High Temperature Diaphragm Seal

Measuring process pressure at 600°C

BADOTHERM®

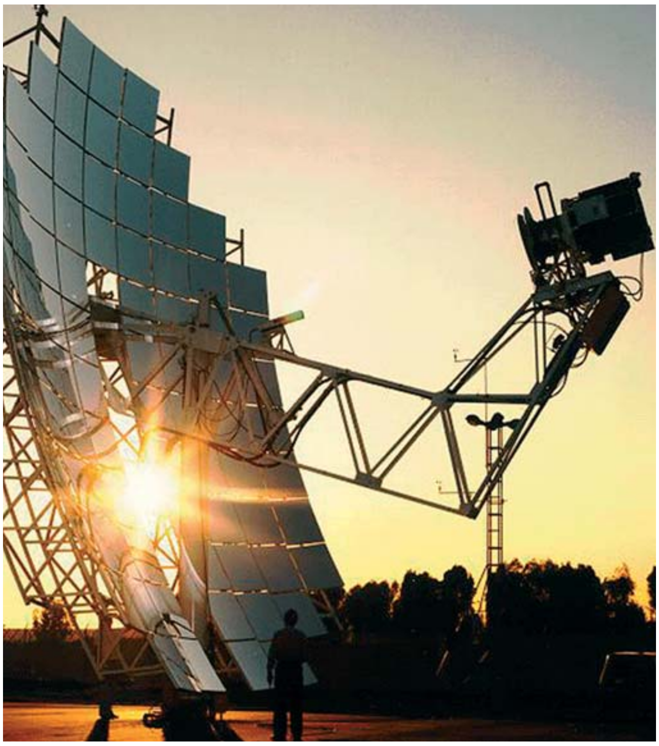
POSSIBILITY TO MEASURE PROCESS PRESSURE AT 600°C

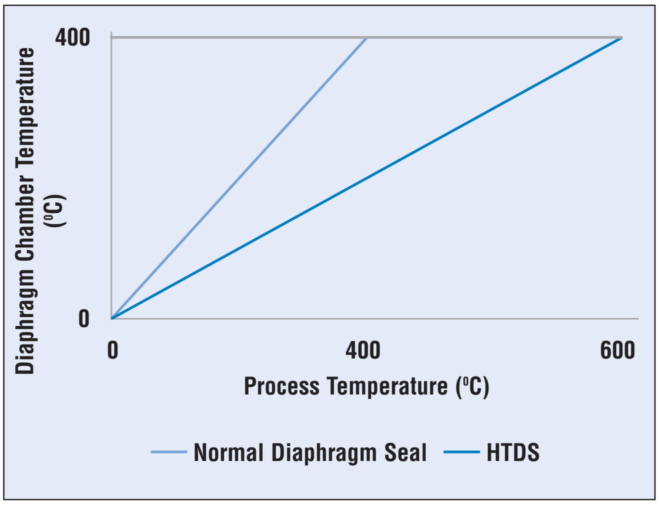
High Temperature Diaphragm Seal

Badotherm Diaphragm Seals are being used in a wide array of industries, to protect the sensitive and vulnerable pressure sensor from the harsh process conditions, such as aggressive and corrosive media, extreme high temperatures, and viscous media. It is a recognized phenomenon in the process industry that higher process pressure and higher process temperature can improve the overall efficiency.

Currently, when measuring pressure with transmitters with Diaphragm Seals, the temperature limit of Diaphragm Seal applications is set at 410°C, as this is the maximum allowed temperature of the filling fluid. Badotherm has developed a new Diaphragm Seal that can withstand **process temperatures up to 600°C**.

To enable a proper functioning of the Diaphragm Seal at these extreme process temperatures, a patented, revolutionary new design and principle is used.The new High Temperature Diaphragm Seal (HTDS) is extensively tested in different circumstances and with various process temperatures. Typical applications for high temperatures can be found in the chemical process industry, petrochemical industry, and in the thermosolar industry, the latter especially in combination with molten salt heat storage.

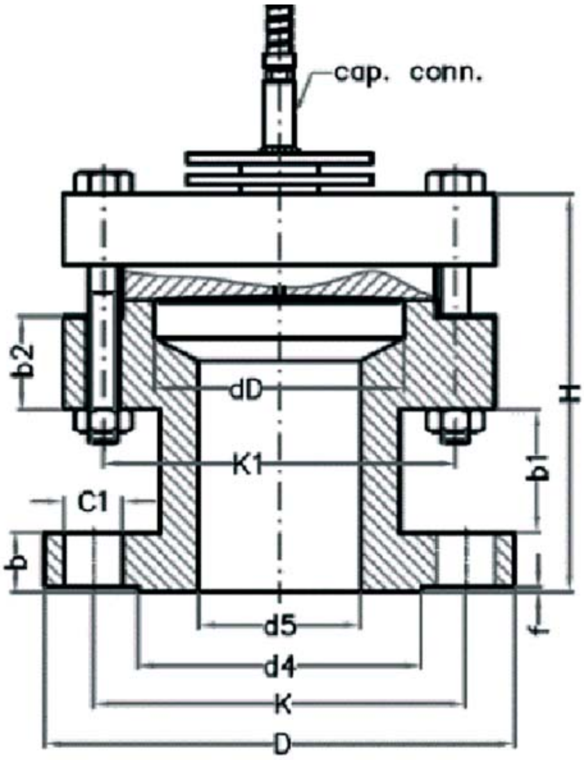




Temperature reduction diaphragm chamber HTDS vs standard Diaphragm Seal

Benefits HTDS vs. cooling down the process temperature to below 400°C

Traditional ways of cooling the process medium to temperatures below 400°C are often done by means of a cooling tower or pipe extension.



Any extension resulting in a longer distance away from the actual process media, may result in a pressure measurement that is not reflecting the process conditions accurately. Still there is a risk that the process temperature is reaching the Diaphragm Seal in the end and hence destroys the fill fluid when exposed to temperatures above 400°C. In case of frequent start-ups, there is the possibility of air inclusion in the pipe resulting in inaccurate measurements. **A cooling tower**, often mounted before the Diaphragm Seal (cooling element, tube or syphon) often has a small hole of approximately 3 to 4 mm, with a high chance of clogging. Further challenges are the dimensions and weight of the total cooling tower construction, also depending of Diaphragm Seal size and rating, but imagine that a 2" 300 RTJ process connection can be fairly heavy. These vertical installations can increase the risk of mechanical stress on the tower due to vibrations. **A piping extension** and nozzle (elbow construction) has a bigger impact and is more difficult to realize later in the project. It has similar disadvantages as the cooling tower, where it is even more difficult to control the temperature at the 'dead end' with heat tracing. This is the case, when for example the temperature needs to be above molten salt solidifying point but also below the filling fluid limitations. Clogging might not be as much of an issue, but it remains difficult to clean residues in the extension of the pipe. Most important is the additional cost involved for piping department for the (elbow) construction.

The **HTDS operates as a traditional Diaphragm Seal** construction, with a built-in mechanical cooling construction. This results in a Diaphragm Seal that can be mounted direct to the process to get immediate feedback and response from the process with actual process conditions. It has far less chance of clogging in this construction. The construction can be heat traced until the upper flange for control of the process temperature. It is a robust application, less prone to mechanical stress when properly installed and mounted.
There is no heavy equipment or special tooling required to install and commission the HTDS and there are no extra costs for piping department to change the piping construction.

Temperature and Static Pressure Limits

The maximum temperature limit is determined by a combination of the filling fluid, the material of the flange body and of the bolts used. For an AISI-321H body and 1.4980 bolt materials the maximum temperature is 600°C (material specifications and maximum temperature according to the ASME B16.5 standard). The maximum operating pressure depends on the flange rating combined with process temperature. The table below presents the temperature and pressure limits for 3 selected filling fluids.

	BSO-60	BSO-61	BSO-62
Temperature Limits			
Max. Process temp.	600°C	550°C	600°C
Min. Ambient temp.	-5°C	-10°C	-40°C
Max. Ambient temp.	50°C	50°C	50°C
dP Static Pressure			
Min. (mbarg)[1]	250	1000	5000
Max. (bar)	40.5	40.5	40.5

[1] At maximum process temperature

DESIGNED FOR THERMOSOLAR & CSP

Accuracy and Other Specifications

The table below presents the accuracy specifications of GP and dP HTDS, as well as the temperature effects, and pressure details.

	GP	dP
Min. span required	1000 mbar	250 mbar
Transmitter min. overpressure required	40 bar	40 bar
Accuracy[2]		
Span 250 mbar	-	2.0%
Span 500 mbar	-	1.0%
Span >1000 mbar		
0-25%	2.0%	1.5%[3]
25-100%	0.5%	0.5%[3]
Temperature effect		
Process temp.	3.21 mbar/10ºC	0.64 mbar/10ºC
Ambient temp. /mtr cap.	1.68 mbar/10ºC	0.34 mbar/10ºC
Transmitter	0.65 mbar/10ºC	0.13 mbar/10ºC
Capillary length	1-15 mtr	1-15 mtr

[2] Calibrated at nominal value at 20ºC ambient temperature
[3] At minimal static pressure of 1 bar

Thermosolar Energy and Concentrating Solar Power Plant

Diaphragm Seal measurements are common in the thermosolar industry, especially the Concentrating Solar Power Plant (CSP). A CSP Plant produces electricity by using mirrors to concentrate sunlight onto receivers which produce steam to generate electricity. The CSP System consists of three major units:

1. Solar Field: Converts solar energy into thermal energy
2. Heat Storage: Stores thermal energy using molten salt as a heat storage medium
3. Power Block: Generates electricity through a steam turbine with steam produced by solar energy

Traditional technologies used in a fossil fuel power plant can be applied to the power block, which utilizes solar thermal energy instead of fossil fuel. Thermal energy storage is one of the most attractive aspects of CSP compared with other renewable energy resources, as it allows precise controllability and stability of electrical supply even during the hours of darkness. Conventional CSP is using traditional Diaphragm Seal technology with temperatures up to 400°C maximum. However, the Molten Salt Parabolic Trough CSP (MSPT-CSP) technology, can operate at temperatures up to 550° C by changing only the heat transfer fluid from hot-oil to molten salt. The merits of MSPT-CSP system are:

1. Higher steam temperature will achieve higher efficiency in power generation
2. Low costs due to less volume required for heat storage
3. Molten salt, used as both heat transfer fluid and heat storage medium, will allow for a more simplified plant design (oil-MS heat exchanger is not required)

The HTDS is perfectly suitable for these process conditions and makes it possible to measure pressure at these temperatures.

Badotherm Diaphragm Seal references - Thermosolar industry:
- Solnova I, III, IV (Abengoa Solar), Spain
- Solacor I, II (Abengoa / JGC), Spain
- Helioenergy I, II (Abengoa / AG Ingeneria), Spain

Badotherm HTDS references - Thermosolar industry:
- Sener - Planta Solar Termoeléctrica Gemasolar, Spain
- PSA - Plataforma Solar de Almeria, Spain (testing)
- Abengoa Solar, Spain (testing)
- Cobra - Crescent Dunes - Tonopah, USA (testing)
- Universidad de Madrid, Spain (testing)

Petrochemical industry

Also in the petrochemical industry, (design) process temperatures above 400°C are becoming more common. However, until now, no Diaphragm Seal fill fluid could withstand this constant high process temperature. Now, there is a solution with Badotherm High Temperature Diaphragm Seal. Many processes may operate below the 400°C, however design conditions may require withstanding a higher temperature. Also in these cases, the HTDS protects your measurement for non-frequent or unexpected higher temperatures.

Badotherm HTDS references - Petrochemical industry:

- Shell Chemicals, Netherlands
- British Petroleum (BP), Germany
- Chevron, Belgium
- Arkema, Malaysia

MEET HIGH DESIGN TEMPERATURES IN PETROCHEMICAL INDUSTRY

About Badotherm

We are a European manufacturer of mechanical process instruments with a worldwide distribution network. We have regional Diaphragm Seal assembly facilities in Europe, the Middle East, India, the Far East and the Americas. We design, engineer and manufacture Diaphragm Seals, Pressure Gauges, Temperature Gauges and Thermowells, Instrument Valves and Manifolds. Next to our product offering, we develop tailor-made solutions for challenging conditions in the field of Diaphragm Seal measurements. Headquartered in the Netherlands, we employ over 225 people in seven different countries.

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