Capillary lines –Tube, armor and protective sleeve

Description

A capillary line is typically used to connect the diaphragm seal remote with the pressure instrument. It allows the separation between the measuring instrument, such as a pressure gauge or transmitter, with the process connection. A capillary is typically built up from a tube, an armor and optionally a protective sleeve.

Tube material

Badotherm capillaries always consist of a tube and an armor. The capillary is a non-wetted part, and standard tube material is TP316L (UNS S31603). Optionally, capillary tube in Alloy 400 (UNS N04400) could be offered.

Tube sizes & weight

For the optimal performance of the applications Badotherm has following diameters of capillary tube.

- Standard : ID 2mm ID (OD = 4.00m; t = 1.00mm)
- Option 1 : ID 1mm ID (OD = 3.00mm t =1.00mm)
- Option 2 : ID 0.7mm (OD = 3.17mm; t = 1.24mm)

The performance of the seal application is impacted with the ID selection, thus are impacting response times or TPE.

The average weight of 1 meter capillary is 0.15 kg.

Pressure information

Capillary Badotherm uses is a seamless small diameter tube. The allowable working pressures are calculated from an allowable stress value for ASTM A269 tubes as listed in the tables of the standards. Values are based on equations from ASME B31.3 and values from BVPC section IID.

Tube size (OD x t)	ID	MAOP	Burst pressure*1	Material
4 x 1 mm	2 mm	690 bar	2800 bar	TP316L
3 x 1 mm	1 mm	921 bar	3800 bar	TP316L
3 x 1 mm	1 mm	900 bar	3800 bar	Alloy 400
3.17 x 1.24	0.7 mm	1046 bar	4600 bar	TP316L

1: Determined by batch testing of capillary.

Testing

A pressure test is performed to determine the product integrity and fabrication quality of the product. This test is performed as a part of the production process to ensure the safety and quality standards. These standards are internal quality standards as well as international standards such as ISO, ASME, EN, and API.

Figure: Typical capillary with armor and black protective sleeve.

Armor material

The two main reasons for the armor is mechanical protection and the extra layer of natural insulation (being air) it provides to the capillary tube, technology taken from gas-filled thermometers. Badotherm uses doubled shielded armor (sometimes called goose neck). This means that there is a double layer that gives the advantages of being stronger when it is accidentally lift on the armor and dirt can enter more difficult. The standard material of the armor is AISI 304, but optional AISI 316 can be selected.

Armor type	OD
Standard AISI 304/316	8 mm
Black /White protective sleeve	10 mm

Protective sleeve material

Additionally, the armour could be protected by a PVC sleeve. Sometimes customers wish to protect additionally against dust and water ingress and possibly corrosive ambient. We have this available in several options. All are options are flame retardant.

	Black	White	White
Colour	Black	White	White
Material	PVC	Polyofin	PVC
Amb. temp range	-30°C … 90°C		
Flame retardant	•	•	UL94-V0
ATEX			•

Considerations with capillaries

- Using a capillary line on a mechanical gauge typically requires the use of a gauge support and gauge adaptor or some other form of surface mount.
- Capillary lines have excellent function for cooling down of process temperature changes. However, the warming through of the process media temperature have an effect on the fill liquid inside the capillary tube to either expand or contract, changing the volume of the fluid. This creates an error in the pressure reading as a function of the total volume of the tubing, pressure instrument and diaphragm seal.
- Process temperature effect: relates to the process temperature effect on the diaphragm seal and (the initial part) of the fill fluid in the capillary through heat transfer.
- Ambient Temperature effect: includes seal temperature effect and am temperature effect. Seal temperature effect relates to the pressure produced on the diaphragm when the temperature changes. The pressure is correlated to an expansion or contraction of the fill fluid in the capillary. Hence it is recommended to reduce
- Mounting temperature effect relates to changes in the weight of the capillary fill fluid caused by density variation correlating to ambient temperatures producing pressure on the diaphragm.
- Mounting effect: A level difference between the pressure instrument and diaphragm seal (common with the use of a capillary line) creates a pressure indication error. However, a known level difference can be compensated for during the calibration of the diaphragm seal assembly.

Note

- Badotherm capillaries are always welded, both to the diaphragm seal as to the instrument, to prevent the chance of leakage. Also, it prevents it can be dismantled and fill fluid can go out.