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The Do's and Don'ts of Pressure Transducers

Abstract

When specifying a pressure transducer for a process measurement, a number of items have to be considered. Some of the more important ones are discussed in terms of the transducer itself as well as the overall measuring system. This information is user-oriented and serves as a practical guide in the selection and application of strain-gage pressure transducers.

Introduction

Over the years, bonded strain-gage pressure transducers have provided a convenient, accurate and reliable means of measuring fluid pressure.

The present day foil strain-gage is far more sophisticated than it's wire-gage ancestor. Going from wire to foil in the early 1950's brought about major improvements in overall transducer performance.

The improvement has been ongoing and today's strain-gage transducers are a far cry from the models built in the past. Significant advances have been made in many areas such as improved heat dissipation, better bonding techniques, superior adhesives, reduced creep and hysteresis effects and improved temperature compensation. The result is a transducer that is more accurate and reliable than other types.

Transducer

To better understand the do's and don'ts of pressure transducers, it's worthwhile taking a brief look at how they work.

The transducer is installed in the system by means of its pressure fitting, which can be either an internal or external threaded connection. The thread itself can be either a tapered pipe thread or a straight thread with an "O" ring or plug seal.

Once installed, the pressure is applied to the transducer causing a force-summing element to convert the pressure into a physical displacement. The force-summing element, which in most cases is a diaphragm, develops surface strains proportional to the pressure.

Strain-gage pressure transducers, by design, are rugged, accurate and stable. They are capable of operating in severe shock and vibration environments as well as a wide variety of electrical and pressure connections can be installed directly at the point of measurement.

Foil Strain-Gage

In order to utilize the pressure to strain relationship, foil strain-gages are bonded to the diaphragm and become the primary sensors. As such, they change resistance as a function of the diaphragm strain, which is, in turn, related to pressure.

The strain-gages, usually four (4) in number, are wired in series to form a Wheatstone Bridge. The bridge concept is used since it's the simplest and most accurate method conceived for measuring small resistance changes. With voltage applied to two (2) opposite corners of the bridge, an electrical output signal is developed proportional to the applied pressure. The output signal level is in millivolts per applied volt and is collected at the remaining two (2) corners of the bridge.

Transducer Signal

Because they can convert fluid pressure into an electrical signal, transducers are user friendly. The signal can be transmitted from the pressure sit to remote locations and used for specific control, monitoring and measurement purposes. They interface with data loggers, data acquisition systems, computers and readout instruments.

Strain-gage transducers are available in both low and high level outputs. The low level output for foil-gage transducers is a 3 mV/V or 30 millivolts at 10 VDC input. High level outputs are 5 VDC and 10 VDC at an input voltage of 24 to 32 VDC and 4-20mA at a 12 to 36 VDC input. For the digital world, the analog-to-digital (A/D) converter is used to translate the analog signal into digital bits.

Although we are talking about a rugged device, requiring virtually no maintenance, transducers are subject to misapplication and damage.

Proper application with knowledge of certain limitations, will assure long transducer life and high integrity performance.

Considerations

The factors that have to be considered in the care and feeding of transducers can be placed into the following categories:

1. Pressure Range

Transducers are designed to provide a specific electrical output for a given pressure range. This relationship is always given in the manufacturer's product specifications. In general, transducers are available in a number of discreet pressure ranges from 0-5 psi to 0-100,000 psi rated pressure. Many suppliers can provide some or all of the ranges in high level or low level electrical outputs.

In choosing a transducer, select a pressure range such that operating pressure is approximately 80% of full-scale. Also, select an electrical output level that is compatible with your system needs. If transducer cable runs exceed 100 feet, consider a high level unit if the environment is intolerant of low-level signals.

2. Pressure/Electrical Connections

All transducers require two connections, a mechanical pressure connection and an electrical connections. Since there are no industry standards established, you have to check the transducer manufacturer's data to determine the configuration he offers with his products.

Pressure fittings are normally made of stainless steel and designed to be leak-free within the operating parameters of the transducer.

The electrical termination on the transducer is usually a multi-pin connector or a cable. The connector usually has 6 pins for compatibility with 6 conductor cables assemblies that go from the transducer to the instrumentation.

Make certain that the transducer you select meets not only performance specifications, but properly mate with your electrical and mechanical connections. There is nothing more frustrating than purchasing a transducer and finding out that it doesn't fit in your standard pressure port.

The same is true of your electrical connection, which has added dimension. Not only must the connection be compatible with your system mechanically, it must also have the same wiring code for electrical pin-to-pin compatibility.

Pay attention to both the pressure and electrical interface.

3. Handling and Installation

A pressure transducer is a rugged device, built in to withstand rigors of the industrial world. It performs its task extremely well and requires very little attention once installed and operating. However, it is a precision measuring device and does require a certain amount of care to maintain its integrity.

During installation, take care not to damage the electrical connector. This is probably the most vulnerable part of the transducer. Denting the connector shell or bending a pin could put the unit out of commission.

Many high level transducers have zero and span adjustment access holes located on the transducer's connector plate. Make certain that these units are installed so the adjustments can be reached with a screwdriver.

The pressure fitting on the transducer is designed to properly secure the unit in place. Do tighten the transducer well to avoid the possibility of leaks. Proper tightening will not harm the transducer's performance and will assure leak-proof operation.

4. Media Compatibility

Because transducers are called upon to operate in a variety of pressure media, they must have some built-in protection against hostile fluids. This is accomplished by making the pressure-sensing end out of hardened stainless steel. 'In most cases, the material is 17-4 PH or 15-5 PH. To further enhance protection, the outer shell or cover is usually made from 303 or 304 stainless steel.

Corrosion of the transducer's diaphragm can change the output sensitivity and affect its structural strength. In almost all system applications, the media is never a problem and should not be of concern. However, if there is any doubt as to which material is best for a given situation, do consult the manufacturer.

5. System

To insure accuracy and reliability, attention has to be paid to the entire system. The transducer is one component in a system that typically includes cabling, signal conditioning, amplification and readout devices.

The largest sources of system error is the input wiring to the transducer. This error is due to noise generated by electrostatic coupling and inductive pickup (EMI/RFI)

The former generates noise due to coupling of the electric fields surrounding signal wires. This is brought about by the capacitance between individual conductors and between the conductors and ground. Capacitive coupling is more of a problem in longer cables because capacitance between conductors increased with cable length.

To eliminate these unwanted signals, use shielded cable and ground only on one end of the shield. Do not ground both ends, or it will become a signal conductor, capacitively coupled to the measured signal.

Motors, power lines, transformers and similar sources generate electro-magnetic fields, which can be picked up inductively. These strong magnetic fields are a source of noise, which can induce signal errors.

Using twisted pairs will effectively cancel the noise due to inductive pickup. In those cases where a low signal level cable is close to high voltage cables, the low level cable can be run in a metal conduit.

The problems caused by grounds are probably the least understood and may well be the most troublesome of all sources of noise. To help minimize grounding problems, a signal circuit should be grounded in one (1) place only. The difference in potential between multiple ground points can cause circulating currents and as a consequence generate noise. A high level of system isolation will keep ground effects to a minimum if all else fails.

As a final note, all electrical interconnects between system components should be properly mated, cleaned and have the highest integrity. More problems are solved in the field by merely tightening a loose transducer connector.

This should serves a s practical guide on selecting and using pressure transducers. Since it can't cover all of your questions, consult directly with the transducer supplier for his advice and help.

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