ATC-Technology

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1 Conventional diaphragm seal systems

Diaphragm seals are used to protect measuring devices from aggressive media or to create a seamless process connection. The process is separated from the measuring device by means of a thin metal diaphragm. A pressure transmission fluid behind the diaphragm transmits the process pressure to the actual pressure sensor.

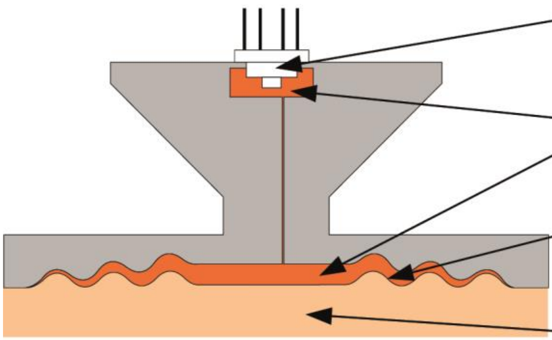

Abb. 1 Diaphragm seal principle

A drawback is that the diaphragm seal is not completely non-reactive. The pressure transmission fluid expands as a result of the process heat and deflects the separating diaphragm. This generates a restoring force depending on the rigidity of the diaphragm as such, which is received as an error in the pressure measurement.

The magnitude of the restoring force is crucially dependent on the thickness, diameter and contours of the diaphragm. The diaphragm must have a certain minimum thickness because of the mechanical resistance required. The limits of what is feasible are quickly reached especially with small diaphragm seals. It is therefore necessary to use an appropriately sized diaphragm seal for critical pressure measurements to ensure that the error caused by process temperature changes remains acceptable.

2 ATC Technology

The ATC technology (ATC = **A**ctive **T**emperature **C**ompensation) drastically reduces this temperature error. The temperature of the pressure transmission fluid is recorded with an additional temperature sensor. This sensor (a Pt100 element) is positioned as close as possible to the separating diaphragm. The sensor thus records the temperature of the oil cushion behind the separating diaphragm with good accuracy.

The temperature of the pressure sensor is also recorded as there is also a significant amount of the pressure transmission fluid around the pressure sensor.

Knowing these two temperatures allows calculating the error caused by the influence of the process temperature and correcting the pressure measurement accordingly.

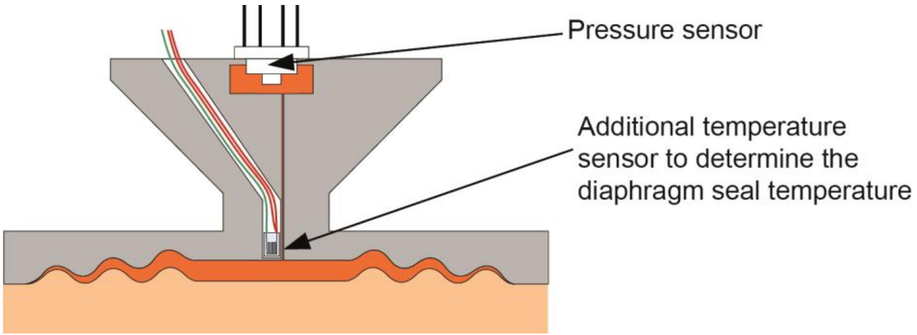

Fig. 2 Positioning of the additional temperature sensor in the diaphragm seal

3 Schematic process

The graphics below show a schematic diagram of the behaviour of a diaphragm seal system. A conventional system without error compensation responds to a jump in temperature with an increase in the pressure signal up to the stationary state in which the complete device is heated. In a device with ATC technology, the compensation takes effect as soon as the temperature reaches the Pt100 element behind the separating diaphragm to then dampen the increase. Theoretically the temperature error can be completely compensated once the stationary state is reached.

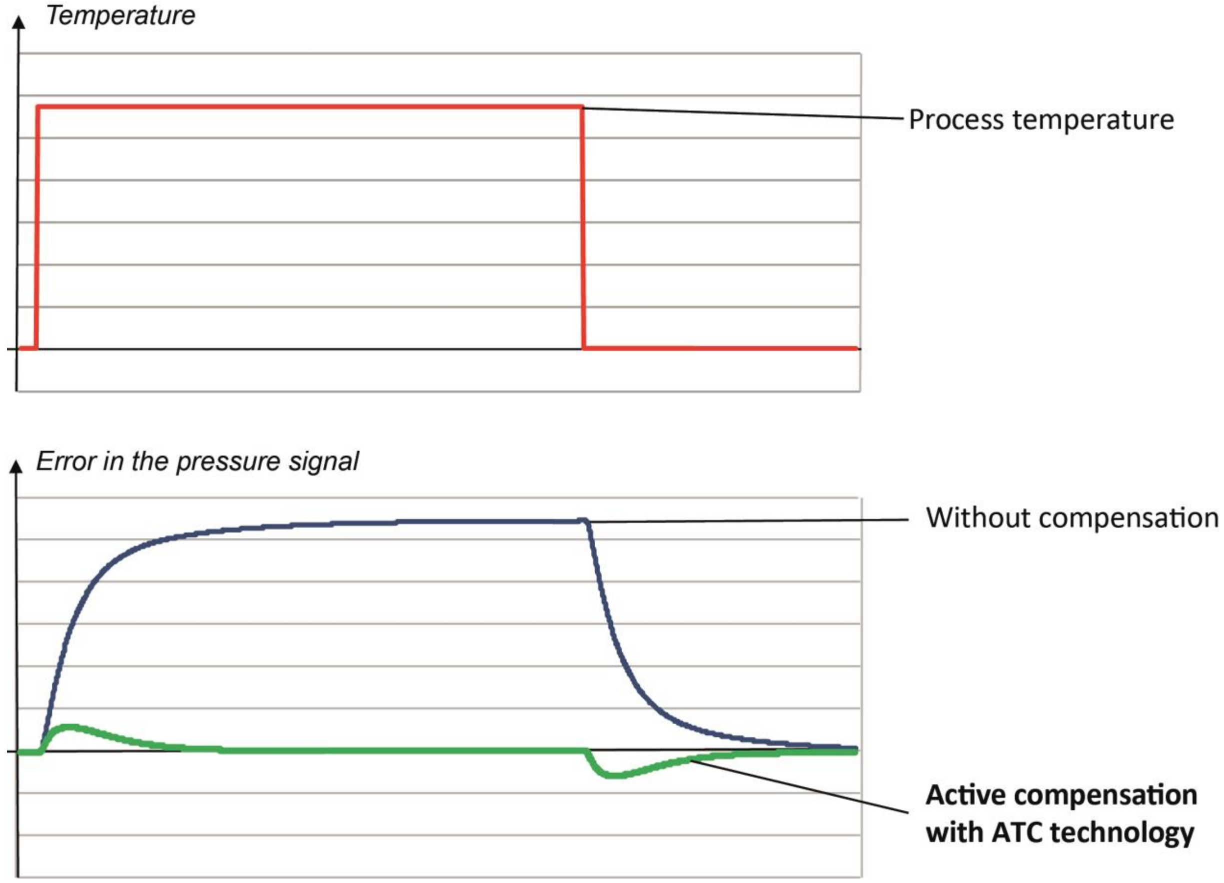

Fig. 3 Schematic comparison of a conventional system / system with ATC

4 Determining correction factors

Correction factors, which are stored in the device, can be calculated from the properties of the diaphragm seal system, such as the diaphragm rigidity, internal volume and the temperature expansion of the pressure transfer fluid. These factors are used to correct the pressure measurement caused by the undesired influence of the temperature. A reduction of the error by up to 80% (stationary state) can be achieved in this way. This means that the temperature error of the diaphragm seal with ATC is only a fifth of the error without ATC.

Individual correction factors for the diaphragm seal system can be determined by a test measurement to further improve the correction. The error in the stationary state can thus be completely eliminated with the exception of the influences of the installation situation.

5 Application areas

Three factors determine whether it makes sense to use ATC technology: the measurement range, the diaphragm seal size and the temperatures occurring.

5.1 Measurement ranges

The pressure transmitter error is dependent on its nominal range (expressed as a percentage of the nominal range). However, the diaphragm seal error caused by the temperature influence is an absolute error (expressed in mbar/10K).

ATC technology is therefore the more effective the smaller the measurement range is.

5.2 Diaphragm seal size

The smaller the diaphragm surface of a diaphragm seal, the larger the temperature error. A reduction in the surface area even leads to a disproportionate increase in the error. ATC technology is therefore particularly recommended for small diaphragm seals. Conversely, it is hard to improve the temperature error that is already very low with large diaphragm seals.

5.3 Temperature differences

The temperature error of a diaphragm seal is proportional to the difference between the process and ambient temperature.

No temperature-related error occurs if the temperature in the process is roughly the same as the ambient temperature. Conversely, high temperature differences lead to high temperature errors.

6 Example of an application

The example of a real measurement with individual correction factors shows the potential of ATC technology. A level measurement was simulated with a temperature-controlled water tank. The correction factors were determined for a very small diaphragm seal (3/4" clamp) and then a temperature ramp was run.

The temperature error was almost completely eliminated in its stationary state. There were minimal deviations from the nominal value during the heating and cooling phases.

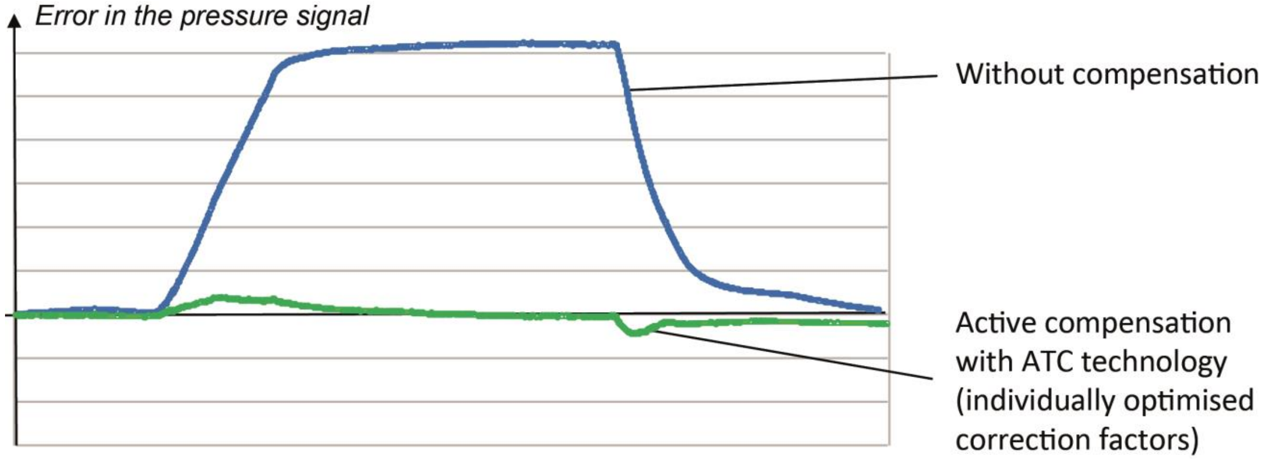

Fig. 4 Test measurement, comparison uncompensated with ATC compensation