Pressure gauge

WISE®

Pressure measurement

There are four types of pressure measurements:

■ Measurement of absolute pressure : Measurements are made with respect to absolute pressure, for example as with atmospheric pressure.
■ Measurement of relative or effective pressure : Measurements are made with respect to ambient pressure, generally atmospheric pressure.
■ Measurement of differential pressure : This is the difference between two pressures.
■ Measurement of vacuum pressure : This is referred to ambient pressure, usually atmospheric pressure.

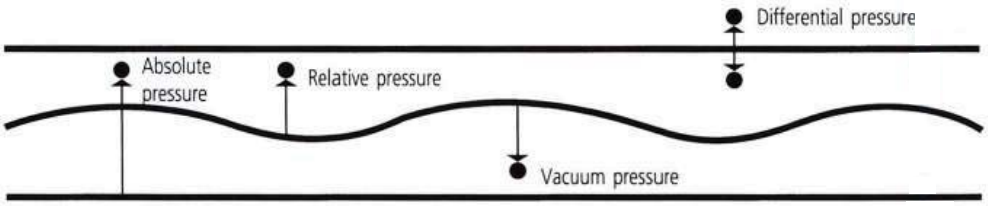
One can also distinguish pressure measurements according to their behavior with time :

Static or quasi-static pressure, which varies only slowly with time. Examples are atmospheric pressure, level measurements and certain pressures in industrial processes such as in the petrochemical, food and pulp and paper industries.
Fluctuating pressure, which can be random or cyclic. Examples are the pressure inside a gun barrel, in a plastic injection mould, in an internal combustion engine cylinder, etc.

Line pressure
(Static pressure)

Atmospheric pressure
(Fluctuating reference)

Absolute vacuum
(Theoretical limit)



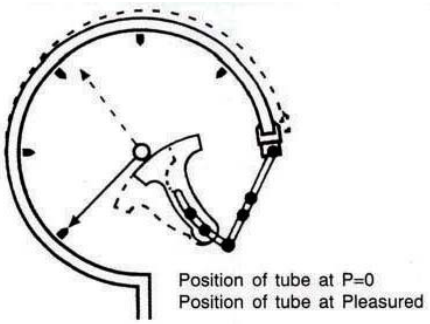
Pressure gauges

Mechanical apparatus indicating the value of the local pressure

1. Bezelring
2. Pointer
3. Window
4. Window gasket
5. Dial
6. Movement
7. Tube
8. Connection
9. Case
10. Oil cap
11. Blow out disc

Principle of operation

The tube is displaced in proportion to the applied pressure, which causes the pointer to move by means of a mechanically amplifying linkage.



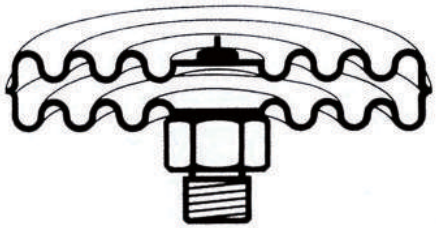
Components of a metallic pressure gauge :

Bourdon tube or 《C》 tube :

The sensing element consists of a metallic tube of various cross-sections shaped in the form of a «C». One end is fixed and connected to the pressure circuit and the other is sealed and free to move. When pressure is applied to the tube the free end is forced outwards.
(Measuring range from around 400 mbar to 60 bar).

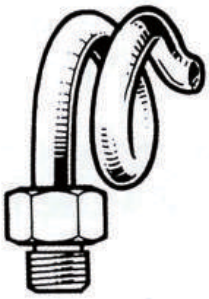
Capsules :

The sensing element consists of two thin corrugated sections laser welded together. The capsule thus formed acts as a cavity that slightly deforms with variations in pressure. It is suitable for measuring very low pressures.
(Measuring range 0 ~ about 600 mbar).



Helical, tubes (or pig tails)

The coil is cylindrical.
It has the same characteristics as a spiral tube but with greater resistance to fatigue due to better stress distribution.
(Measuring range about 60 ~ 3,000 bar).



Bellows :

The sensing element consists of two flanges connected to a flexible cylinder.
Pressure applied to the interior of the chamber causes it to deform by an amount proportional to the pressure.
They are mainly used in differential pressure gauges and pressure switches.

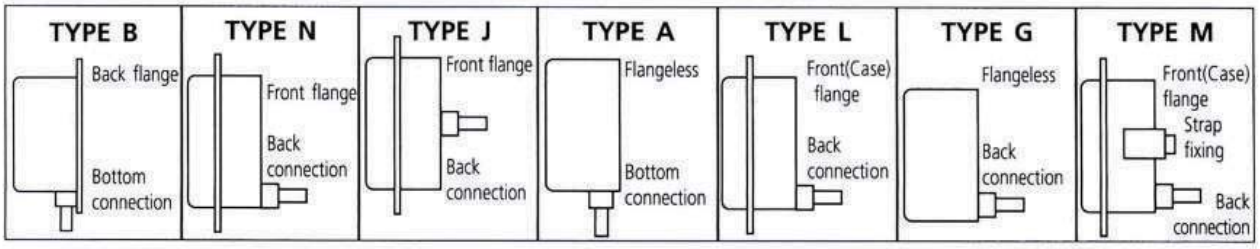
Spiral tubes :

These use the same principle as the «C» tube but with the deflection of the free end of the tube amplified due to the spiral shape.
They are mainly used in gas expansion thermometers.

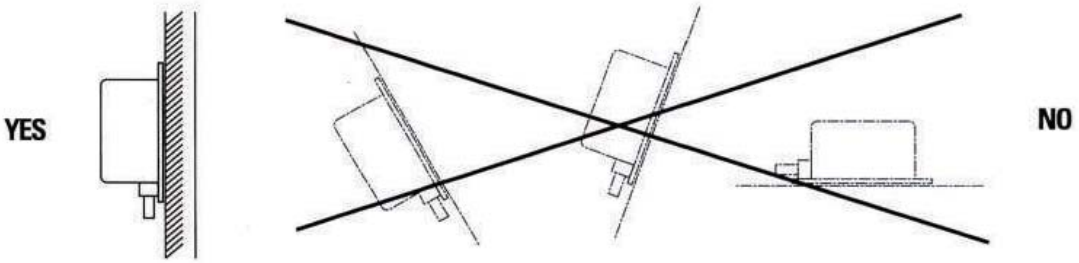
Mounting

Cases

Different types of cases are possible according to position of the connection.



Position



Always vertical, otherwise specify the direction and angle.
A pressure gauge is calibrated in a vertical position, however and this is not a defect, the pointer may be out of zero if the instrument is horizontal, chiefly for low pressure ranges.

Threads

Standard threads are : parallel BSP (gas) or conical NPT (briggs).

1. Parallel thread BSP (gas).
   Place a gasket between the end of the thread and around the spigot.
2. Conical thread NPT (briggs)
   Tightness is achieved metal on metal without any gasket. However a teflon tape wound around the thread provides a better tightness and makes the screwing easier.

Bourdon tube

The bourdon tube can be made of bronze, st. steel, monel, nickel-silver alloy, etc...
Sometimes for low or differential pressures, the tube is replaced by a capsule or by 2 bellows.

Oxygen

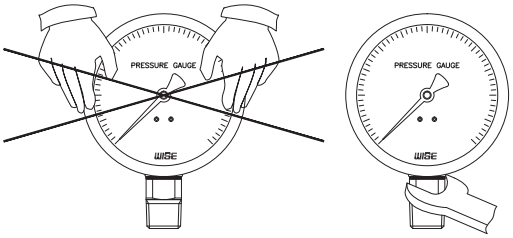
WARNING :
For oxygen service, oil-free manometric parts is imperative.
Specify when ordering.

Installation

Never install the pressure gauge by turning the case but mount it with a wrench by means of the hexagon or flats provided on the socket.

Isolating cocks

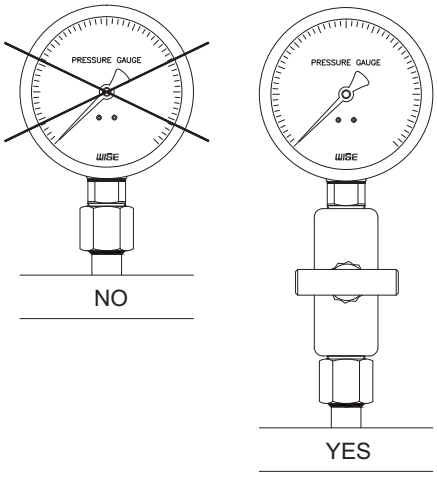
A pressure gauge must never be mounted an isolating cock.



NO YES

Vibrations

Vibrations of the pressure gauge must be avoided to prevent excessive wear of the mechanism.
It would be better to set the gauge on a rigid support on which the vibrations of the pipe have no influence (Consult our chemical seal/accessories manual).
A flexible small diameter capillary can also be placed between the gauge and diaphragm seal.
A capillary can also occasionally be used as a vibrations or pulsations dampener.

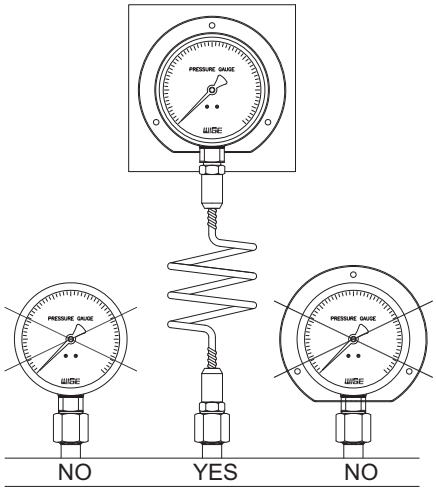


NO YES

Pressure pulsations

In the case of pressure measurements of pulsating fluids a dampener should be fitted between the pressure gauge and the pipe.

Adjustment of dampener will be done on line, where the gauge is used, according to the pressure pulsations.



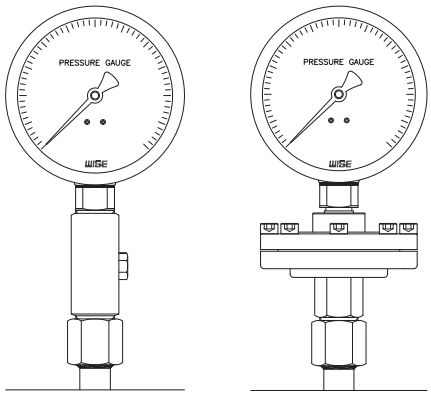
NO YES NO

Corrosion

If stainless steel or monel do not provide sufficient guarantee against corrosion place a diaphragm seal between gauge and pipe (Consult our chemical seals/ accessories manual).

Parts of the diaphragm seal in contact with fluid (Bottom housing, diaphragm intermediate ring) are made of a material withstanding.
Corrosive fluids : Steel, stainless steel, nickel, tantalum etc... or coated with corrosion-proof materials (Teflon, Halar, Kel F, etc).

Bottom housing can be made of Carbon steel, Stainless steel, Hastelloy B or C, Tantalum, etc.



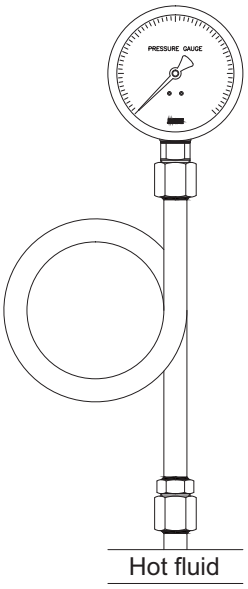
Pulsations Corrosivefluids

Dampener Diaphragm seal

Excessive temperatures must be avoided

If the joining «Tube socket» is soft-soldered the gauge must not be subjected to a permanent temperature over 80°C (180°F).
If the joining «Tube-socke» is brazed the gauge must not be subjected
to a permanent temperature over 120°C (270°F).
If the joining «Tube-socket» is arc-welded (Stainless steel tube) the gauge must not be subjected to a permanent temperature over 250°C (482°F)

NOTE : The mentioned temperatures are temperatures inside the bourdon tube.



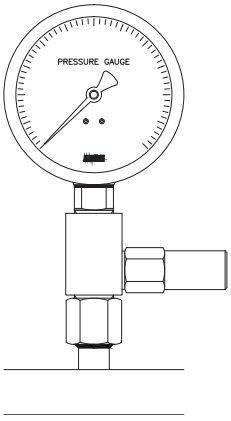
Siphon

Overpressure

Before calibration all our Bourdon tubes are subjected to an overload test, so that in normal utilization our gauges should be able to withstand the following overpressure without any damage.

30% of maximum graduation up to 100 bar.
15% of maximum graduation over 100 bar

A short pipe of small section, placed in between the hot fluid and the pressure gauge is sometimes efficient enough to lower the temperature to acceptable values. A siphon, especially on vapor, can be used after having been initially filled by a fluid condensed at cold temperatures. In this case, do not purge the siphon. In all cases, the first pressure increase must be carried out slowly to enable the hot fluid to cool off.



Overload device

Diaphragm and lower housing materials

This choice is directly linked to the aggressivity of the fluid to be measured.
Corrosion however depends also on surface condition of the parts subjected to a corrosive agent, on the circulation of air (Hence of oxygen) dissolved in the fluid, on the presence of catalytic agents or conversely of corrosion inhibitors.
The following table provides general indications of compatibility.
Considering the complexity of corrosion phenomena, it is mandatory to check the choice of material (T., concentration, pressure, shape... influences).

Materials	To be used with	Do not used with
316L stainless steel	◦ Strong and weak acids (Except mineral ones) ◦ Strong and weak bases ◦ Acid, neutral or basic salts ◦ Sea water ◦ Oxidizing media ◦ Hydrogen	◦ T fluid > 100°C ◦ Strong oxidizing agents at high concentrations ◦ Hydrochloric and sulphuric acids in concentrations > 2% and T > 20°C ◦ Feme chloride ◦ Fluorine, fluoride ◦ Wet chlorine ◦ Concentrated nitric acid at high temperature ◦ Oxalic and chromic acids

Other definitions

Microswitches :

This is the electro mechanical device which switches on or off the control or monitoring circuits.
Various versions are available depending on the control requirements or the pressure (or temperature) switch environment.

Setpoint :

This is the point at which the microswitch changes of state.
This point is set either in factory or by the end-user.

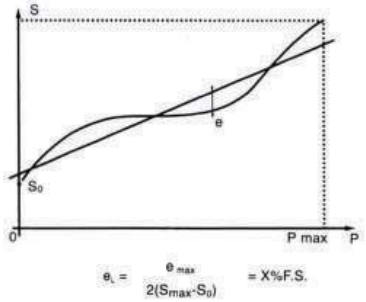
Fixed deadband :

Depends on the microswitch characteristics.
Used generally for safety operations and small deadbands.
WARNING : some versions can only be implemented with fixed deadband.

Linearity :

Greatest deviation of the sensor output curve from a specified straight line over a desired pressure range. One method of computing is least squares which mathematically provides a best fit straight line (BFSL) to the data.

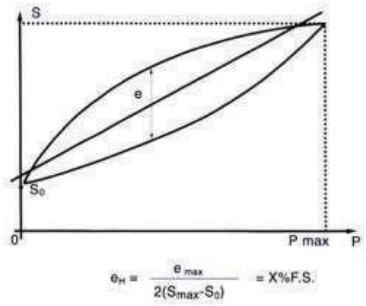
- This line usually dose not pass through the 4 and 20 mA points.
- This line dose not have the same slope as the theoretical curve.
- This linearity error is expressed in % of the full scale.



Hysteresis :

Hysteresis is the output deviation at a certain input pressure when that input is approached first with increasing pressure and then with decreasing pressure.

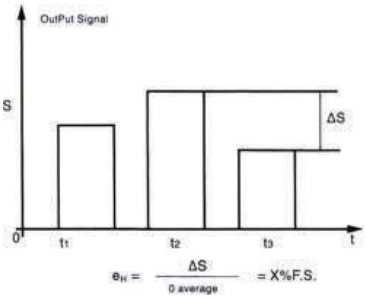
- This hysteresis error is half the reversibility error.
- It is expressed in % of the full scale.



Repeatability :

Repeatability error is the deviation in output readings for successive applications of a given input pressure with other conditions remaining constant.
The accuracy at 20°C (Global error) can be calculated according to two possible methods :

- Best fit straight line (BFSL)
- End point linearity



Maximum deformation

The displacement of the point of application of a force for the full measurement range.

Stiffness

Stiffness is defined as the quotient of the change in applied force on the sensor and the corresponding deformation of the sensor measured in the direction of the force.

$K = \frac{F}{X}$ where : F = Applied force
X = Deformation of the sensor

Fineness :

The ability of the sensor not to modify the value of the quantity being measured.

Limit load :

The value of the upper limit of the range of non-deterioration relative to the input quantity.