pipe. However, bore holes in the pipe introduce the risk of undefined corners and edges, especially as the seams in most cases must be welded by hand. In addition, the welds can no longer be treated mechanically once they have been installed in the pipe, with the result that the required surface quality within the pipe is hard to influence.

This risk can be avoided by the use of thermowell systems, which are specifically designed for hygienic applications. The German manufacturer LABOM has developed the HIT thermowell system for hygienic Invasive Temperature Measurement. It consists of standardised sections of straight or angled pipe, which has a small welded thermowell. The electro-polished pipe sections, which have a hygiene-compliant interior surface roughness, only need to be orbitally welded by the customer to the process line. The key benefit is that the operator can use a controlled orbital welding process, enabling consistently good welds to be produced with minimal roughness. There is thus no need for process connections with the associated work and hygiene risk

Photo 2: The thermowell is hygienically integrated into the pipe.

Hygienic temperature measurement with thermowells

All HIT sections of pipe have an M12 device connection, which directly matches the GA2730 resistance thermometer from the MiniTherm range. The device can therefore be screwed into the HIT components. The HIT sections of pipe can be used in a wide range of process lines, as all three ranges are manufactured with different pipe widths in accordance with DIN 11866: series A: DN10 to DN32, series B: DN13.5 to DN33.7 and series C: ½ inch to 1 ½ inches.

The GA2730 thermometer with its Pt100 measuring resistor with 3-wire technology achieves class A measuring accuracy in line with DIN EN 60751. In accordance with the standard, the response time was tested in running water with a speed of 0.4 metres per second. With a thermowell measuring 6 x 1 millimetres, the response time T90 = 16 seconds. The value T90 denotes the time that it takes, before the measuring device displays 90 per cent of a sudden temperature change. Additional options are available for processes, which require even faster response times – such as the above mentioned biotechnical processes in drug manufacture. Therefore T90 can be shortened to 6 seconds if the space between the end of the measuring resistor and the base of the thermowell is filled with heat sink compound. LABOM supplies a special non-toxic silicone-free compound as part of its overall package for invasive temperature measurement.

The thermometer can respond even faster when using thermowells with tapered tip, these are also available from LABOM. All thermowells are manufactured as standard in accordance with the specifications per DIN 43772, although customer-specific modifications are also possible. LABOM also offers a service to calculate thermowells to provide mathematical proof of resistance to static and dynamic loads for special applications. Together with the material certificates in accordance with DIN EN 10204-3.1 for HIT pipes and thermowells per se, this offers a high level of process safety and reliability to users in the food, pharmaceutical and biotechnology industry.

Author: Dipl. Ing. Rainer Scholz