DICKOW PUMPEN

mag-safe

Monitoring device for magnetic coupled pumps

Temperature rise in sealless magnetic driven pumps

In sealless pumps with magnetic couplings and metallic containment shells, eddy currents are generated which lead to heat and cause temperature rise of the pumped liquid inside the containment shell. In order to prevent inadmissible temperature rise, this heat must be dissipated through an internal cooling flow.

However, below minimum flow, the temperature will rise remarkably.

Dry running is the worst of these flow related conditions. The heat built up in the containment shell can cause temperature rise of more than 200°C (392°F) within seconds, this can cause the magnets to demagnetize if the temperature is not reliably monitored.

Sleeve bearing, allowable temperature

Sealless pumps require sleeve bearings which work in the pumped liquid. The sleeve bearing material in DICKOW-pumps is Silicon Carbide with diamond like carbon coating, providing dry running capability. The widely used term "process lubricated bearing" is not quite correct, since many pumped fluids (e.g. LPG) have no lubrication abilities.

Similar to the situation between the faces of mechanical seals, a stable fluid film is required between the slide faces. If temperature rise in the magnet end causes vaporization of the pumped liquid, this fluid film breaks down and the sleeve bearing runs dry and fails sooner or later. Although, the DLC coating can accept dry running in an empty pump because no hydraulic loads are acting, it cannot save the bearings if dry running occurs under upset operating conditions. Only a reliable temperature monitoring can avoid such upset conditions. When handling volatile liquids, the relation between temperature and pressure in the magnet end and the boiling point of the liquid should be considered in any case.

PT100 - temperature probes

The most common temperature monitoring systems are PT100-elements. The disadvantage of these elements is the location outside of the magnets.

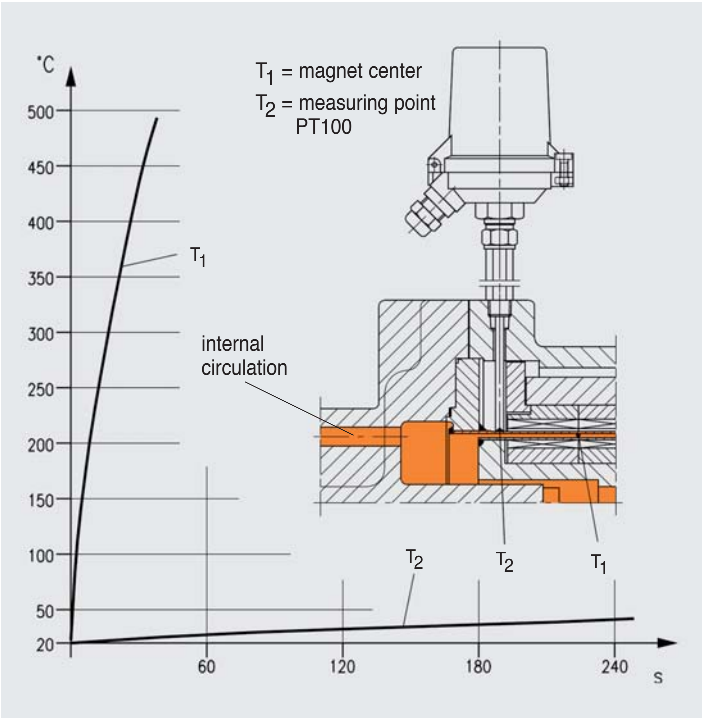
This is proved by the test results shown in the graph below. The graph shows the temperature rise (T_2) at the PT100 and the temperature rise (T_1) in the center of the magnets during dry running of a pump over a period of 4 minutes.

In the center of the magnets the temperature rises very fast and can reach, depending on the magnetic losses, 450 – 500°C (840 – 930°F) already after 30 seconds. The temperature reading at the PT100 after 4 minutes is 40°C (105°F) only.

These results prove that the PT100-probe cannot act as a dry running protection.

To obtain reliable readings from the PT100-probe, the pump must be vented respectively properly filled with pumped liquid and the internal circulation flow must transport the heat from the magnet center to the measuring spot of the PT100. This is provided in our NM-pumps with circulation from discharge to discharge by rotor back vanes and the PT100 located at the return of the internal cooling flow (after passing the magnet area).

Problems with temperature rise can also occur through unreliable temperature reading of the PT100 in pumps with cooling flow circulation from discharge to suction, or in case of decoupled magnets and starved cooling flow.

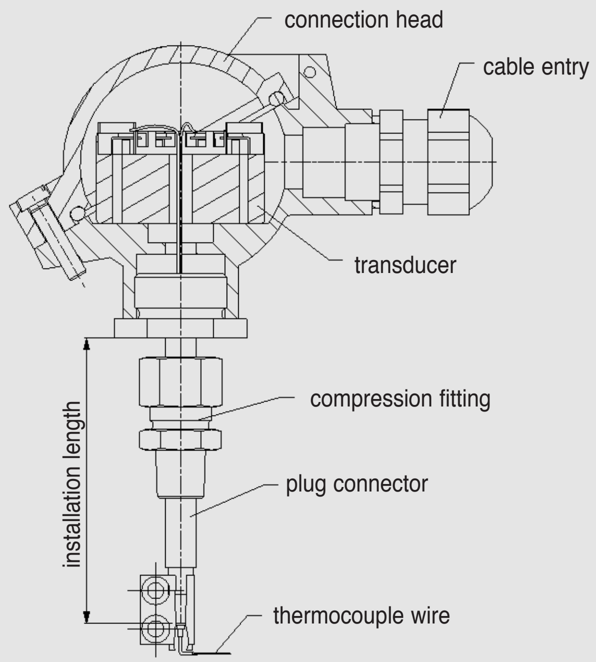


Working principle

The mag-safe is developed and designed for monitoring DICKOW-sealless pumps with metallic containment shells and preventing serious pump failures. The mag-safe system is patented, Pat.No. 0610562.
The Ni-thermocouple wire is spot-welded to the containment shell surface and forms a thermocouple.

Contrary to the PT100, the mag-safe reads the temperature in the center of the magnets between shell and magnets direct at the heat source. Temperature changes in the thermocouple generate voltage changes. The transducer converts these changes into a linear output signal of 4 to 20 mA. This gives the possibility to set any shut-off temperature within the range of -50 to +300 °C (-60 to +570 °F).

Design



Advantages / protective function

<table>
<tr><th>problem</th><th>symptoms</th><th>possible affects</th><th>protection through mag-safe</th></tr>
<tr><td>dry running</td><td rowspan="5">temperature rise, hot containment shell surface</td><td>damage of sleeve bearings, demagnetization of the magnets</td><td rowspan="5">alarm or immediate shut-off if the allowable temperature limit is exceeded</td></tr>
<tr><td>closed discharge valve, clogged circulation channels, operation below minimum flow</td><td rowspan="2"><u>volatile liquids:</u>
vaporization of liquid in sleeve bearing area,
failure of bearings through dry run

<u>non-volatile liquids:</u>
demagnetization of magnets through overheat</td></tr>
<tr><td>decoupled magnets</td></tr>
<tr><td>dry running through exceeded boiling point in containment shell area</td><td>vaporization of liquid in sleeve bearing area,
failure of bearings through dry run</td></tr>
<tr><td>solids/sediments between rotor and containment shell</td><td>rupture of the containment shell, leakage</td></tr>
<tr><td>worn out antifriction bearings</td><td>increased vibrations and noise level</td><td>rupture of the containment shell through rubbing of drive rotor</td><td>shut-off when connection wire is cut</td></tr>
</table>

The mag-safe is highly recommended for handling boiling liquids, for liquids which tend to polymerize if a certain temperature is exceeded and for service conditions where no monitoring of antifriction bearings is provided.

Technical data

The **mag-safe** is - according to DIN EN 50020 chapter 5.4 - a simple electrical equipment and is not subject to the EU-Directive 94/9/EG.

Measuring range:	-50 °C up to +300 °C
Minimum speed pump:	> 300 min^{-1}; lower speeds will lead to heavy fluctuating temperature indications (> 10K) resp. mA-signals.
Ambient temperature:	-40 °C up to +75 °C
Protection class:	IP65

Transducer

Classification:	Exia IIC T5 / T6, ATEX II 1G
Type-examination-certificate:	TÜV 07 ATEX 347151 X

Cable entry

Material:	Brass nickel-plated ; gasket EPDM, clamping cage polyamide
Classification:	Ex II 2G Exe II
Type-examination-certificate:	PTB 04 ATEX 1112 X

Connection head

Material:	Aluminium-diecasting ; magnesium content ≤ 3%

Thermocouple

The thermocouple on which the measurement is based, consists of containment shell material 1.4571 or 2.4610 and of alloyed standard wire nickel / copper.

Temperature / voltage output signal

input [mV]	output [mA]	temperature [°C]
-3,150	4,00	-50
-2,700	4,46	-40
-2,250	4,91	-30
-1,800	5,37	-20
-1,350	5,83	-10
-0,900	6,29	0
-0,450	6,74	10
0,000	7,20	20
0,450	7,66	30
0,900	8,12	40
1,350	8,57	50
1,800	9,03	60
2,250	9,49	70
2,700	9,94	80
3,150	10,40	90
3,600	10,86	100
4,050	11,32	110
4,500	11,77	120

input [mV]	output [mA]	temperature [°C]
4,950	12,23	130
5,400	12,69	140
5,850	13,14	150
6,300	13,60	160
6,750	14,06	170
7,200	14,52	180
7,650	14,97	190
8,100	15,43	200
8,550	15,89	210
9,000	16,34	220
9,450	16,80	230
9,900	17,26	240
10,350	17,72	250
10,800	18,17	260
11,250	18,63	270
11,700	19,09	280
12,150	19,54	290
12,600	20,00	300

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