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Technical Note #8

Orientation Effect In Low-Range Pressure Transducers

When selecting a pressure transducer, knowing as much as you can about the application is critical so as to provide the best device to meet your accuracy requirements. In a low-pressure measurement application, the orientation of, or the acceleration on the transducer can affect the results being measured.

There are many different types of sensor technologies used in pressure transducers: Piezoresistive silicone sensors and Bonded Foil Strain Gauge are very common types. Many times, it is possible to utilize either of these sensor technologies for the same application. However, the required measuring range of the device and application criteria affect which technology is best utilized. Bonded Foil Strain Gauge (BFSG) is typically used at higher pressure levels, normally from 500 PSI and above. Since this Tech Note is concentrating on orientation effects in low-range pressure transducers, we will look more closely at Piezoresistive silicone sensors.

Typically for a Piezoresistive design, the measuring cell (as noted in Fig 1a) is surrounded by a small volume of oil with very low viscosity. Normally, this is Silicone oil, but alternate oil fills may be used. For example, Fomblin oil is the preferred option in O_2 applications. This oil fill is separated from the process media by a metal foil diaphragm, such as 316L SST, Hastelloy or Titanium. See Figure 1 for additional details.

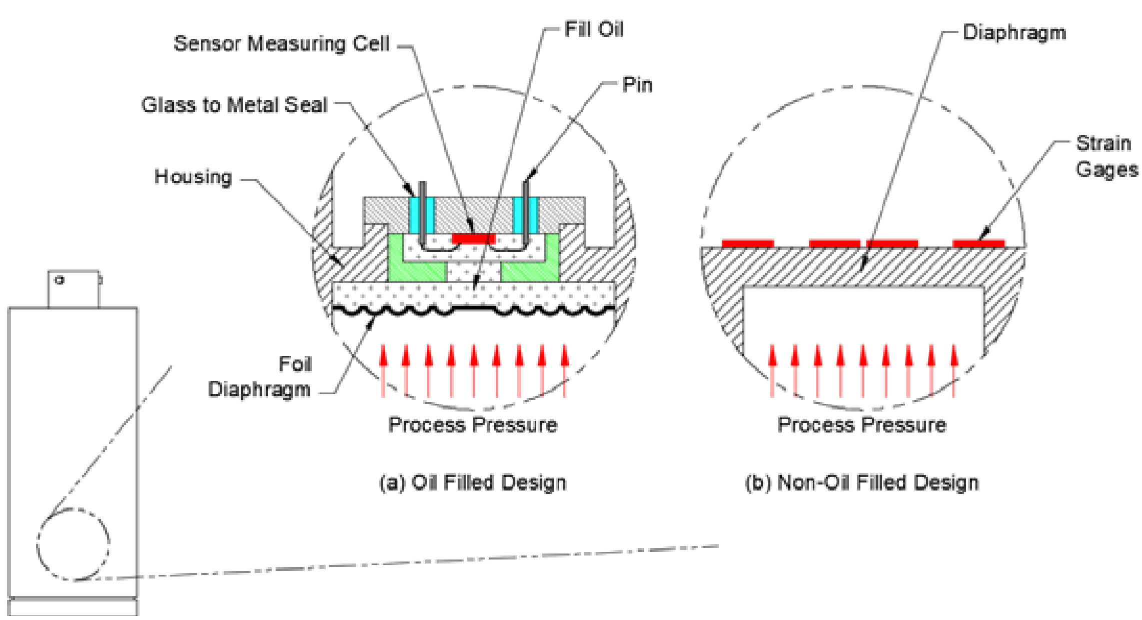

Figure 1: Generic representation of Pressure Sensor Configurations

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Orientation & Acceleration Effect

As Process Pressure is applied to the foil Diaphragm, the pressure load is transmitted to the Oil which is then transmitted to the Measuring Cell which generates the sensor output. During calibration of this type of device, the unit is mounted vertical, with the process port facing down and electrical connector facing up.

The weight of the oil can affect the sensors output if the orientation of the sensor is changed due to gravity. This is especially true for sensors with very low measuring ranges which are more sensitive to acceleration / orientation.

For example, in the normal vertical calibration position, the oil is being pulled by gravity away from the Measuring Cell. If the transducer is flipped over 180° with the process port now facing up and the electrical connector down, the weight of the oil fill is now being pulled onto the Measuring Cell due to gravity, seemingly adding pressure to the measurement.

In order to negate these orientation effects, a non-oil filled sensor would be selected, especially in applications wherea the orientation of the transducer cannot and will not remain fixed.

To evaluate the affects of orientation and acceleration on an Oil Filled sensor, a vibration test was performed using a 0 – 2 PSID differential style sensor. The vibration test was performed in both the perpendicular and parallel test directions relative to the face of the foil diaphragm with the sensor in a “Filled” and “Non-Filled” condition (the “Non-Filled” condition was generated by carefully removing the foil diaphragm allowing the oil to drain from the chamber). (This 1 g vibration / acceleration test simulates the same effect as rotating the sensor 180° from the sensor’s calibration orientation.)

The worst-case maximum shift was measured as 0.13% FSO/g for the Oil Filled sensor, which was approximately 65X greater than the “Non-Filled” sensor configuration.

It is also noted that in a microgravity environment, acceleration or orientation effect on an oil filled sensor is negligible. In qualified 1 PSID Oil Filled sensors on a flight to the International Space Station, the transducer showed negligible affect on the output due to acceleration.

The above affects only apply on low range oil filled pressure transducers. Orientation or acceleration effects on Oil Filled sensor designs whose pressure ranges are greater than 5 psi are considered negligible.