CHEMICAL ENGINEERING
FACTS AT YOUR FINGERTIPS
Department Editor: Scott Jenkins

Pressure measurement considerations

Pressure measurement in the chemical process industries (CPI) is crucial to many unit operations, and selecting the most effective pressure sensors for a given situation can be complicated by a range of factors. An initial key to selection is establishing an accurate understanding of exactly what is meant when the term "pressure" is used, since there are different types. Other critical considerations include the following: media compatibility, environment, process control, electrical isolation and output signal.

Pressure types

Pressure measurements can be affected by what type of pressure sensing equipment is used, and understanding the different types of pressure is a prerequisite for selecting sensors or gages for your application. Accuracy can suffer if pressure types are misunderstood. Differences in pressure types have everything to do with the reference point for a given pressure measurement. Here are definitions for five common pressure types:

Gage pressure — Gage pressure, the type that most people first imagine when thinking of measuring pressure, covers a positive pressure range. Its zero (reference) point is set at ambient pressure, and it is unaffected by changes in barometric pressure because the sensor is open to the atmosphere. This allows the current atmospheric pressure to be the reference against which all subsequent changes in pressure are measured. Gage pressure effectively can measure pressures below 1 psi, as well as pressures up to 200,000 psi.

Vacuum pressure — Like gage pressure, vacuum pressure's zero point is ambient pressure, and sensors measuring it are vented — and therefore unaffected by barometric change. Since vacuum pressure refers to a negative pressure range, the distinction between vacuum and gage pressure is really a function of direction and magnitude. Sensors measuring this type are commonly used in vacuum pump systems and applications where suction is required.

Compound gage pressure — This pressure type is the combination of gage and vacuum pressure in that it involves both positive and negative pressure changes. Its zero is therefore set at atmospheric pressure, and it is vented. The value of a compound gage is seen when used in applications where the pressure fluctuates from positive to negative and vice-versa. Sensors measuring this pressure type typically do not exceed 100 psi in range.

Sealed pressure — Sealed pressure refers to a situation where the pressure sensor is not vented. This is primarily done to protect the sensor, by avoiding the introduction of moisture or dust into the sensor housing. The sensor is sealed with a pressure equal to the atmospheric pressure at the time of sealing. This pressure then becomes the reference pressure against which all pressure changes are measured.

Because it is sealed, unvented pressure sensors are unavoidably affected by barometric pressure changes. It is not typically used in low-pressure applications because the barometric shift of a few psi would affect measurement accuracy significantly. However, at 1,000 psi and above, the relatively small shift would go unnoticed and can be smaller than the error band of the sensor.

In one real-world case, a sealed pressure type sensor was calibrated at a manufacturing facility in Utah and then shipped to Indiana. The atmospheric pressure differences between the locations caused the unit to fail in Indiana, while it worked properly in Utah.

Absolute pressure — Absolute pressure is used when the zero point must be set to absolute zero. To achieve this, the sensor is also sealed, but under a vacuum condition, so that air molecules are removed from the enclosure. This then becomes the reference point and allows measurements to be made with reference to absolute zero. By definition and design, this is sensitive to barometric changes. Unlike sealed pressure, absolute pressure is often used in low-pressure applications measuring atmospheric conditions, such as in weather stations, aircraft and laboratories.

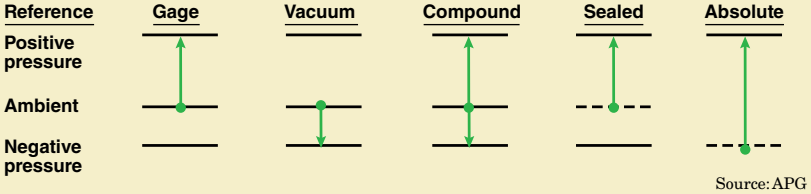
Notes

Material on pressure types was contributed by Elden Tolman, product design engineer at Automation Products Group Inc. (APG; Logan, Utah; www.apgsensors.com).

MAIN FACTORS TO CONSIDER FOR CHEMICAL PRESSURE MEASUREMENTS

Factor	Reason	Solution
Media compatibility	A pressure-sensing element will come in contact with varying concentrations of chemicals, temperatures and pressure ranges depending on the industry sector in which the application appears, including petrochemicals, food, pharmaceuticals, water, refrigeration, alternative energy or power generation	Pressure sensors constructed from one-piece 316L stainless steel, nickel and cobalt-based superalloys are free from internal welds, O-rings and very thin isolation diaphragms offer excellent media compatibility for most chemicals. The one-piece design ensures outside media do not permeate the sensor body
Process control	New processes for heavy oil, alternative energy and water purification systems demand extreme operating conditions, such as low ambient temperatures (–50°C), high media temperature (150°C), as well as complex and volatile gas-liquid mixtures	Pressure sensors with new technologies and wetted materials are needed. High-temperature, oil-free, bulk silicon piezoresistive sensors are ideal for these emerging markets. Superalloys, such as Inconel, Hastelloy and Waspalloy, with thick sensing diaphragms, offer the best solutions without the need for complex sensor packaging and expensive secondary seals
Environment	Rain, ice, dust and pressure washers can cause water to seep into sensor housings and cause electronics to shortcircuit	Absolute and sealed-gage reference pressure sensors protect electronics from these conditions. If venting is required to maintain accuracy at low pressures, provisions must be made for dry, noncorrosive environments for sensors to "breathe"
Electrical isolation	Improper grounding and lightning strikes can cause electrical failures of pressure sensors, as a result of isolation failure	Pressure sensors with custom electronics and a sensing element able to withstand 500 V d.c. isolation can work in extreme electrical conditions
Output signal	Depending on distance and environment, certain output signals can experience signal loss or generate noisy signals	A 4–20-mA output signal is recommended for transmission lengths greater than 15 ft in environments with electrical noise

Table content submitted by Karmjit Sidhu, vice president of business development at American Sensor Technologies (Mount Olive, N.J.; www.astsensors.com)



Source: APG