PENTRONIC GROUP Europe's leading manufacturer of temperature sensors

NO. 2019-2

PENTRONIC NEWS

it's all about temperature!

SOLAR ENERGY THE FOCUS OF AZELIO'S SUCCESSES

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Summer and just enough sun!

In the last issue I wrote about our continual work towards sustainability. It can be worth thinking of that now the summer holiday is almost here and hopefully we will be able to enjoy our beautiful countryside and take a cooling evening dip in a nearby lake. When I write "just enough sun" I am referring to the hope that our forests can remain alive and that our valuable water will be enough for everyone.

In this issue you can read a report about Azelio, which is developing facilities to transform solar energy into electricity. As we continue to electrify the world, we need access to "clean" electricity to charge not only cars but also bicycles and phones.

We have continued our digital journey this spring by introducing a new CRM system, a new website and invoice scanning. The aim is to improve customer service, efficiency and the environment.

If you have not yet explored our new website pentronic.se I hope you will have the opportunity to encounter us there. It features improved search functions, a product filter and a clearer structure for finding the right information. We welcome your opinions so that we can continue to serve you and your requirements in the best possible way.

Finally, I would like to wish you a wonderful summer and a warm welcome back after the holiday.

Happy reading!

Rikard Larsson
Managing Director

SOLAR ENERGY THE FOCUS OF AZELIO'S SUCCESSES

Azelio is currently one of Sweden's most interesting companies. By combining proven technologies in new ways to harvest and store solar energy, Azelio has developed ways to safely produce solar electricity in an environmentally sound and cost-effective way. *Pentronic News* spoke with Azelio's CEO Jonas Eklind about how 200-year-old technology can be part of the solution to ensure tomorrow's energy supply.

STORING ELECTRICITY is difficult and inefficient and also requires expensive and environmentally harmful batteries. Azelio uses Thermal Energy Storage (TES) to store heat in an aluminium alloy – heat that can then produce electricity even when it is dark outside by using high-efficiency Stirling engines. Each unit can store heat for 13 hours of nominal operation.

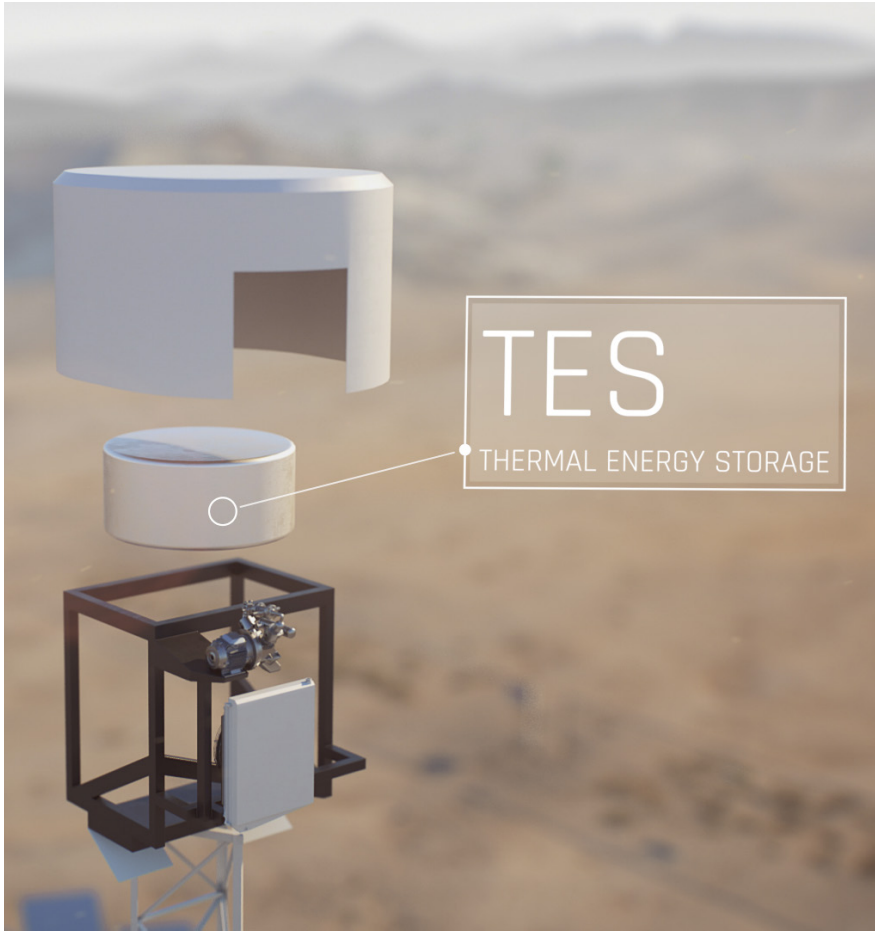
Focusing on facilities ranging from 500 kW to 20MW, Azelio is developing solutions where diesel engines were previously the only option. The solutions operate at a fraction of the cost per kWh compared with other technologies – even traditional generators that run on fossil fuels. The Stirling engine is well known but few companies can supply an engine with the same operational reliability as Azelio's. With more than two million hours of operational experience, Azelio can build an engine that runs for a full 6,000 hours between each service event. The company already has a production line in the locality of Åmal in west-central Sweden for the small-

scale production of Stirling engines. Planning for large-scale production in the nearby town of Uddevalla is fully underway.

"We developed this TES solution over a number of years in collaboration with several universities in Sweden and Germany," Jonas Eklind explains. "But for us, it's also important not only to have development and concepts – our solution must work and it must be efficient and commercially justifiable. With our demonstrator in Åmal, we've shown that the technology works and is just as stable as we claim."

There is a lot of interest in Azelio. Following a name change and a stock market launch last autumn, the company has presented several new solutions and collaborations that are attracting great attention around the world.

"We have a solution that fills a gap between the small-scale production



of solar electricity, which we see on many private house roofs today, and the large-scale facilities that have also been around for a while now," Jonas continues. "The large scale is necessary for cost effectiveness when using traditional CSP (Concentrated Solar Power) technology."

Temperature plays a role!

To heat the material that will store the energy, mirrors are used to direct the sunbeams at the material. Under the right conditions, on a sunny day this simple but effective method can heat the aluminium alloy to 600 °C outright.

To achieve this simple efficiency, complex tools were required.

"In order to offer this solution, our engineers had to work for many years both on the Stirling engine and on developing the right material for heat storage," Jonas says. "It was also crucial that we also have the capacity to industrialise the products. We base our work very much on experience from the Swedish automotive and aviation industry and we use its principles for the quality assurance of our engines."

Pentronic also has many years of experience working with this industry. Azelio and Pentronic have collaborated for a number of years to monitor the temperature of Azelio's processes. Because thermal storage and the thermal differences inside the Stirling engines are the core of the technology, complete knowledge of the temperature is naturally very important.

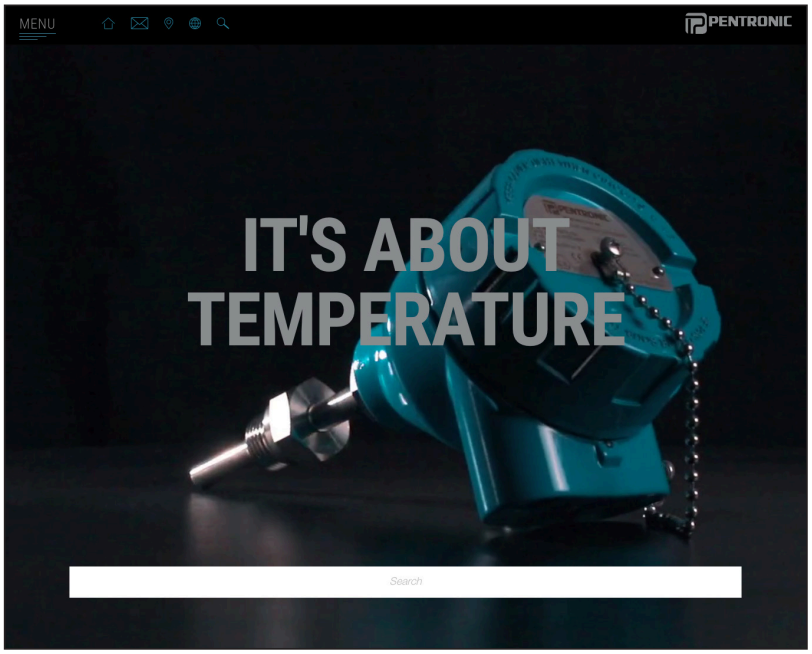
"Measuring the temperature of these processes is very important," explains engineer Mikael Karlsson at Azelio. "Pentronic specialises in this and has contributed both knowledge and products to make it possible over the years. They're experts in temperature but are also used to thinking industrially and finding effective solutions."

For Pentronic, Azelio is an interesting customer.

"What Azelio is doing is very exciting and we are great believers in fossil-free solutions for power production," concludes Pentronic's Managing Director Rikard Larsson. "It's fun for us to work with a company whose products can really make a difference to global sustainability."

PENTRONIC IS BEING DEVELOPED AND UPGRADED

During this past winter and spring, Pentronic has implemented a number of projects to update our IT tools. As a customer, you will primarily notice that we are now launching our website with greater functionality and user friendliness. At the same time as that is being done, Pentronic is also switching its CRM system to SuperOffice, which will improve our ability to efficiently serve our customers.



"Both the website and the CRM system we had before were good in many ways," comments Sales Manager Björn Tunek. "The reason we're now upgrading is that the previous tools are simply starting to become outdated and today's alternatives have so much more to offer."

The possibility of finding information quickly and easily is very important today. The new website will help Pentronic improve accessibility and make it easier for customers to find important information. The new website will streamline the working method internally and free up time for our service staff.

"Many customers choose Pentronic because of our engineers, who love to carefully fine-tune technical solutions, to customise and optimise products," continues Björn. "Our most important service is still done on site at our customers' premises and over the phone in a creative dialogue. We want to have more time to do this, and that's why it's important that our website supports us with simpler, standardised information."

The Pentronic website has a huge amount of information about products and temperature measurements, but many of our customers sometimes felt it was difficult to find the right information and the search function was not optimal.

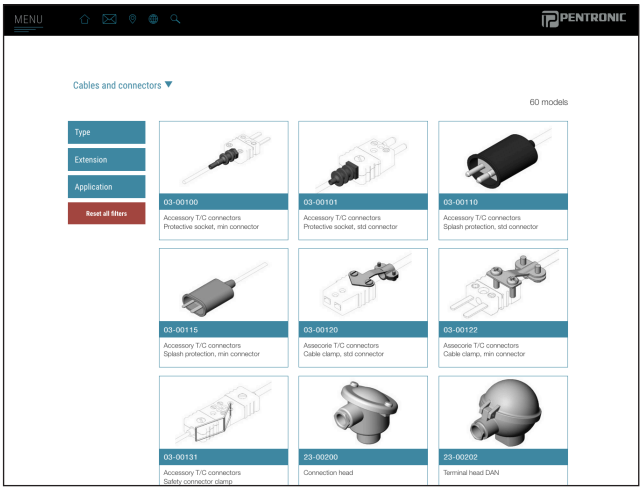
"Our new website is faster and also interactive in a way that will help us support our customers better," comments Göran Rälg, Inside Sales.

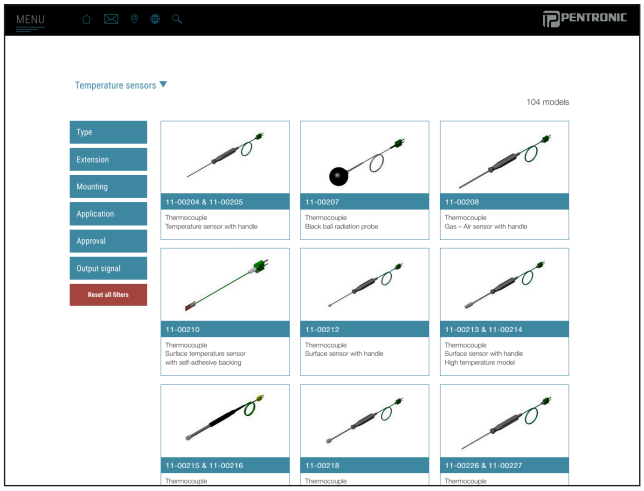
Customer Relationship Management system

Also called a CRM system, this helps companies to keep customer data and contact details in good order. For many years Pentronic has used basic tools to keep track of important information about our customers. Now, as we introduce the new website, we also migrate to a new custom-designed CRM system.

Pentronic's new system will help sales engineers and service personnel to answer customers more quickly and efficiently. Information and past history will be more easily accessible and organised.

For you as a customer, it is important to know what information is being stored and processed. We fully comply with our policy regarding personal data, which you can find on our website www.pentronic.se. If you have more thoughts about this or anything else, you are always welcome to contact us.





PRODUCT INFORMATION www.pentronic.se

CAPELLA C3, A VERSATILE AND PORTABLE TWO-COLOUR PYROMETER

Pentronic can present a new product that satisfies a long-term demand: a handheld two-colour pyrometer.

It is especially suited for measuring high temperatures on metallic surfaces, and is therefore very useful in the metal industry.

The C3 also has an optical finder and a laser sight with a green beam, which works better on materials that glow red at high temperatures.

An extra function makes it possible to turn off the two-colour function and only use one wavelength like a normal IR pyrometer. This is very handy when investigating the material's emission factor.

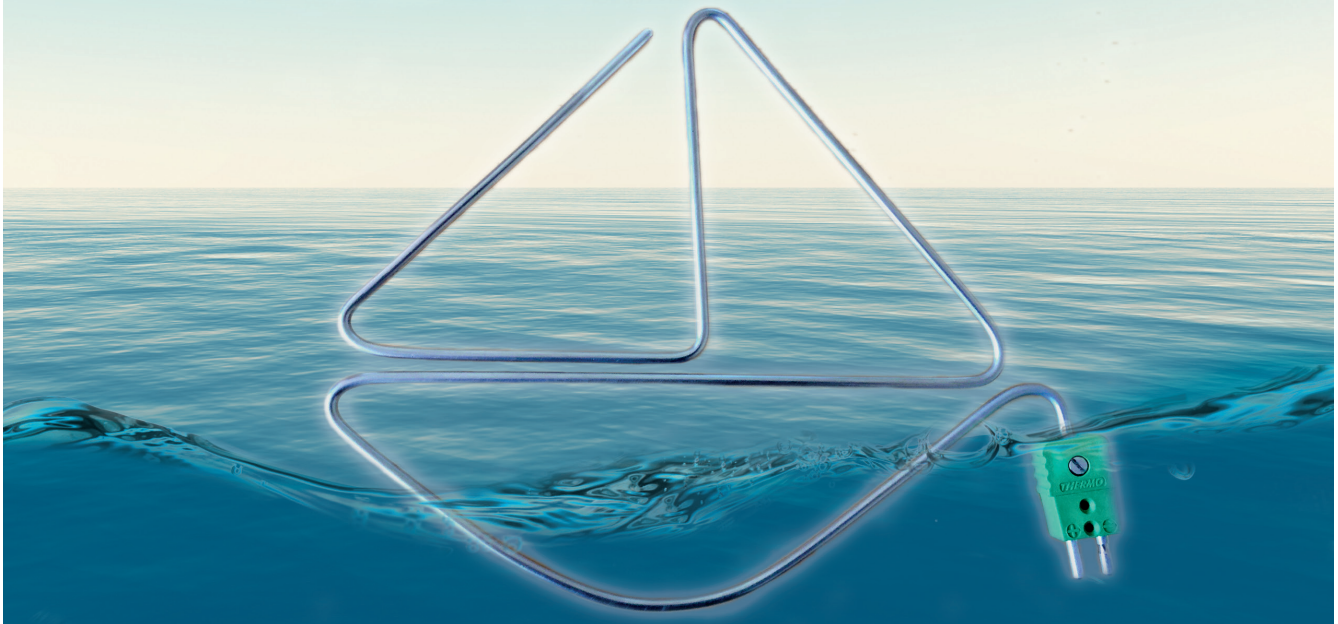
Art.no: 06-72000

The optics have also been designed so the user can set the focus at various measurement distances, such as 1.2 mm at 380 mm or 29 mm at 10 metres.

The manufacturer has also designed the optical finder to function well when the user is wearing protective goggles or a visor.

The measurement time is fast – under 1 millisecond – and there are various measuring ranges from 300 °C to 2500 °C depending on the model. The instrument comes with a built-in memory plus software enabling further analysis and data export.

SUMMER BREAK



Summer is here, bringing with it vacations and some time off to recharge our batteries. This year Pentronic's main vacation period is scheduled for weeks 29 and 30 (July 15th–28th). During this period we will close Pentronic for maintenance and upgrades and we will not be processing any orders.

Orders placed on or before July 10th will be planned and confirmed before the break. The last day of shipping is July 10th.

Orders placed during the vacation will be processed on the 29th and planned from that date.

Sales and service teams will be available for your questions until July 12th and after this we will have limited availability for two weeks.

Don't hesitate to contact us if you have any questions or concerns.

More information plus contact details during the break will be posted on our website www.pentronic.se

MEASUREMENT ERROR DUE TO THERMAL CONDUCTION IN A SHEATHED THERMOCOUPLE

QUESTION ? ANSWER

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

QUESTION: When you calculate the measurement error when measuring with a sheathed thermocouple, you often disregard the heat transfer in the thermocouple itself. How correct is this assumption?

Mats K

ANSWER: To discuss this common assumption, we begin by considering a sheathed thermocouple that is measuring the temperature of a flowing liquid. We assume that the liquid's temperature is constant. We also assume that the temperature of the wall is higher than that of the liquid. Heat is now transferred from the wall to the thermocouple and along the thermocouple by means of thermal conduction. From the thermocouple, heat is transferred to the liquid by means of forced convection. The temperature of the thermocouple decreases along with the distance from the wall. The temperature of the measuring junction is influenced by the physical properties of the sheathed thermocouple and the convective heat transfer to the liquid. The temperature difference between the measuring junction in the thermocouple and the liquid, ΔT °C, is the measurement error resulting from the thermal conduction in the thermocouple. In the stationary case, this measurement error can be estimated with the help of the following equation:

$$\Delta T = T_{meas} - T_{fluid} = 2(T_{wall} - T_{liquid})/(e^{a} + e^{-a})$$

where T_{meas} is the temperature in °C of the measuring junction, T_{liquid} the temperature of the liquid in °C, T_{wall} the temperature of the wall in °C at the thermocouple's attachment point, and a is a parameter

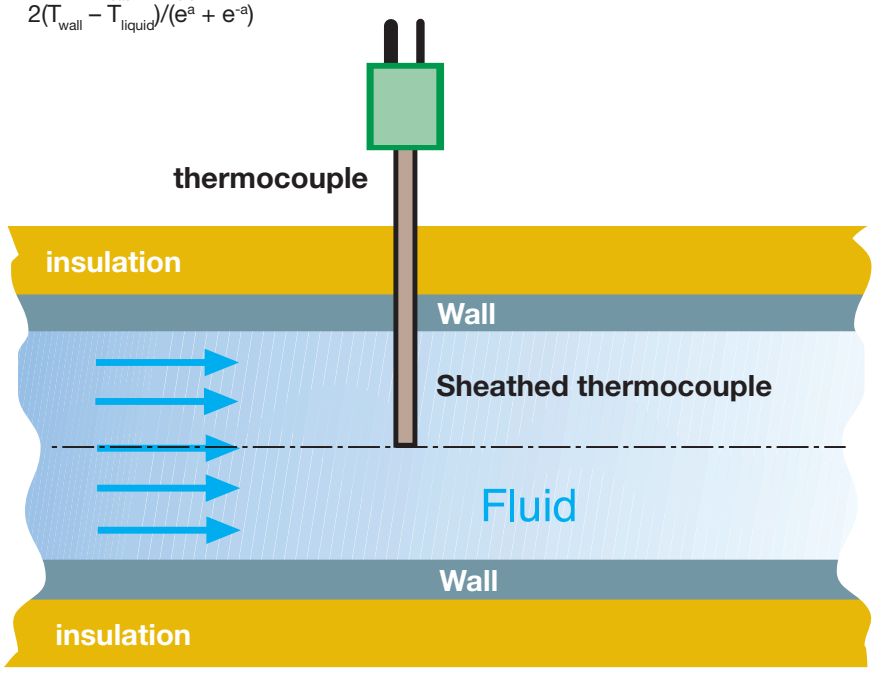
$$a = L(4h/(kD))^{0.5}$$

where L is the thermocouple's length in metres, h the convective heat transfer coefficient between the thermocouple and the liquid in W/(m²K), k the thermal conductivity of the thermocouple in W/(m K), and D the outer diameter of the sheathed thermocouple in metres. The thermocouple consists of various materials, which means that we must use an average value for the thermal conductivity.

The longer the thermocouple is, the larger parameter a becomes. In turn, this means that the expression $(e^{a} + e^{-a})$ increases and thereby the measurement error decreases. If you choose a thermocouple with a smaller diameter, parameter a also increases and the measurement error decreases. If the flow velocity increases, the convective heat transfer coefficient h will increase. Parameter a increases and the measurement error decreases. A higher value of the thermal conductivity of the thermocouple reduces parameter a and the measurement error increases.

If the flowing fluid is a gas, the same expression basically applies as for a liquid. In general, this type of measurement error is less when we are measuring in liquids than when we are measuring in gases, because the convective heat transfer coefficient is normally higher in liquids than in gases. When calculating the total measurement error when measuring the temperature of gases, we must also consider the possible effect of radiation.

In many cases, we do not know enough about the flow to be able to determine the convective heat transfer coefficient. This value is required if we want to determine the measurement error due to the thermal conduction in the thermocouple. By changing the thermocouple's insertion depth and studying the temperature change, we can often get some idea of the degree to which the measurement error is due to the length in the specific case in question.



Example

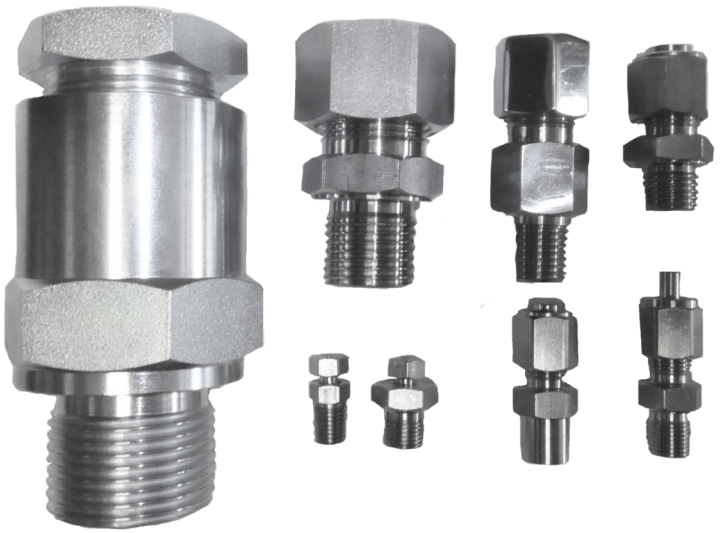
In Q&A, *Pentronic News 2019, #1* we discussed measuring the air temperature inside a long pipe with an inner diameter of 200 mm and an air flow of 5.3 m/s. The pipe temperature was 50 °C, the air temperature 15 °C, the length of the sheathed thermocouple 100 mm and its outer diameter 4 mm. In that case, the convective heat transfer coefficient was 112 W/(m²K). Due to the radiation, the thermocouple will measure a temperature that is 1.4 °C higher than the air temperature of 15 °C.

If we consider only the thermal conduction in the thermocouple and the heat transfer from the wall to the air via the thermocouple, we find that the measurement error due to this heat flow is less than 0.1 °C, which in this case means that the error can be disregarded. However, if the thermocouple's length were 50 mm instead of 100 mm, the measurement error would be approx. 2 °C. Calculating the measurement error is based on a number of assumptions, but the result still often gives us a good idea of what measurement error we can expect.

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

COMPRESSION FITTINGS – A NECESSARY COMPONENT

A compression fitting, also called a screw fitting, makes a temperature sensor complete. They are used in most industries, including food and packaging, pharmaceutical manufacturing, vehicles and engines, the process industry, as well as research and education.



Compression fittings are used to fix probe tips into position and to help prevent leakage. As a rule, the compression fitting is threaded and is screwed into position but when necessary it can be welded.

Common types of thread are conical and straight pipe threads plus metric fine threads.

The standard material is acid-resistant stainless steel. The probe tip is assumed to be round, i.e. made of a pipe or sheathed material, and is clamped fast by compressing a pierced cone around the probe tip.

The cone can be made of various materials but the most common are steel or PTFE (a fluoroplastic with properties that give it very low friction). The steel type is also available in a spring-action version equipped with a slot.

The PTFE cone can be used at temperatures under 200 °C, in cases with low pressure differences, and when it is necessary to be able to adjust the cone along the probe tip.

The steel cone is used at higher temperatures and in cases where the pressure difference is considerable. The compressing cone cannot be moved after it has been tightened.

A spring-action steel cone does not provide a seal against a pressure difference or liquids, but on the other hand, it can be moved along the temperature sensor's pipe.

Most compression fittings are designed for use with a probe tip but for customers who need to mount several sensors at the same connection point there is a multi-compression fitting, Model 9640000, for up to 24 probe tips.

For mounting larger thermocouples at high temperatures, there is a compression fitting with a graphite seal that can withstand up to 450 °C.

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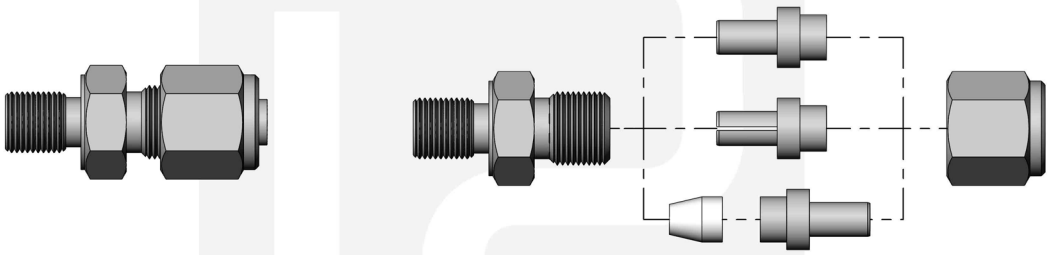

We are often asked what withstanding pressure the compression fitting has and what tightening torque should be used. It is difficult to generalise about this, because it depends on the sensor diameter, the wall thickness of the temperature sensor pipe etc. A good rule of thumb is to tighten it as hard as you can with your fingers and then make a mark at the 6 o'clock position and then tighten it one and a quarter turns until the 9 o'clock position.

Compression fittings should only be mounted and removed when the system is not under pressure.

Some combinations are pressure tested; the test results can be supplied on request.

The above-mentioned compression fittings are part of our standard product range. If you require specific solutions and customised models, or if you have other questions, you are welcome to contact us for assistance.

PENTRONIC
Bergsliden 1, SE-593 96 Västervik
Tel. +46 490-25 85 00, Fax. +46 490-237 66
www.pentronic.se