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IT´S ALL ABOUT TEMPERATURE!
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Pentronic's new managing director is experienced in advanced technology and demanding customers

The top job at Pentronic is changing hands. Rikard Larsson (left) is the company's third managing director since it was founded and succeeds Lars Persson.

Since it was founded Pentronic has had two managing directors.

It's now time for the second, Lars Persson, to retire.

His replacement, Rikard Larsson, was most recently the factory manager at Autoliv Electronics in Motala, Sweden.

Pentronic was founded by Torsten Lindholm, who retired in 1990. His replacement was Lars Persson. Since then, the company has belonged to three exchange-listed groups, Indutrade since 2001.

In 1990 the company was one of several sensor manufacturers in Sweden. Today Pentronic is the leader in northern Europe. Back then the company had annual sales of SEK 30m and 50 employees; now the figures are SEK 130m and 90 employees.

"Our big customers are global leaders in their fields," Lars Persson says. "They select their suppliers from a global market based on quality, delivery precision and cost. Today we are successfully competing against the world's leading sensor manufacturers."

Development and sales

Accordingly, Indutrade chose the new managing director very carefully, in order to both make the most of Pentronic's corporate culture and to continue developing the company.

Rikard Larsson has made his career in fields which are also based on cutting-edge expertise. He originally worked for Sweden's military sector as a project manager at the development department of what was then FFV Aerotech and is now part of Saab.

"In 1998 I moved to Autoliv, where I began as a project manager in development and then moved to sales, first as a key account manager and then with business development and as the sales manager for our electronics customers in Sweden, the UK and Italy," he says.

Autoliv is a world leader in automobile safety systems and can be found everywhere cars are made. Its customers are in the global automotive industry, with all that involves in terms of demands for the highest quality, innovative ability, reliable deliveries, short lead times and competitive prices.

Attracted by the unique expertise

In 2011 Larsson was appointed manager of the Autoliv factory in Motala and had intended to stay there. But the opportunity to become managing director for an expertise-driven company like Pentronic changed his mind.

"Mainly I was attracted by Pentronic but also by its owner," he explains. "Indutrade is a unique group of companies in that its subsidiaries have a large degree of freedom and also access to broad-based expertise within their sister companies and the central management."

Larsson's great interest in engineering means he likes to work closely with both development and production. His career resembles how many people in Pentronic have worked their way up. The difference is that he has done so at various companies. The result is a managing director experienced in development, manufacturing and sales.

OEM experience

"One of Rikard's most important types of experience is that he has worked with sales to major OEM customers with extremely high demands. Two-thirds of Pentronic's production goes to similar customers," says Lars Persson, adding that small customers are of course also important.

"All companies are small at first. We've been privileged to work with many that have become large over time."

The handover between the two directors will occur gradually this spring. Rikard Larsson says that Pentronic has a lot of expertise and many well-educated employees. But above all, he singles out what distinguishes the business he will now lead: "Pentronic can measure temperature."

Rikard Larsson will have a nice view from his office window at Pentronic.

Supporting tubes give strength, a fast response time and simplified installation

Pentronic's thermocouples sheathed in a supporting tube are produced and sold in large quantities. The reason is that they meet machinery manufacturers' typical but often conflicting demands for robust construction and rapid response time.

In addition, mounting attachments can be supplied pre-attached to the sensor, enabling immediate installation either when a new machine is being manufactured or when a spare part is required for a pre-existing machine.

Customers are increasingly demanding a fast response time because machines must be able to handle shorter and shorter cycle times. This means that the sensor's probe tip must be thin so that heat can easily be transferred to the thermocouple wires inside the sheath. On the other hand, the sheath must not have so large a cross section area that the heat is transferred to the surroundings, which leads to measurement errors. Mechanical strength is necessary to withstand such forces as strong flows and vibrations as well as to enable the secure fastening of mounting attachments such as the compression fitting shown here. A supporting tube is an excellent solution which meets these requirements and which can also be made much thicker than the actual probe tip.

Pentronic's sensors sheathed in a supporting tube are available in and can be constructed in many different versions to facilitate both temperature measurement and installation in customers' products.

Approvals necessary for many markets

Temperature sensors are not only critical to products' function. More and more, the sensors must also be approved for their purpose and in their respective markets so that the products they are installed in can be used or exported.

In more and more cases Pentronic has already done this work.

Within the EU there is a regulatory framework which means that an item approved in Sweden, for example, can be exported unaltered to the other member states.

"But even within Europe there are also industry-specific requirements," explains Roland Gullqvist, sales manager at Pentronic, and gives the example of EHEDG. This Europe-based non-governmental organisation provides certification for industries on equipment used in the food industry with the aim of ensuring hygienic processes.

Pentronic has temperature sensors for the food industry certified in accordance with EHEDG.

The corresponding requirements in the USA are called 3A Sanitary Standards. There the construction standards are different, and Pentronic has a number of 3A-approved sensors and thermowells.

Growing markets

Special construction requirements apply for maritime use. The standards are set by the classification societies. Without such approval, insurance and compensation are at risk. Pentronic has, for example, temperature sensors for engine monitoring that are approved by the leading classification societies.

A number of countries have their own requirements. For example, Russia has its own system for temperature sensors, Pattern Approval Russia, also called Metrology Certificate. Most of Pentronic's existing sensors are approved in Russia. This approval should not be confused with GOST, which most closely resembles the European Economic Area's CE marking.

Time and money

Certificates and approvals cost time and money to obtain and keep. One recent example is the product approval in Belarus obtained by Pentronic.

"The Belarusian authority sent three inspectors here, who were with us a week," Gullqvist says. "Then it took our accredited laboratory two weeks to verify all the properties of the actual sensors."

Approvals also have to be renewed, which normally occurs after three to five years.

There are also industry-specific approvals. For example, Pentronic is approved to supply products to the Swedish and Finnish nuclear power industry.

For Pentronic's customers, the growing number of valid certificates and product approvals is an important means of accessing new markets.

"It costs time and money to get and keep approvals and certificates," says Roland Gullqvist, shown here with some temperature sensors with valid certificates and product approvals.

How cold is it in the refrigerator?

QUESTION: To measure the temperature inside my refrigerator I use a refrigerator thermometer, which hangs under one of the shelves. How good is this measuring method?

Maj F

ANSWER: The temperature inside a refrigerator depends on many factors, including how the refrigerator is constructed and used. The thermometer's heat exchange with the air inside the refrigerator occurs via convection. Heat exchange via radiation occurs between the thermometer and the refrigerator's walls, door, shelves, evaporator unit and food contents. In the thermometer itself, heat transfer occurs via conduction. Because the conditions vary, the measured temperature will also vary, partly depending on where inside the refrigerator the thermometer is located.

The heat leaking into the refrigerator through its door and walls is transferred out from the refrigerator compartment via the evaporator unit, which usually is placed on the refrigerator compartment's back wall. Via the refrigeration cycle this heat is transferred to the condenser, where it is then transferred to the air in the room outside the refrigerator. The condenser is usually located on the back of the refrigerator. The refrigeration compressor is not in constant operation, which means that the evaporator unit's temperature varies, and thereby so, too, does the temperature inside the refrigerator. The measured temperature thus varies both with the thermometer's location inside the refrigerator and over time.

Every time you open the refrigerator door, warm air from the room enters the refrigerator compartment. This air must be cooled down and the heat is transferred out from the refrigerator compartment via the evaporator unit. Food items placed inside the refrigerator compartment must also be cooled if they are warmer than the refrigerator compartment's temperature. If we assume that 300 litres of air must be cooled from room temperature (20 °C) to 5 °C, this means that just over 5 kJ must be transferred to the evaporator unit. If 1 litre of milk at room temperature is put inside the refrigerator, just over 60 kJ must be transferred to the evaporator unit.

The thermometer has a certain mass, which means that fluctuations in the air temperature are moderated and you get a phase shift. [Ref 1]. If you want to easily determine an approximate average temperature you can measure the temperature in a mug of water, which you put in various places inside the refrigerator compartment. The length of the response time varies from case to case. You can also use measuring equipment which reads the temperature continuously at one or more locations and calculates the average temperature. As with all measuring processes, you should calibrate the thermometers being used.

Questions should be of general interest and be about temperature measurement techniques and/or heat transfer. QUESTIONS ? ANSWERS !

A complicated measurement problem

Measuring the temperature in a refrigerator is an example of a complicated measurement problem, where the temperature depends on both time and the thermometer's location. Evaluating the measurement result requires, among other things, an understanding of how the heat exchange occurs between the thermometer and its surroundings. In this case, the measurement result is affected by the properties of the refrigerator, the refrigerator's contents at the time, the thermometer being used, etc.

References see www.pentronic.se > News > Pentronic News > Pentronic News Archive [Ref 1] Pentronic News 2008-4

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STRAIGHT FROM THE LAB

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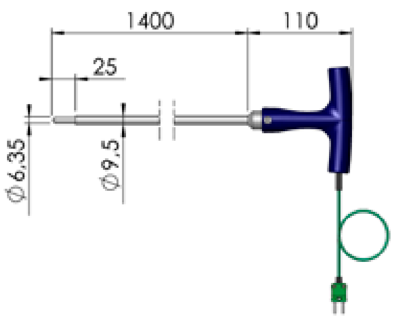
The same accreditation covers both laboratories

The Swedish Board for Accreditation and Conformity Assessment (Swedac) has approved the merger of Pentronic's two calibration laboratories in Verkebäck south of Västervik and in Karlstad, both in Sweden. Both will still be used but they now share the same accreditation with the number 0076.

Customers will notice no difference except if they personally bring in and collect their equipment, in which case they can now choose the closest laboratory," explains laboratory manager Lars Grönlund.
Pentronic has owned the Karlstad facility for a number of years but it continued to operate under its own name. Last autumn the two companies merged, but their accreditation had to be handled as a separate issue involving an extra audit by Swedac. "That process is now finished and both units fall under the same accreditation," Grönlund says.

Accreditation involves a lot of administration, in this case twice the work for the two laboratories. Now resources have been freed up for other uses and the same methods and identical equipment can be used in both locations.

The merger creates greater redundancy – that is, more security for Pentronic's customers. In the remote event that one laboratory would burn down, Pentronic will still be able to do calibrations with basically unchanged measurement uncertainty under the existing accreditation.



A handheld, fast and robust sensor

Pentronic markets temperature sensors for penetration measurements in such materials as heaps of biomass, wood chips, compost, soil, hay, asphalt or bitumen and similar substances. The sensor is equipped with a reduced probe tip for rapid response times and a sturdy supporting tube with a handle for inserting and removing the sensor.

The sensor is suitable for hand-held indicators intended for type K thermocouples. Pentronic also keeps an inventory of the lengths L: 1000 and 300 mm, the latter of which has a tip diameter of 4.8 mm and a supporting tube diameter of 6.35 mm.

Type N thermocouples give smaller calibration errors than type K thermocouples at high temperatures

Traditionally, type K thermocouples are used and calibrated at high temperatures in such contexts as the steel industry. Previously, the accuracy requirements were so low that calibration errors could be ignored, if they could even be measured at all at that time. However, today's requirements are higher and as a result, calibration errors become significant. This article explores the causes.

The basic rule for all calibration is that the conditions must be identical when doing the calibration and when doing the in-process measuring. [Ref 1]. The thermocouple's output signal depends on the products of sensitivity S [µV/°C] and the temperature differences, which are summed up along the thermocouple's entire length from the measuring junction to the reference junction. See Equation 1. S is also referred to as the Seebeck coefficient. When measuring as shown in Figure 1, the entire signal is generated where the thermocouple passes through the wall. Other temperature differences along the entire thermocouple are to all intents and purposes zero.

$$E = \sum_{0}^{n} [S_n * (T_n - T_{n+1})] \qquad (1)$$

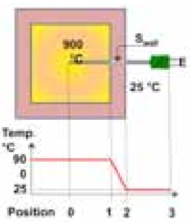


Figure 1. A thermocouple measures the temperature difference between its end points. In accordance with Equation (1) we get: $E = S_{0\text{-}1}$ (900-900) + $S_{1\text{-}2}$ (900-25) + $S_{2\text{-}3}$ (25-25) which gives $E = 875\ S_{1\text{-}2} = 875\ S_{wall}$. The signal is thus generated where the thermocouple passes through the wall.

The sensitivities S_n and temperatures T_n in Equation (1) are linked to the length divisions (the positions in Figure 1) of the thermocouple. Signals can only be generated for the units of length where $T_n \neq T_{n+1}$. For better adaptation to real temperature distributions, Equation (1) can be altered to an integration function.

Sensitivity seldom homogenous

Figure 2 illustrates the basic problem that calibration and measurement can occur under different conditions. When measuring inside a heat treatment furnace, the output signal E is generated where the almost three-metre-long thermocouple passes through the wall 2.1 to 2.5 m from its probe tip. See the blue curve. When calibrating, e.g. in a calibration furnace, the insertion depth is often limited to 15 to 20 cm from the tip. We apply Equation (1) to the calibration and measuring processes respectively:

$$\Delta E = S_{cal}\,(900 - 25) - S_{wall}\,(900 - 25)$$

Other terms become zero given the virtual absence of temperature differences. The difference in output

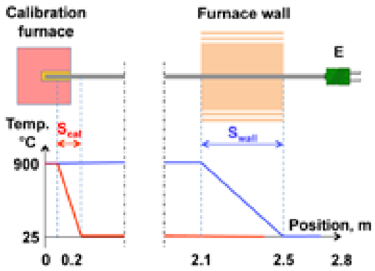


Figure 2. On the left, a thermocouple is under calibration in a 15-cm-deep furnace. On the right, the same thermocouple is being used to measure in a heat treatment furnace. The signal is generated where the temperature changes, which to all intents and purposes only occurs at the positions marked with S_{cal} and S_{wall} for calibration and measuring respectively.

signal should be zero because we are comparing the thermocouple with itself within a short period of time. However, it turns out that difference of several degrees can occur, which means that $S_{cal} \neq S_{wall}$.

There are several reasons for the difference. One is ageing, which can occur differently in the tip and where the thermocouple passes through the wall due to different temperature histories: respectively a constant 900 °C versus all temperatures between 25 and 900 °C. Another property is SRO, which is related to the lattice structure of the thermocouple materials. The structure varies with temperature and time and affects the sensitivity S. See Figure 3. The variation appears as a hysteresis phenomenon. [Ref 2].

SRO negatively affects both types K and N thermocouples but to a differing extent. For type K, the critical zone must be within approx. 250–550 °C and the maximal deviation from the normal output signal can be elevated up to 4–5 °C. For type N thermocouples, the corresponding critical zone is a couple of hundred degrees higher at about 700 °C with a positive deviation of approx. 1–2 °C. This applies to the sheath material Inconel 600®, which is also common in type K thermocouples.

SRO hysteresis

Figure 3 shows how much a type K thermocouple drifts at various temperatures and times. In the ground state the sensitivity is approx. 40 µV/°C. Already after five minutes at 450 °C it has increased by 0.3 µV/°C, which corresponds to 0.75 °C per 100 degrees of temperature difference along the altered zone of the sensor probe.

As long as the thermocouple is kept under 550–600 °C, the achieved change is retained, and this altering process does not stop until after about a month's continual operation. This means that heat treatment to this stage and the subsequent calibration produce a stable sensor but with a shifted scale.

For that part of the sensor which is inserted into a temperature of more than 600 °C the sensitivity reverts to the ground state. Rapid cooling (seconds) leads to the ground state being preserved as long as

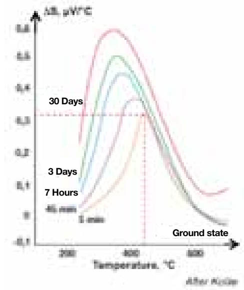


Figure 3. The SRO phenomenon's influence on type K thermocouples at various temperatures and exposure times. Already after five minutes at 450 °C sensitivity S has increased by 0.3 µV/°C.

the temperature does not exceed approx. 200 °C. Figures 4a–d show the hysteresis when measuring at more than 600 °C. In this situation, prior heat treatment is of doubtful benefit. A better way to reduce the SRO hysteresis is to instead use type N thermocouples. These also have a significantly lower long-term drift (ageing) than type K thermocouples at high temperature.

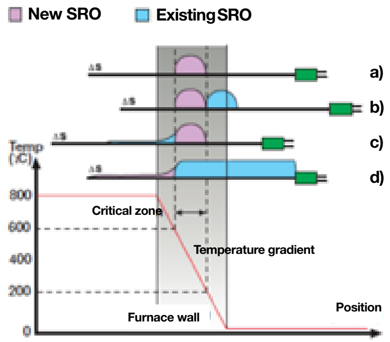


Figure 4.
a). The initial situation of an unused sensor. ΔS increases over time. The reading is immediately affected.
b). The sensor is pulled out quickly by an amount corresponding to the critical zone's width. Previously generated ΔS remains and ends up partly within the gradient. New SRO is generated in the critical zone. The reading increases.
c). The sensor is pushed in by an amount corresponding to two zone widths. Existing SRO is generated backwards above the zone boundary. The reading is reduced and we return to Position a.
d). Prior heat treatment has no beneficial effect because the then-achieved increase in ΔS falls away at temperatures above 600°C. Only an unknown part of the increase lies within the gradient and makes an indefinable contribution to the output signal.

References see www.pentronic.se > News > Pentronic News > Pentronic News Archive
[Ref 1] PentronicNytt 2014-1
[Ref 2] StoPextra 2010-1

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