Whitepaper

How to Select Differential Pressure Transducers

For Low Differential, Critical Pressure Applications
PART 2 of 2

WWW.TEESING.COM

OVERVIEW

System manufacturers are providing the highest quality, most reliable and most energy efficient automobiles, airplanes, turbine and gas engines, and associated components ever produced. This is due in large part to the manufacturers' ever increasing demand for rigorous test and measurement of these products. Differential pressure transducers are an integral part of that process for applications that demand reliability, repeatability and high accuracy.

Differential pressure transducers are commonly used in test stands, wind tunnels, leak detection systems and other applications. Engineers for each application look for transducer improvements important to their industry.

The performance of today's differential pressure transducers has improved to provide solutions to demanding applications. This paper discusses six characteristics and considerations to note when selecting a pressure transducer for low differential, critical pressure applications.

Sections in this whitepaper include:

- Orientation Effect
- Vibration
- Overpressure Protection
- Line Pressure Effect
- Response Time
- Other considerations

CONTENT

Sections

1. Orientation Effect

Improper installation, vibration or even system maintenance can cause a transducer to change orientation. This is known as the orientation effect, which has traditionally been a problem for other types of sensing technologies. Even a properly installed unit will have marginal gravity effect. Here's why: a unit rotated 180 degrees has gone from positive to negative gravity, causing a change in force of 2 G's. In that case the sensor can't distinguish between the weight put on it through gravity from the force that is applied through the pressure ports. Consequently, it will combine the gravitational weight effect with the port pressure and send a false signal.

The orientation effect can be considerably worse in rotated units that have their sensors filled with silicone oil or some other isolation fluid. Those units have the weight of both the diaphragm as well as the fluid fill, acting on the sensor. Again, the unit cannot establish the true pressure and will emit an erroneous value with changes in position.

Fortunately, some transducers have capacitance diaphragms that are, thin, of very little mass, and have no fluid fill which make them minimally affected by gravity. Therefore, these units can be mounted in any orientation with confidence that that they will deliver highly reliable measurements. This is especially true for installations where space is at a premium. For optimal installation, the unit should be mounted in the same orientation in which it was calibrated. For instance, if it was factory calibrated in the vertical position with the pressure port downward, it is advisable to orient it this way in the field to minimize the orientation effect. When this is not possible, the minimal zero offset shift can be compensated for by manually adjusting the zero offset on the sensor or through a secure calibration key.

2. Vibration

Similarly, low-frequency vibrations transmitted from a nearby motor or fan can influence an otherwise properly oriented sensor. For example, the fluid in an oil-filled sensor may pick up low frequency vibration and transmit an inertial load the diaphragm, which is incorrectly interpreted as changing process pressure.

To avoid this vibration effect, end users may need to mount transducers in remote, quiet areas. Likewise, if the reference port is vented, it needs to be channeled to an area without acoustic vibration noise or wind. In the case of a wind tunnel, a pitot-static tube is mounted such that both pressure ports are connected to a remotely mounted transducer by flexible or semi-flexible tubing to prevent turbulent air noise or mechanical vibration from being transferred to the sensor

Engineers may consider using a capacitor transducer design to minimize orientation and vibration issues by using a stretched stainless steel diaphragm that is not fluid filled. The only gravity effect it has is the weight of the diaphragm, which is not insignificant, but very small and is easily compensated for in the field.

3. Overpressure Protection

Overpressure and reverse pressure protection have been, and continue to be, premium issues with leak detection system manufacturers. These systems look for small leak rates in applications in which differential pressure is low and static pressure is very high. Leak detection manufacturers increasingly want to measure lower and lower leak rates. Because the leak rate is directly proportional to differential pressure, they want the ability to measure smaller and smaller differential pressures. To accomplish this requires increasing the static test pressure even higher.

Unfortunately, under these conditions of low differential pressure and very high static pressure, a unit that is accidentally over-pressured could require major recalibration or, more probably, be rendered useless. The same result applies if a gross leak occurs in the system being measured.

The latest generation of transducers has addressed these concerns. As a result, sensors are much more robust. They are considerably more tolerant of overpressure events in both positive (process) and negative (reference) directions. This is an important, new feature. Previously, sensors were protected only in the positive direction. But a leak in the reverse direction could cause an overpressure in the unit's reverse direction. Transducers with adequate protection in both directions are suitable for applications in which an unintentional overpressure event or a gross leak might occur. If it does, the transducer will continue to function.

Transducers can withstand occasional pressures up to their proof pressure rating, say 150 PSI, and then will return to their natural state. Beyond the proof pressure the diaphragm may become permanently deformed, causing the zero to shift. Pressures beyond the burst pressures of 300 PSI, for example, applied to either port will breach the containment chamber—a weld might fail, a seal might leak, or the diaphragm or case might rupture.

WWW.TEESING.COM

OEMs and applications engineers must be aware of the transducer's proof and burst pressure limitations. Furthermore, they must understand that their own system can be accidentally vented, or that a component of the tested device may not be leak tight, either of which could potentially damage the transducer. Accordingly, they should only use a small, rugged, stainless steel transducer with appropriate pressure protection in both directions that can withstand those unintended events.

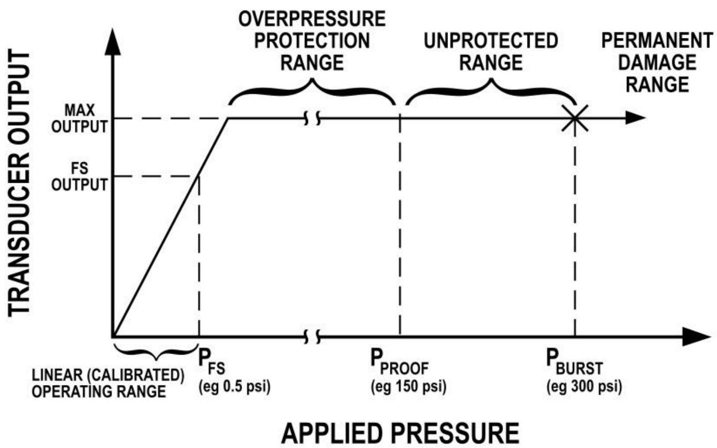

Diagram 11: Pressure Transducer Performance Limits

4. Line Pressure Effect

In addition to overpressure, changes in line pressure can be a concern, especially in leak detection applications where static line pressure is elevated. Line pressure is the absolute pressure applied to the transducer's ports. Some changes in static line pressure, however, can produce minor stress-induced variations to the sensor's geometry. These stresses in turn modify the unit's calibration response, affecting the zero and span of the transducer. The latest generation of sensors incorporates designs that significantly minimize the amount of stress that static pressure can apply to the sensing element. Look for a transducer with a low-pressure effect rating, such as 2% FS/100 PSIG.

Fortunately, errors due to line pressure can be easily corrected by recalibrating or re-zeroing the unit. This can be accomplished manually, by means of a potentiometer, or by using advanced models that have a small calibration key accessory with a digital display that mounts on the transducer for easy and secure calibration adjustments. Calibration key functions include reset trimming for zero, span, or recovering factory settings.

WWW.TEESING.COM

5. Response Time

Response time is another important factor, especially for pressure control and in wind tunnel applications. A transducer's response time—the time interval for the transducer to product the output signal in response to an applied pressure—is primarily determined by the technology in the unit's sensing element and its Electronics. Diaphragms that use capacitive sensing typically respond very quickly. They detect and measure pressure through the change in charge across a sensing capacitor, one plate of which is a diaphragm that deflects slightly with changes in applied pressure. The resulting change in capacitance is detected by the transducer's electronics, which linearizes, thermally compensates, conditions, and outputs a proportional, high-level signal.

The need for fast response time is dependent upon the application. For example, in wind tunnel events where dynamic air velocity changes are measured, the signal output from the transducer must change with the velocity, thus requiring a fast response time. A response time of 10-80 milliseconds is typically acceptable for most test stand, leak detection and wind tunnel applications. Response time is less critical for routine process and monitoring applications that usually respond in seconds versus milliseconds. When designing a system it is important to understand the response times required of a pressure transducer and faster is not always better. Sometimes a fast transducer can respond to short, unfiltered and undesirable system noise or turbulent pressure oscillations if the transducer response is too fast. In these cases, filtering the output signal will damp out these unwanted disturbances.

6. Other Considerations

It is also advisable to select a transducer with excellent long-term stability—its ability to retain performance characteristics for a relatively long time period, especially span stability. Usually, this will be less than 0.15% FS/Yr. This rating will be listed on the unit's specification sheet.

Also check the specification sheet to see if the transducer is CE and RoHS compliant. Having the CE mark means that the transducer meets the EU's consumer safety, health and environmental requirements. RoHS compliance designates that the unit is limited to the maximum allowable concentrations of six hazardous substances: lead, mercury, cadmium, hexavalent chromium, PBB, & PBDE.

Finally, find a supplier that offers transducers in multiple configurations. This allows end users the ability to work with one manufacturer that can provide different units with specific accuracies, resolutions and ranges that are ideal for their various applications.

System designers and manufacturers of test stand and leak detection systems, as well as application and sales engineers and distributors, are constantly searching for transducers with state-of-the-art features and capabilities to meet their difficult and challenging requirements. They can be confident that today's differential pressure transducers have high accuracy, abundant overpressure capability, low thermal error, excellent stability, high-line pressure capability, as well as rugged stainless steel construction. These features are constantly being improved upon by transducer suppliers through their ongoing research & development programs. These ever improving sensors help ensure that system manufacturers will continue to produce the highest-quality products.

About the Authors:
Gino Pinto is the Manager of R&D Engineering at Setra Systems Inc. where he has worked for over 17 years with primary responsibilities in research, design and new Product Development. With over 28 years of industry experience, Gino had also worked at successful start-up companies having since been acquired by Motorola, Goodrich Corp., and Gefran Inc. Gino received his Masters of Science in Mechanical Engineering and BSME from UMass Lowell and holds 9 US patents related to sensing devices.

Melanie Cavalieri is the Product Planner for Industrial Products at Setra Systems, Inc., She is responsible for new product development and marketing for Industrial, Refrigeration and Medical markets. Prior to entering the marketing role at Setra, Melanie worked in Quality and Manufacturing for Setra in Boxborough, MA and Kollmorgen Motors in Radford, VA. Melanie also has R&D experience at Kodak Versamark in Dayton, OH and Ethicon Endo-Surgery in Blue Ash, OH. Melanie has a Bachelor of Science in Mechanical Engineering from Purdue University.