PENTRONIC NEWS

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IT´S ALL ABOUT TEMPERATURE!

PENTRONIC Scandinavia's leading manufacturer of industrial temperature sensors

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Why frozen food stays at the right temperature all the way to the shops

Torbjörn Svensson calibrates all of Bring Frigo's instruments and temperature sensors once a year so that frozen foods can have a temperature of -18°C in the shops.

We take it for granted that frozen foods are at -18°C when we buy them in the supermarket. But getting there involves a long chain of temperature measurements and well-planned routines for regular calibration.

"Our promise to the customer is the right temperature all the way to the consumer," says Torbjörn Svensson, temperature specialist at Bring Frigo.

The company, which offers thermally controlled transport services, was an early player in the transport of frozen and chilled foods. It began operating in 1950 as Helsingborgs Fryshus. Today Bring Frigo has unique experience and competency in the sector.

Storing and transporting chilled and frozen foods is trickier than it sounds. Every part of the load must be kept at the right temperature throughout the transport chain in order to achieve an unbroken chilled and frozen chain.

"Everything is designed for hot summer days," Torbjörn says. "The cooling capacity on board the lorries is enough to keep the temperature constant but not to lower it."

Fast sensors

Even when goods are loaded onto a truck via weathertight channels, their temperature goes up every time they are reloaded. Allowances must be made for this while the goods are still in storage at Bring Frigo.

"In our freezer warehouses the temperature is -25°C so the products will be at a guaranteed 18°C in the shops," Torbjörn says.

Bring Frigo's own hauliers transport the goods. Everyone follows the same routines and uses a hand-held instrument with a special built-in sensor. The company is now replacing that sensor with a model equipped with a reduced probe tip that provides a fast reading. This sensor is supplied by Pentronic in Bring's green corporate colour.

"The new ones are so sensitive that they react to the heat caused by friction if you insert them in between the packages too quickly," Torbjörn says.

Detailed measurement

The drivers measure the temperature when the goods are loaded. On arrival at the destination, it is the terminal staff who take the readings. When the first pallet is unloaded, the sensor is inserted in between two packages so it is in contact with the product. The display shows how quickly the sensor's temperature drops. The sensor must then remain in place for three to four minutes.

Temperature readings of the goods are then taken at various locations in the lorry's load compartment. If any of the readings show too high a temperature, a more detailed measurement is then taken using another instrument, which is equipped with two specially manufactured temperature sensors of different lengths. Both of these are made by Pentronic and are flat so they can be inserted a long way in between the packages and achieve good contact.

"It's important that the air can circulate freely in the entire load compartment," Torbjörn explains. "If the pallets are positioned wrongly or if anything else stops the air from circulating, the temperature in parts of the load can become too high."

Calibrated annually

In Helsingborg the company has its own calibration laboratory, which is customised for the relevant temperature range. The laboratory consists of an alcohol bath with a reference instrument and a working standard, which is sent to Pentronic once a year to be calibrated. All the instruments and temperature sensors used by Bring Frigo are calibrated in Sweden every year. Torbjörn also monitors the refrigeration and freezer rooms in Sweden, Norway and Denmark, and is also involved with training.

There is not enough room here to describe the entire system. But there are few companies – in any industry – with such well-planned routines for temperature measurement and calibration.

"My predecessor, Kjell-Åke Lundh, worked for over 15 years to fine-tune the routines, and my job is to carry on his work," Torbjörn Svensson says.

This Christmas Pentronic donates money to the Swedish branch of SOS Children's Villages, which continues supporting the Astrid Lindgren Children's Village for orphaned children in Bouar in the Central African Republic. As our customer you share in the gift – it is our Christmas present to you.

SOS BARNBYAR SVERIGE

Third recruit from the lab

Pentronic's sales reps stand out from the crowd. They are all engineers and problem solvers. The latest addition is Karoline Haneck, who has 11 years of experience from Pentronic's accredited laboratory for temperature calibration.

"I was interested in technology at an early age so it was natural to choose such an education," says Karoline, who studied production, design engineering and economics.

Her first job was to design the interiors of pigsties. When Pentronic had a vacancy at its accredited calibration laboratory, she applied and got the job.

A good school

Temperature measurement had only been mentioned in passing during her formal schooling. That is usually the case, so Pentronic has long experience of training new employees.

"The laboratory was a good school," she says. "In such a rigorously controlled operation, there are clear rules and routines."

After only a few years, her duties became more independent and she also began working with inspection and calibration assignments out in the field.

"It's valuable to see how customers operate and what their measurement environments look like," she explains.

Karoline spent 11 years at one of northern Europe's leading accredited calibration laboratories for temperature. But a while ago she was invited to join the sales team. The laboratory has supplied Pentronic's sales engineers in recent years. Two of her colleagues, Jonas Bertilsson and Michael Steiner, have the same background.

Helps the customers

On the difference between working in the lab and working with sales, she says:

"The laboratory is an independent unit which has to be impartial. We supply facts. As a sales engineer I help customers to solve their measurement problems and measure correctly. It's both challenging and stimulating."

It doesn't hurt that the customers are both knowledgeable and pleasant to work with.

Karoline's first tasks as a sales engineer included working with district heating plants. But due to the retirement of another colleague, her field of work has expanded to also include responsibility for distributors and consultants.

Even a temperature specialist also has a life outside of work. In the coastal community of Västervik, spending time on the water is almost obligatory and Karoline shares this interest with her whole family. But when other family members head off on a fishing trip, Karoline sometimes instead takes off on her motorcycle.

Karoline Haneck became a sales engineer after 11 years with Pentronic's calibration laboratory.

Training and new technology make in-house calibration interesting

Do it yourself or bring someone else in? The question has no obvious answer.

"It depends on what process is involved and what requirements there are for the temperature measurements," explains Jonas Bertilsson of Pentronic.

Pentronic offers both calibration services and equipment. In some industries there is an increasing trend to purchase calibration services from an outside source.

"In other industries, companies are instead building up their own calibration resources because they take a large number of measurements with high performance or verification requirements," Jonas says.

The necessary know-how

Twenty-five years ago, when ISO 9000 made its breakthrough, many companies chose to do their own calibration. In some cases the equipment remained unused, because calibration is long-term work that requires competent personnel. Pentronic's courses have proven to be a much-appreciated way to train calibration operators.

"For lower temperatures and modest accuracy requirements within ± 0.1 °C it is relatively easy to create a calibration station yourself with a block furnace or simple water bath," Jonas continues. "If you want to achieve accuracies of ± 0.01 °C it is immediately more difficult to do correct calibrations. Even if the water bath is specified for stability within ± 0.01 °C there are many treacherous error sources to include in the uncertainty calculations and that requires expertise in this field."

Pentronic offers training in calibration and measurement uncertainty assessment. The practice sessions are greatly appreciated.

Like all technology, calibration equipment has developed since then. One current example is calibration furnaces and mini baths, which have become easier to use, have improved performance and cover a significantly broader temperature range than before.

The world's first

One example is Isis from Isotech*. It is the world's first block calibrator that can handle temperatures down to -100 °C. Previously this was only possible with sophisticated liquid baths. It is a dry process without expensive or harmful chemicals and has a patent pending.

"With this new technology there is reason to again consider what is the best solution – to train your own employees and do the calibration in house or to purchase the service from an outside source," Jonas concludes. "Conditions now are different than they were just a few years ago."

** See: http://goo.gl/ZEDTsc*

How cold are the Christmas buffet dishes?

QUESTION: It's soon time for us to have our Christmas buffet and some of the dishes of food on the table should be kept chilled. Does that really work?

Anna W

ANSWER: It's time again for the Christmas buffet and some of the dishes of food must be kept warm and others must be kept cold. It is not difficult in terms of heat technology to keep food warm but unfortunately it is not so easy to keep dishes on the buffet table at a low temperature.

One effective method of keeping food cold is to place the dishes of cold food on a bed of crushed ice. The ice melts but as long as pieces of ice remain in the mixture of ice and water, the temperature is 0 °C. Heat is transferred to the food and the serving dishes via natural convection from the air in the room and radiation from the room itself. The heat transfer inside the food and the serving dishes occurs via conduction, and the heat is then transferred further to the bed of ice. Lamps nearby the buffet table and heat from the guests also heat up the food. See Figure 1.

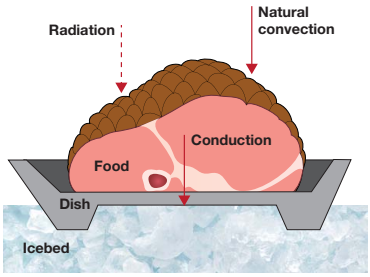


Figure 1. The bed of ice chills the entire bottom of the serving dish.

Another way to keep food cold is to place the serving dish on a cold tray. The heat transfer from the serving dish to the tray is not as efficient as the heat transfer from the serving dish to the ice bed. In the air gap that can exist between the serving dish and the tray, the heat transfer occurs mainly via conduction. See Figure 2. Even if the serving dish has a flat bottom, the contact between the dish and the tray is not perfect. We can regard this as a kind of contact resistance between the serving dish and the tray. The food can therefore become somewhat warmer than in the previous case with the bed of ice. If the moisture in the air condenses on the tray and serving dish, this will increase the heat transfer to the tray.

The tray can be kept cold in various ways. One method is to chill it with a refrigerating machine. Another method is for the tray to contain a phase change material with a suitable melting point. As long as the material continues to melt, it will maintain the melting temperature. For example, you could use a suitable salt, a wax mixture, or water as a phase change material. One disadvantage of using phase change materials is that the tray must be chilled at regular intervals so that the material resolidifies. How long the tray then remains cold depends on such factors as the amount of phase change material, the type of material and the amount of heat being supplied. If you only use a cold metal tray, it must be chilled often in order to work properly.

One less effective method is to put the serving dish directly on to table. In this case, even if

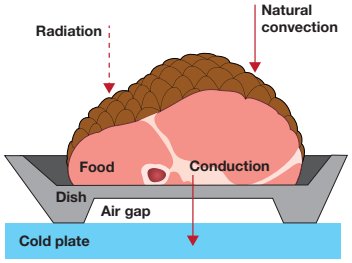


Figure 2. An air gap reduces the heat transfer to the tray.

you place the dish onto an insulating cork mat, heat from the table will also be transferred to the dish and food by conduction and the food will quickly warm up.

If the food and the serving dish are at refrigerator temperature from the beginning, it is often not difficult to keep the food cold for a limited period of time if the serving dish is placed on a cold surface. For example, when you use a bed of ice, the bottom of the serving dish has a temperature of 0 °C as long as all the ice has not melted. The recommended temperature inside a refrigerator is 4 – 5 °C. It is important that both the food and the serving dishes are at refrigerator temperature from the start and not at room temperature. In the latter case it will take time before the food cools down to refrigerator temperature, and in the worst case the cooling process is so slow that it does not occur at all while the food is on the table.

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

QUESTIONS? ANSWERS!

If you measure the temperature of the food, you must do so at various places within the food and at various times. The food's temperature varies because the heat transfer inside the food and to/from the food varies both according to the position and over time. The influence of the contact resistance on the heat flow can be significant.

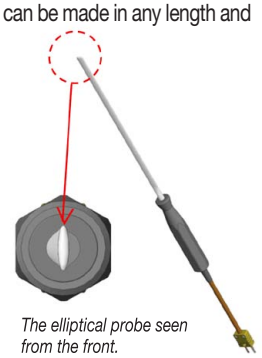
If you have questions or comments, contact Dan Loyd, LiU, dan.loyd@liu.se

New temperature sensor for food inspection

Pentronic presents a new hand-held sensor for taking temperature readings between cartons. One use for the sensor is as one of the quality control steps in the cooling chain for the distribution of frozen or chilled foods.

The foods are at a sufficiently low temperature before their journey to the customer begins. The cooling capacity en route is limited and at best the load can maintain its initial temperature. The temperature sensor has an elliptical cross-section so it can easily be inserted in between the cartons to take a reading when they are unloaded or reloaded.

The sensor can be made in any length and with a type T or K thermocouple. A miniature plug makes it easy to connect the sensor to most hand-held instruments. A practical cable length is 1 m.



The elliptical probe seen from the front.

STRAIGHT FROM THE LAB

Calibration services in the field

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Companies are tending to use external experts to inspect and calibrate their equipment rather than building up their own organisation to do the job.

"More and more companies prefer that we take our equipment to them and do the job there," says Lars Grönlund, manager of Pentronic's accredited calibration laboratory.

The most common services are either to inspect the customer's entire measurement chain from the sensors to the process computer, or to inspect selected parts of the chain.

Demand to replace existing temperature sensors with new calibrated ones is now also starting to increase.

"Company organisations are so streamlined today that there is no room for specialist expertise of this kind," Lars explains.

Calibration certificates for work done in the field have the same legal status as those issued after calibrations done in Pentronic's laboratory. Be aware, though, that the measurement uncertainty is lower for calibrations done in the laboratory's controlled environment.

Temperature limits in types K and N thermocouples

Two of the most common standards for thermocouples are IEC 60584 and ASTM E230. They describe different temperature intervals and different associated tolerances. Both standards state that they only apply to unused thermocouples, which indicates that thermocouples are perishable goods. How can we determine the service life of metal-sheathed thermocouples such as types K and N for a specific measurement environment or temperature level?

One reason for using base metal thermocouples in metal-sheathed form is the advantages they offer when used to take mobile readings. For example, they can travel with an object through a tunnel furnace in order to determine the temperature distribution along the furnace, and also from the surface to the core of the object requiring heat treatment.

IEC 60584:2013 is the current applicable international standard for thermocouples and ASTM E230/E230M-12 is the applicable American standard from 2012, which has a lot of international influence. See Figure 1 for the tolerances in types K and N plus [Ref 1] for other thermocouples in the standards.

Unused thermocouples are defined as type K or N if they meet the standards' tolerances for the relevant type. Many factors in the user's measurement environment can influence a thermocouple's service life, which is therefore very hard to predict. ASTM spans a larger temperature range, which can be harder to achieve than the somewhat closer intervals given by IEC.

The service life is determined by the requirements for measurement accuracy. We would emphasise that the tolerances apply to unused thermocouples. See Figure 2. The diameter of sheathed thermocouples influences their service life, which generally speaking increases with the sheath diameter. The construction of a sheathed thermocouple is shown in Figure 3. The insulation between the sheath and the wires very often consists of highly compressed magnesium oxide, MgO. Metallic sheath and/or protection tube do not guarantee that foreign materials will be prevented from diffusing into the thermocouple's wires when the temperature approaches 1000 °C. If the wires react with external substances from the measurement environment or internally between the metal casing, the insulation or the wires, the result is often an altered Seebeck coefficient, that is, a different sensitivity, and the thermocouple displays deviating values over time. If the product of the reaction is a non-conducting material, the instrumentation will indicate a break, as the entire area of the wire has been "eaten up" somewhere by the reaction.

Type K & N	IEC 60584 Tolerance (°C)		
Tolerance class	1	2	3
Range	-40 < T < 1000	-40 < T < 1200	-200 < T < 40
Greatest of	±1.5 or ±0.004•|T|	±2.5 or ±0.0075•|T|	±2.5 or ±0.0075•|T|
Type K & N	**ASTM E230/E230M-12 Tolerance (°C)**		
Tolerance class	Special	Standard	Standard (K)
Range	0 < T < 1260	0 < T < 1260	-200 < T < 0
Greatest of	±1.1 or ±0.004•T	±2.2 or ±0.0075•T	±2.2 or ±0.02•T

Figure 1. Tolerance classes for types K & N thermocouples given in the international IEC standard and the American ASTM standard. Note the difference in the measuring ranges between the standards and the respective tolerance classes. Note that the data only applies to unused thermocouples!

Diameter (mm)	Temperature (°C)
∅ 0.5	700
∅ 1.0	700
∅ 1.5	920
∅ 2.0	920
∅ 3.0	1070
∅ 4.5	1150
∅ 6.0	1150
∅ 8.0	1150

Figure 2. General temperature limits recommended by ASTM E 608/E 608M for various diameters of types K & N sheathed thermocouples. No account has been taken of aggravating environments. Higher temperatures lead to a shorter service life and/or more unstable measurement values.

Sheath material

Unavoidable contaminants in the molten material used to make the wires can also cause the thermocouple's readings to vary according to its position in the furnace. Similar behaviour is caused by the SRO hysteresis phenomenon in types K and N thermocouples. Type K can display up to +5 °C of error at around 400 °C and type N about +1 °C of error at around 750 °C, the latter assuming that an Inconel sheath is used, which is the most common type. See [Ref 2]. Sheath material comes in various types of metal, which also have limit values for their operational use and melting point. See Figure 4.

The operating time until disruptive measurement errors start occurring therefore varies according to the measurement environment and the sensor's properties. You can obtain a basis for deciding what operating time is sufficient before replacing the thermocouple by doing an in situ calibration [Ref 3].

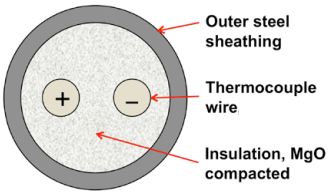

Figure 3. A metal-sheathed thermocouple in cross-section with an outer diameter of D. The sheath's thickness is approx. 0.1 D and that of the wires approx. 0.2 D.

Inappropriate use can also cause large measurement error. Magnesium oxide, MgO, has many good physical properties but loses its insulating ability dramatically over 600 °C. This can lead to some electrical shunting effects for those parts of the thermocouple that pass through high temperatures, for instance in a tunnel furnace, with large measurement errors as a result. For fixed installations, such errors can be avoided by using thermocouple wires in highly pure ceramic and with highly pure, closed outer protection tubes. The noble metal types R, S and B are examples of such fixed installation temperature sensors.

Ask us

Types K and N thermocouples should be used in oxidative environments. Accordingly, reducing environments such as hydrogen gas can cause measurement error. Vacuum environments cause the evaporation of various substances to occur at considerably lower temperatures than at normal pressure. In this way, the composition and sensitivity of the thermocouple wires can be affected even at a low temperature. In addition, the heat transfer to the thermocouple is impeded in that no convection occurs.

In conclusion, it is extremely difficult to accurately predict a thermocouple's operating time. The best way is to measure the temperature drift using the in situ method, where that is relevant, and, based on the result and on your own wishes, to adjust such factors as the diameter. Before the maximum deviation is reached, the thermocouple should be scrapped and replaced with a new one. In cases of doubt you are welcome to consult Pentronic.

Temperature limits for sheathing materials (°C)			
Material	Max. working temp. Rec. contin.	Max. working temp. Max. in air	Melting point
AISI 304	*900*	*1050*	*1404*
AISI 316	*925*	*900*	*1371*
Inconel 600	*1150*	*1095*	*1399*

Figure 4. The maximum operating temperature limits recommended for various sheath materials for continual use and for use in the air, plus their respective melting points, given in the ASTM's Manual on the Use of Thermocouples in Temperature Measurement*, 4th edition, 1993.*

References, see www.pentronic.se > ...
[Ref 1]: ... > To download > Useful links > Thermocouples > IEC 60584:2013
[Ref 2]: ... > News > Pentronic News > P N Archive > PN 2014-2 p. 4
[Ref 3]: ... > News > Pentronic News > P N Archive > PN 2014-3 p. 4

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