

- Pressure Gauge Designs
- Protective Accessories
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# Pressure Gauges & Switches

Pressure gauges and switches are among the most often used instruments in a plant. But because of their great numbers, attention to maintenance—and reliability—can be compromised. As a consequence, it is not uncommon in older plants to see many gauges and switches out of service. This is unfortunate because, if a plant is operated with a failed pressure switch, the safety of the plant may be compromised. Conversely, if a plant can operate safely while a gauge is defective, it shows that the gauge was not needed in the first place. Therefore, one goal of good process instrumentation design is to install fewer but more useful and more reliable pressure gauges and switches.

One way to reduce the number of gauges in a plant is to stop installing them on the basis of habit (such as placing a pressure gauge on the discharge of every pump). Instead, review the need for each device individually. During the review one should ask: “What will I

do with the reading of this gauge?” and install one only if there is a logical answer to the question. If a

approaches the specification of pressure gauges with this mentality, the number of gauges used will be

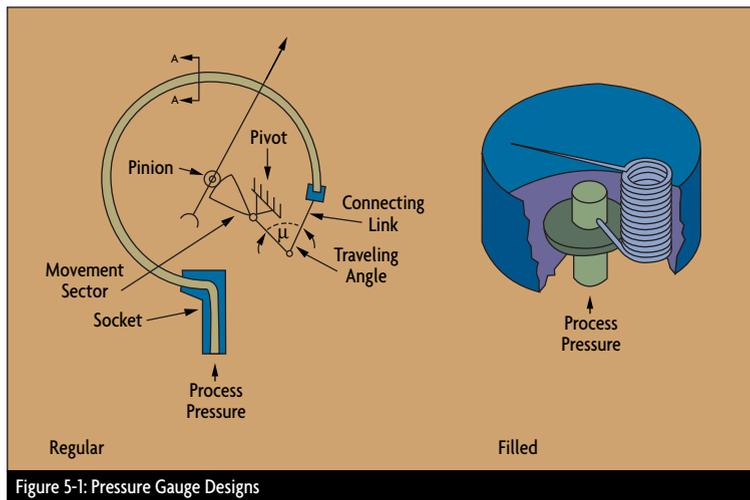


Figure 5-1: Pressure Gauge Designs

gauge only indicates that a pump is running, it is not needed, since one can hear and see that. If the gauge indicates the pressure (or pressure drop) in the process, that information is valuable only if one can do something about it (like cleaning a filter); otherwise it is useless. If one

reduced. If a plant uses fewer, better gauges, reliability will increase.

## Pressure Gauge Designs

Two common reasons for gauge (and switch) failure are pipe vibration and water condensation, which in colder climates can freeze and damage the

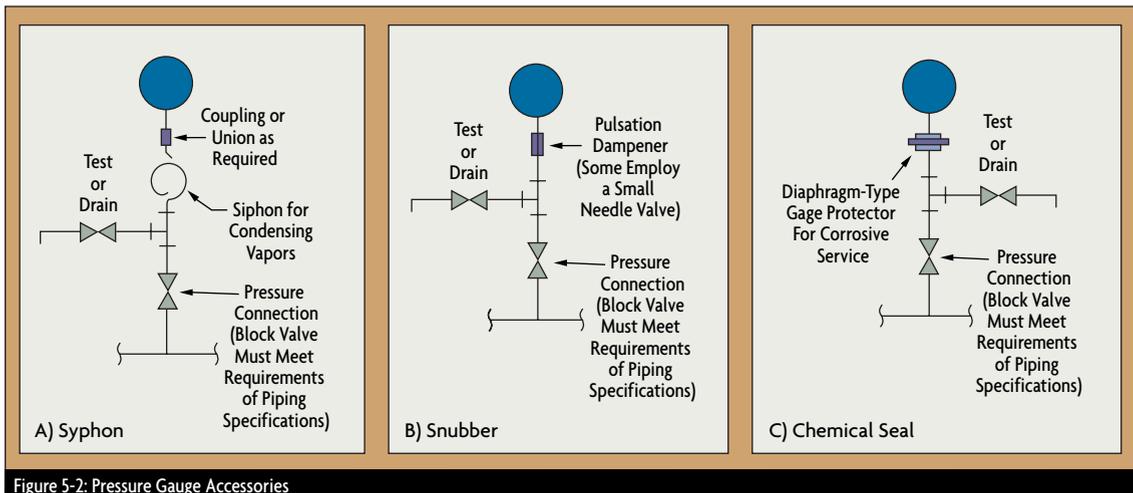


Figure 5-2: Pressure Gauge Accessories

gauge housing. Figure 5-1 illustrates the design of both a traditional and a more reliable, “filled” pressure gauge.



Pressure switches with adjustable setpoints.

The delicate links, pivots, and pinions of a traditional gauge are sensitive to both condensation and vibration. The life of the filled gauge is longer, not only because it has fewer moving parts, but because its housing is filled with a viscous oil. This oil filling is beneficial not only because it dampens pointer vibration, but also because it leaves no room for humid ambient air to enter. As a result, water cannot condense and accumulate.

Available gauge features include illuminated dials and digital readouts for better visibility, temperature compensation to correct for ambient temperature variation, differential gauges for differential pressures, and duplex gauges for dual pressure indication on the same dial. Pressure gauges are classified according to their precision, from grade 4A (permissible error of 0.1% of span) to grade D (5% error).

### Protective Accessories

The most obvious gauge accessory is a shutoff valve between it and the process (Figure 5-2), which allows

blocking while removing or performing maintenance. A second valve is often added for one of two reasons: draining of condensate in vapor service (such as steam), or, for higher accuracy applications, to allow calibration against an external pressure source.

Other accessories include pipe coils or siphons (Figure 5-2A), which in steam service protect the gauge from temperature damage, and snubbers or pulsation dampeners (Figure 5-2B), which can both absorb pressure shocks and average out pressure fluctuations. If freeze protection is needed, the gauge should be heated by steam or electric tracing.

Chemical seals (Figure 5-2C) protect the gauge from plugging up in viscous or slurry service, and prevent corrosive, noxious or poisonous process materials from reaching the sensor. They also keep the process

fluid. For high temperature applications, a sodium-potassium eutectic often is used; at ambient temperatures, a mixture of glycerine and water; and at low temperatures, ethyl alcohol, toluene, or silicon oil.

The pressure gauge can be located for better operator visibility if the chemical seal is connected to the gauge by a capillary tube. To maintain accuracy, capillary tubes should not be exposed to excessive temperatures and should not exceed 25 feet (7.5 m) in length. The chemical seal itself can be of four designs: off line, “flow-through” type self-cleaning, extended seal elements, or wafer elements that fit between flanges.

The spring rate of the diaphragm in the chemical seal can cause measurement errors when detecting low pressures (under 50 psig, 350 kPa) and in vacuum service (because gas bubbles dissolved in the filling fluid

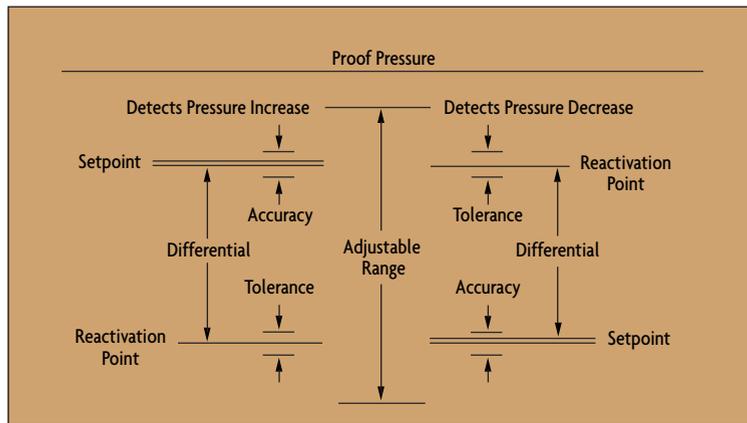


Figure 5-3: Pressure Switch Terminology

fluid from freezing or gelling in a dead-ended sensor cavity. The seal protects the gauge by placing a diaphragm between the process and the gauge. The cavity between the gauge and the diaphragm is filled with a stable, low thermal expansion, low viscosity and non-corrosive

might come out of solution). For these reasons, pressure repeaters often are preferred to seals in such service. Pressure repeaters are available with 0.1% to 1% of span accuracy and with absolute pressure ranges from 0-5 mm Hg to 0-50 psia (0-0.7 to 0-350 kPa).



Pressure gauges come in a wide variety of ranges and units.

### Pressure Switches

Pressure switches serve to energize or de-energize electrical circuits as a function of whether the process pressure is normal or abnormal. The electric contacts can be configured

as single pole double throw (SPDT), in which case the switch is provided with one normally closed (NC) and one normally open (NO) contact. Alternately, the switch can be configured as double pole double throw (DPDT), in which case two SPDT switches are furnished, each of which can operate a separate electric circuit. The switch housings can meet any of the NEMA standards from Type 1 (general purpose) to Type 7 (explosion proof), or Type 12 (oil tight).

Figure 5-3 illustrates the terminology used to describe pressure switch functionality and performance. When the pressure reaches the setpoint (which is adjustable within the range), the switch signals an “abnormal condition” and it does not return to “normal” (the reactivation point) until the pressure moves away from the abnormal condition by the “differential” (also called dead-band). The precision of setpoint actuation is called its “accuracy,” while the precision of reactivation is called “tolerance.” 

### References & Further Reading

- *Omegadyne® Pressure, Force, Load, Torque Databook*, OMEGADYNE, Inc., 1996.
- *The Pressure, Strain, and Force Handbook™*, Omega Press LLC, 1996.
- *Instrument Engineers’ Handbook*, Bela Liptak, CRC Press LLC, 1995.
- *Process/Industrial Instruments and Controls Handbook*, 4th Edition, Douglas M. Considine, McGraw-Hill, 1993.