Overview of pressure measurement

Areej

Pressure Measurement

Pressure Transmitters

Pressure is one of the most common properties to detect. We frequently sense differential pressure to determine fluid flow, liquid level, and equipment performance. Pressure transmitters can be designed to measure absolute pressure or gauge pressure. All sensors will sense pressure above atmospheric. Most, but not all, will measure pressure below atmospheric (a partial vacuum). Most sensors may be used to measure static pressures as well as dynamic pressures. Pressure sensing and signal transmission is accomplished in a number of ways. A basic knowledge of the types of sensors available will allow one to properly select a pressure sensor for a given application.Table lists the type of pressure sensors available and a typical application rage.in this session we are gonna discuss about an overview of pressure measurement

To know about Basics of Pressure Scales click the link below

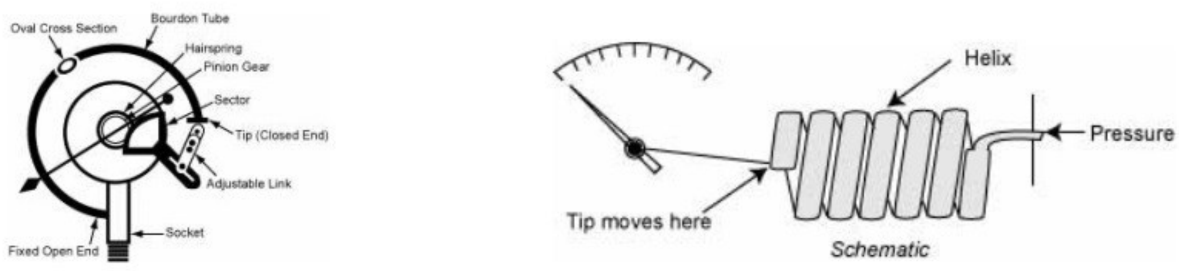
https://automationforum.co/basics-pressure-scales/

Type	*Vacuum Range*	*Pressure Range*	*Typical Accuracy*	*Additional Errors*
Strain gage	1 mm Hga to -10 in w.g.	+3 in w.g. to 10^6 psi	0.1% span to 0.3% FSO	0.25% FSO Drift over 6 months 0.25% FSO per 1000 F
Capacitive	300 mm Hga to -1 in w.g	+5 in w.g. to 10^4 psi	0.1% reading or 0.01% FSO	0.25% FSO per 1000 F
Potentiometric	-200 in w.g. To -1 in w.g.	+5 in w.g. To 10^4 psi	0.5% to 1.0% FSO	Subject to mechanical wear and temperature drift
Vibrating Wire	1 mm Hg to -2 in w.g.	+5 in w.g. to 10^4 psi	0.1% span	0.1% span over 6 months 0.2% span per 1000 F
Piezoelectric	N/A	+10 in w.g. to 10^4 psi	1% FSO	1% FSO per 1000 F Not for use with Static Pressures
Magnetic	-200 in w.g. to -1 in w.g.	+1 in w.g. to 10^4 psi	0.5% FSO	2% FSO per 1000 F Susceptible to stray magnetic fields
Optical	N/A	+1 in w.g. to 10^6 psi	0.1% FSO	Highly stable Not suitable for industrial use

Application Range for Pressure Transmitters

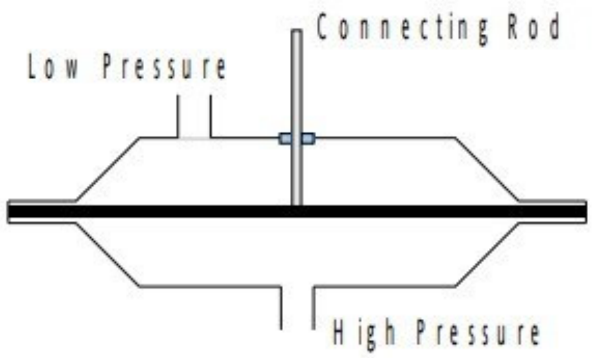
The Sensing Element

The sensing element of a pressure transmitter will either be some form of a Bourdon tube or a diaphragm. The Bourdon tube is commonly used in mechanical pressure gauges. The typical Bourdon tube is a hollow tube, usually of a roughly oval cross section, with a “C” shape. The end of the tube is attached, through a linkage mechanism, to a pointer. When pressure is applied, the tube deflects. The pointer registers the pressure on a calibrated dial. The Bourdon tube may also take on a spiral or helical shape to make it better suited for different pressure ranges. Figure depicts different forms of the Bourdon tube. Although used primarily for mechanical indication, it may also be used for transmission of an electronic signal [How does a Bourdon tube gauge work?]



Bourdon Tube Designs

Another common pressure sensor is the diaphragm. This consists of a membrane clamped in a sealed housing. One side of the membrane is subjected to process pressure while the other is subject to a reference pressure. If that reference pressure is atmospheric, the sensor detects a gauge pressure. In such a case, if the process pressure is above atmospheric, it is connected to the 'high' port. Conversely, if the process pressure is below atmospheric, it is connected to a low port. On the other hand, if the low port is connected to the low pressure of a process, and the high port is connected to the high pressure of a process, the sensor senses a differential pressure. If the reference
side of the diaphragm is subjected to a sealed vacuum, the sensor will detect absolute pressure. A link is mechanically boded to the diaphragm so as to transmit the movement of the sensor into an electronic signal. There are a variety of electronic transducer elements used to perform this function.



Diaphragm Sensing Unit

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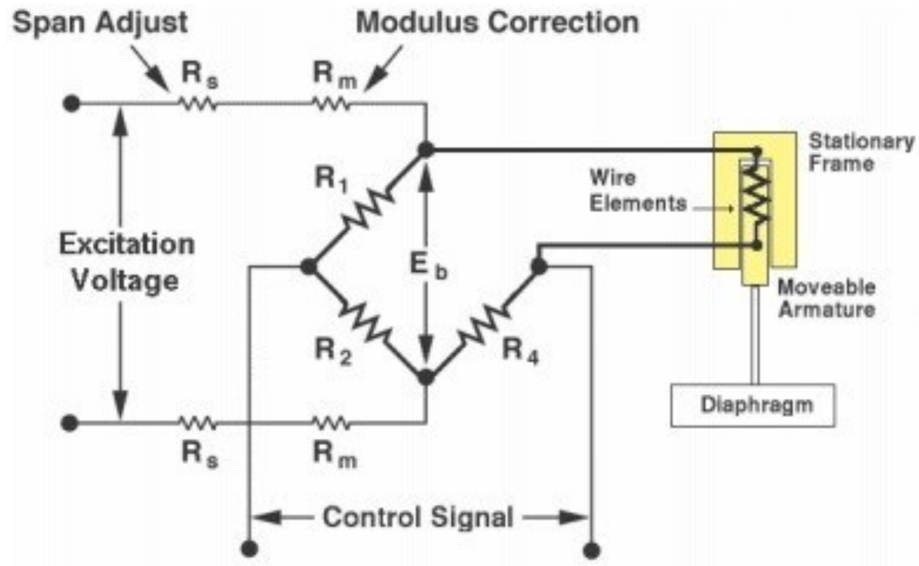
The Transducer Element

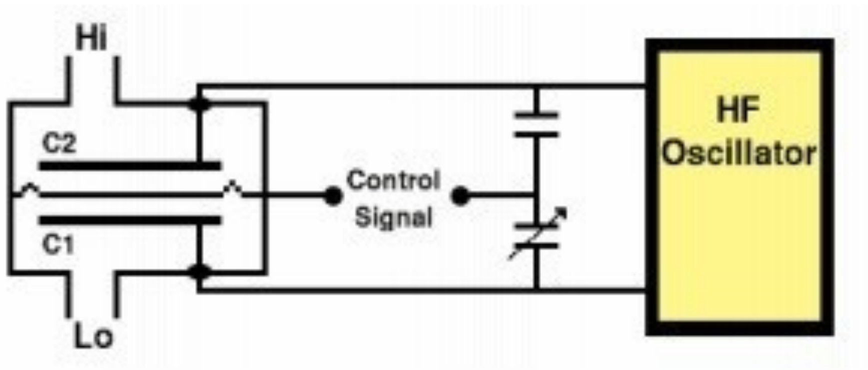
One such transducer element is the strain gauge. Pressure transducers designed on the basis of a strain-gauge are widely used measure the movement of the diaphragm of the sensor. They are frequently used for narrow-span pressure and differential pressure measurements. One type of **strain gauge** consists of a stationary frame and a moveable armature to which is attached several wire elements. The strain-gauge works upon the principle that the resistance of a wire elements change as they are stretched. Since this resistance change is very small, the electronics used must be sufficiently sensitive to register such changes. The most common method of detecting this resistance change is through the use of a Wheatstone bridge. The Wheatstone bridge is especially appropriate since it is easy to compensate for temperature variations through a trim resistor (Rm). Figure shows a schematic of a strain-gauge instrument.



Schematic of Strain Gage Pressure Transmitter

Capacitance-type pressure transmitter

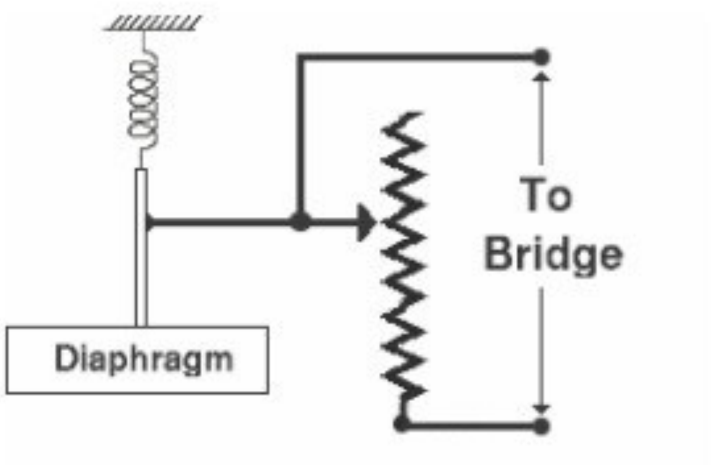
Capacitance-type pressure devices were designed for sensing low absolute pressures. They can be designed as a single-plate capacitor or as a double-plate capacitor. In each, a high frequency oscillator is used to charge the sensing electrodes. In the two-plate design, the movement of the diaphragm causes a change in the capacitance of the unit. This change in capacitance is directly related to pressure. The single-plate design uses a single plate on one side of the diaphragm. As the diaphragm moves with applied pressure, the capacitance changes. In both designs, some form of bridge circuit detects this change in capacitance. The transducer element is designed to output a standard process signal.



Capacitance Pressure Transmitter

Potentiometric pressure transducer

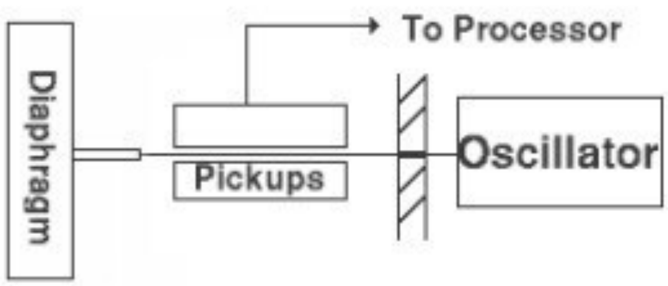
The potentiometric pressure transducer is a device comprised of a high quality variable resistor mechanically bonded
to the sensing element. As the position of the sensing element moves in response to an applied process pressure, the resistance varies proportionally. The variable resistance is usually part of a Wheatstone bridge, which transforms the measured resistance to a calibrated control signal. Although a very simple and inexpensive device, it does suffer from temperature errors and mechanical wear.



Potentiometric Transducer

Vibrating wire pressure transducer

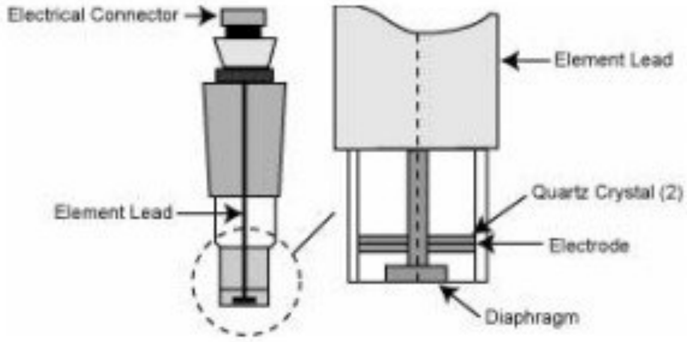
Another form of transducer is the vibrating wire. This transducer works on the same principle as a string instrument; a wire will vibrate at some natural frequency when placed in tension. In this type of transducer, the sensing element is attached to a wire and places it in tension. An oscillator circuit provides the external excitation to force the wire to vibrate at its natural frequency. A pickup coil senses this frequency that correlates to the applied process pressure. This transducer tends to be highly repeatable and highly accurate. As such, it is an excellent transducer for differential pressure measurement. It’s disadvantages clude susceptibility to external vibration and to temperature variation. It also exhibits a nonlinear output. These disadvantages are often countered by processing the signal through a microprocessor, making this an excellent choice for accurate and precise measurement.



Vibrating Wire Pressure Transducer

Piezoelectric pressure transducer

The piezoelectric pressure transducer is used to measure dynamic pressures such as those resulting from shock or vibration. Its primary element is a quartz crystal. When this crystal is subjected to a pressure, it generates an electrical signal proportional to that pressure. However, this signal decays rather rapidly, thus the reason it cannot be used for static pressures. Since they generate their own current, they do not need an external power source. They are quite rugged and respond very quickly, but do require special care in installation.



Piezoelectric Pressure Transducer

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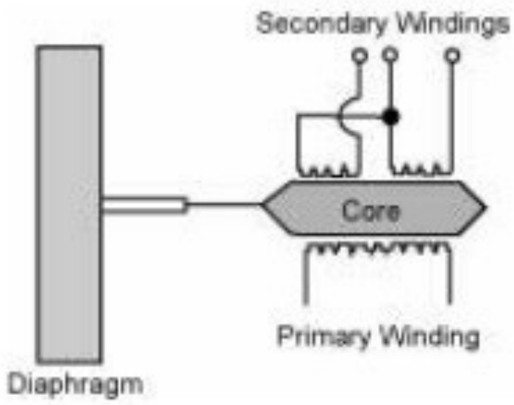
Linear Variable Displacement Transformer (LVDT)

Another class of pressure transducers is based upon the use of electrical inductance, magnetic reluctance, or eddy currents. Once the most common is the Linear Variable Displacement Transformer (LVDT). This unit indicates pressure by sensing the position of a rod within the windings of an insulated coil. As shown in Figure , three coils are wired
within an insulated tube. An AC voltage is applied to the primary winding. An iron core is positioned within the primary winding by the movement of the pressure sensor element inducing a voltage the secondary windings.
The position of the rod results in different voltages in each of the secondary windings. It is this differential voltage that can be related to the applied pressure. The sensitivity and resolution of the device varies with the number of windings and the ratio of the number of windings on the primary coil to the number of windings on the secondary coil.



Schematic of LVDT Pressure Transducer

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Do you want to read more about LVDT check the link below

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