PRESSURE SENSOR

Definition

A **pressure sensor** is a device that measures the pressure, typically of gases or liquids.

Basics

A **pressure sensor** measures the pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a gas or fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor generates a signal related to the pressure imposed. Typically, such a signal is electrical, but it might also include additional means, such as optic signals, visual signals and/or auditory signals.

Pressure sensors are used in numerous ways for control and monitoring in thousands of everyday applications. Pressure sensors can be used in systems to measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensors can alternatively called pressure transducers, pressure transmitters, pressure senders, pressure indicators among other names.

Pressure sensors can vary drastically in technology, design, performance, application suitability and cost. A conservative estimate would be that there may be over 50 technologies and at least 300 companies making pressure sensors worldwide.

There are also a category of pressure sensors that are designed to measure in a dynamic mode for capturing very high speed changes in pressure. Example applications for this type of sensor would be in the measuring of combustion pressure in an engine cylinder or in a gas turbine. These sensors are commonly manufactured out of piezoelectric materials like quartz.

Some pressure sensors function in a binary manner, i.e., when pressure is applied to a pressure sensor, the sensor acts to complete or break an electrical circuit. Some speed cameras use them. These types of sensors are also known as a pressure switches.

Types of fluid pressure measurements

Pressure sensors can be classified in term of pressure ranges they measure, temperature ranges of operation, and most importantly the type of pressure they measure. In term of pressure type, we can categorize them in five categories:

- **Absolute pressure sensor**

This sensor measures the pressure relative to perfect Vacuum pressure (0 PSI or no pressure). Atmospheric pressure, is about 100kPa (14.7 PSI) at sea level. Atmospheric pressure is an absolute pressure.

- **Gauge pressure sensor**

This sensor is used in different applications because it can be calibrated to measure the pressure relative to a given atmospheric pressure at a given location. An example of gauge pressure would be a tire pressure gauge. When the tire pressure gauge reads 0 PSI, there is really 14.7 PSI (atmospheric pressure) in the tire.

- **Vacuum pressure sensor**

This sensor is used to measure pressure less than the atmospheric pressure at a given location.

- **Differential pressure sensor**

This sensor measures the difference between two or more pressures introduced as inputs to the sensing unit. For example, measuring the pressure drop across an oil filter. Differential pressure is also used to measure flow or level in pressurized vessels.

- **Sealed pressure sensor**

This sensor is the same as the Gauge pressure sensor except that it is previously calibrated by manufacturers to measure pressure relative to sea level pressure (14.6 PSI).

Different technologies used in making pressure sensors

- **Fiber optic sensors**

This technology uses the properties of fiber optics to affect light propagating in a fiber such that it can be used to form sensors. Pressure sensors can be made by constructing miniaturized fiber optic interferometers to sense nanometer scale displacement of membranes. Pressure can also be made to induce loss into a fiber to form intensity based sensors.

- **Mechanical deflection**

This technology uses the mechanical properties of a liquid to measure its pressure. Such as, the effect of pressure on a spring system and the changes of compression of spring can be used to measure pressure.

- **Strain gauge**

This technology makes use of the changes in resistance that some materials experience due to change in its stretch or strain. This technology makes use of the change of conductivity of material when experiencing different pressures and calculates that difference and maps it to the change of pressure.

- **Semiconductor Piezoresistive**

This technology uses the change in conductivity of semiconductors due to the change in pressure to measure the pressure.

- **Microelectromechanical systems (MEMS)**

This technology combines microelectronics with tiny mechanical systems such as valves, gears, and any other mechanical systems all on one semiconductor chip using nanotechnology to measure pressure.

- **Vibrating elements (silicon resonance, for example)**

This technology uses the change in vibration on the molecular level of the different materials elements due to change in pressure to calculate the pressure.

- **Variable capacitance**

This technology uses the change of capacitance due to change of the distance between the plates of a capacitor because of change in pressure to calculate the pressure.

Applications

There are many applications for pressure sensors but we can narrow them down to two major categories:

- **Pressure sensing**

This is the direct use of pressure sensors to measure pressure. This is useful in weather instrumentation, aircraft, cars, and any other machinery that has pressure functionality implemented.

- **Altitude sensing**

This is useful in aircraft, rockets, satellites, weather balloons, and many other applications. All these applications make use of the relationship between changes in pressure relative to the altitude. This relationship is governed by the following equation:

$$h = \frac{(1 - (P/P_{ref})^{0.19026}) \times 288.15}{0.00198122}$$

This equation is calibrated for an altimeter, up to 36,090 feet (11,000 m). Outside that range, an error will be introduced which can be calculated differently for each different pressure sensor. These error calculations will factor in the error introduced by the change in temperature as we go up.

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