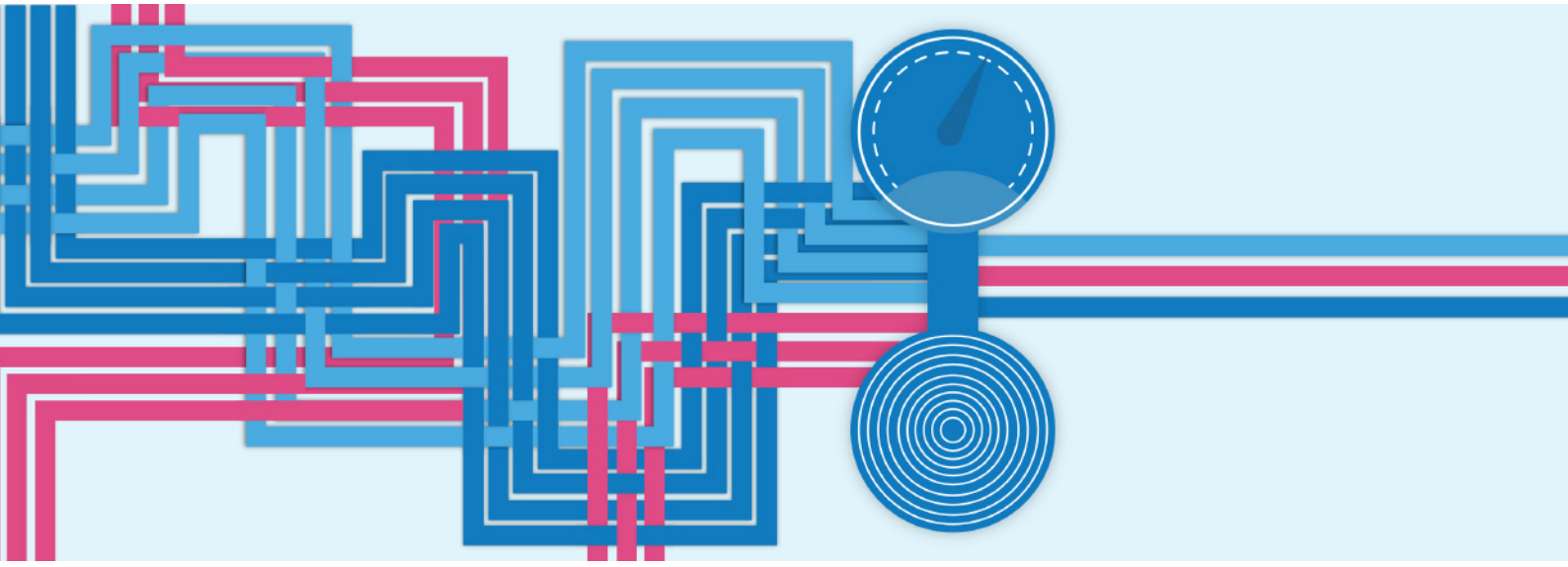
BADOTHERM®



Badotherm: Diaphragm Seal Solutions

HTDS – High Temperature Diaphragm Seal suitable for Pressure Measurement up to 600°C

It is a recognised phenomenon in the process industry that higher process pressure and temperature can improve the overall efficiency of the process. When measuring with a transmitter with Diaphragm Seals the temperature limit of Diaphragm Seal applications is currently set to 420°C, as this is the maximum permitted temperature of the filling fluid. Specifically for the thermosolar industry for molten salt applications, Badotherm developed a Diaphragm Seal that can withstand process temperature up to 600°C.

HTDS – High Temperature Diaphragm Seal suitable for Pressure Measurement up to 600°C

CSP with Molten Salt Heat Storage

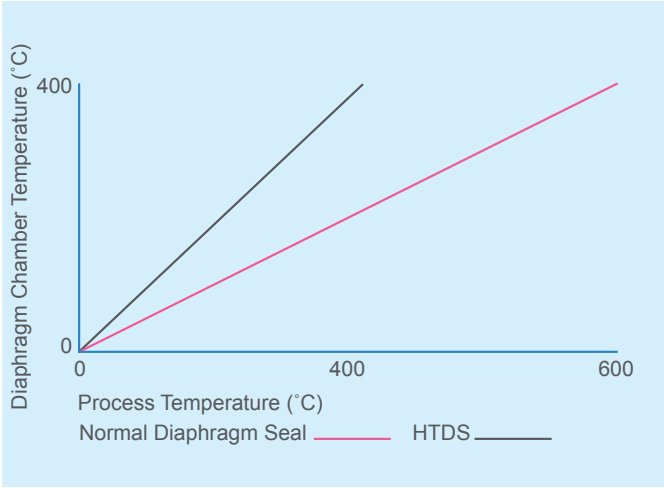
Concentrating Solar Power plant (CSP) produces electricity by using mirrors to concentrate sunlight onto receivers, which produce steam to generate electricity. Traditional technologies used in a fossil fuel power plant can be applied to the power block, which utilizes solar thermal energy instead of fossil fuel. Most renewable technologies suffer from a discontinuous energy supply and an unpredictable output due to altering weather conditions and/or energy demands. CSP plants, equipped with a **Molten Salts** Storage System, store excess heat and stay operational also during evening hours and cloudy days, which significantly increases their electricity output. However, the Molten Salt Parabolic Trough CSP technology, can operate at temperatures up to 550° C by changing only the heat transfer fluid from hot oil to molten salt. A higher steam temperature will achieve higher efficiency in power generation, and at lower costs due to less volume required for heat storage. Additionally, molten salt, used as both heat transfer fluid and heat storage medium, will allow for a more simplified plant design as the oil-MS heat exchanger is not required.

Diaphragm Seal measurements are common in the thermosolar industry. However, for Molten Salt heat storage, the operating temperature was around 550°C. This gave a huge challenge as fill fluids technology did not go above 420°C.

Typical CSP central receiver -power tower- technology.

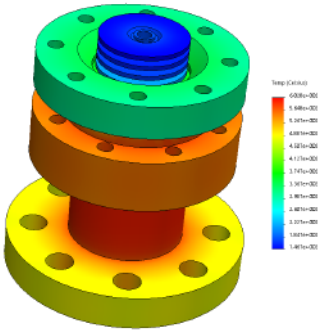
Solution Developed

Badotherm has developed a Diaphragm Seal that can withstand process temperatures of up to 600°C. To enable a proper functioning of the Diaphragm Seal at these extreme process temperatures, a revolutionary new design and principle is used. Badotherm has a Patent on the High Temperature Diaphragm Seal (HTDS).



Temperature comparison HTDS and standard Diaphragm Seal.

The new High Temperature Diaphragm Seal (HTDS) has been extensively tested in different circumstances and with various process temperatures. The graph presents the temperature reduction measured in the diaphragm chamber of the HTDS in comparison to a normal Diaphragm Seal. The HTDS is suitable for both gauge and differential pressure transmitters.



3D simulation and testing HTDS.

Advantages of the HTDS

One of the major advantages of the HTDS is that the installation is similar to a standard Diaphragm Seal. The direct mounting on the process, reduces the chance for clogging and give accurate process information. Workarounds such as cooling towers influences the conditions at the sensing element and the final pressure measurement may not reflect as accurate what is going on in the process as opposed to the HTDS. Still, the cooling tower creating the risk that process temperature is reaching the diaphragm seal hence destroying the fill fluid with maximum limit of 400°C. Cooling towers also are prone to clogging, as often a small hole of 3,5 mm is. The HTDS also reduces the chance for possible air inclusion, which is more common in the pipe.

For Molten Salt applications, often the Diaphragm Seal is insulated at a certain temperature to keep the salt molten. Please consult Badotherm for specific insulation recommendation for the HTDS.

Temperature and Static Pressure Limits

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

	BSO-48	BSO-42	BSO-02
Temperature Limits			
Max. Process temp.	600°C	550°C	600°C
Min. Ambient temp.	-20°C	10°C	-40°C
Max. Ambient temp.	50°C	50°C	50°C
dP Static Pressure			
Min. (mbar)*	250	1000	13700
Max. (bar)	40.5	40.5	40.5

** Minimum pressure at maximum operating temperature.*

Note: optional vacuum protection, but vacuum cannot be measured.

Technical 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*		
Span 250 mbar	-	2.0%
Span 500 mbar	-	1.0%
Span >1000 mbar		
0-25%	2.0%	1.5%**
25-100%	0.5%	0.5%**
Temperature effect Δ10°C		
Process temp.	3.21 mbar	0.64 mbar
Ambient temp. /mtr cap.	1.68 mbar	0.34 mbar
Transmitter	0.65 mbar	0.13 mbar
Capillary length	**1-15 mtr**	**1-15 mtr**

* Calibrated at nominal value at 20°C ambient temperature.

** At minimal static pressure of 1 bar.

Example: HTDS mounted to a Yokogawa EJA-E 530.