Pressure Measurement

Analog gauges

Where are gauges?

- Medical breathing air
- Sprinkler systems
- Hydraulics
- Bottle regulators
- Process lines
- Food and beverage manufacturing
- **Where else?**

Open Discussion

What Causes Gauges To Fail?

Common Pressure Gauge Failures and Solutions

What Causes Gauges to Fail?

- Mechanical vibration
- Pulsation/Spikes/Overpressure
- Temperature
- Corrosion
- Clogging
- Mishandling/abuse

What Causes Gauges to Fail?

Mechanical Vibration

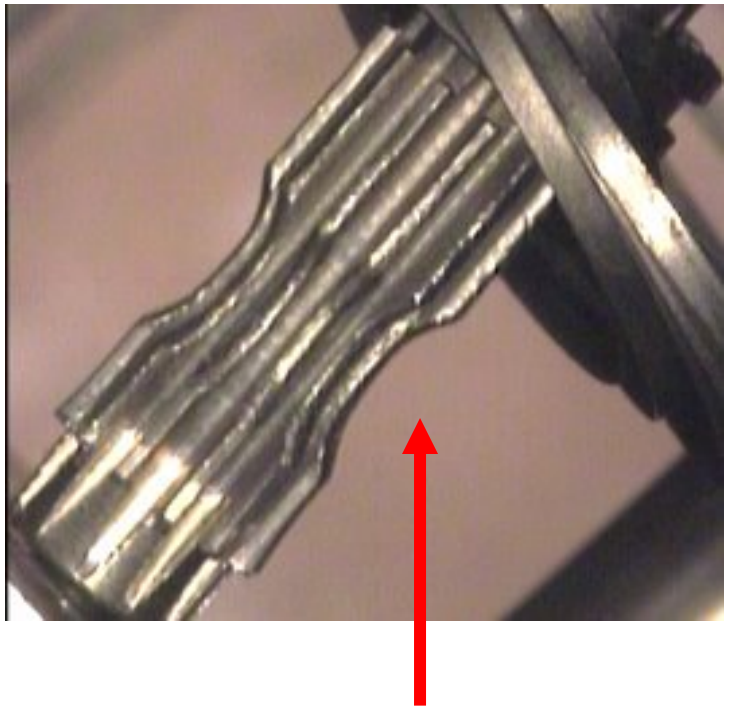
Common Pressure Gauge Failures and Solutions

Failure – Mechanical Vibration

- Caused by vibrating equipment near the gauge
- Usually occurs from pumps or similar type of reciprocating equipment
- Increases wear on movement & internal components
- Difficult to read pressure due to gauge vibration
- Similar to premature failure caused by pulsation

Common Pressure Gauge Failures and Solutions

Failure – Mechanical Vibration

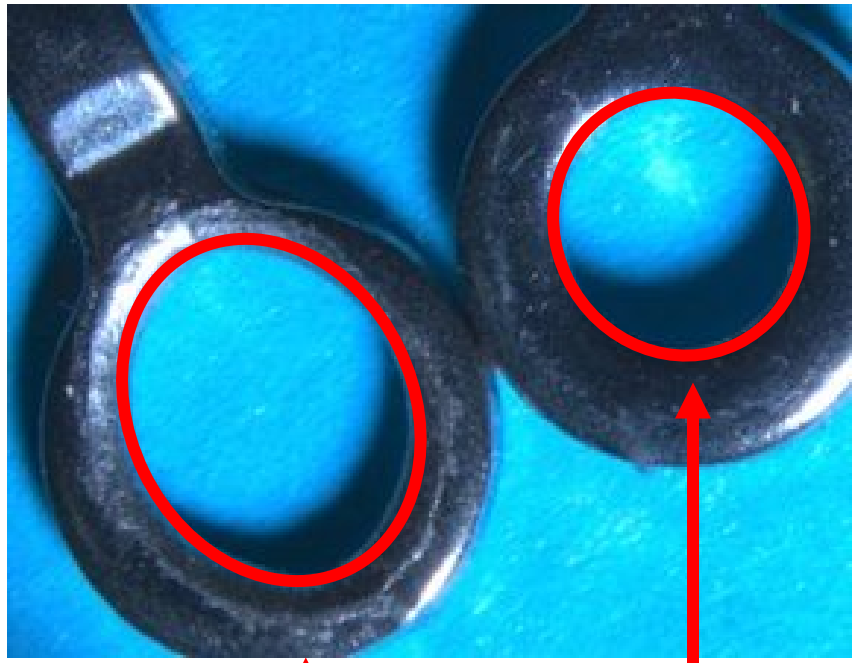


Worn Pinion Gear

Worn Segment Gear

Common Pressure Gauge Failures and Solutions

Failure – Mechanical Vibration



Worn Link

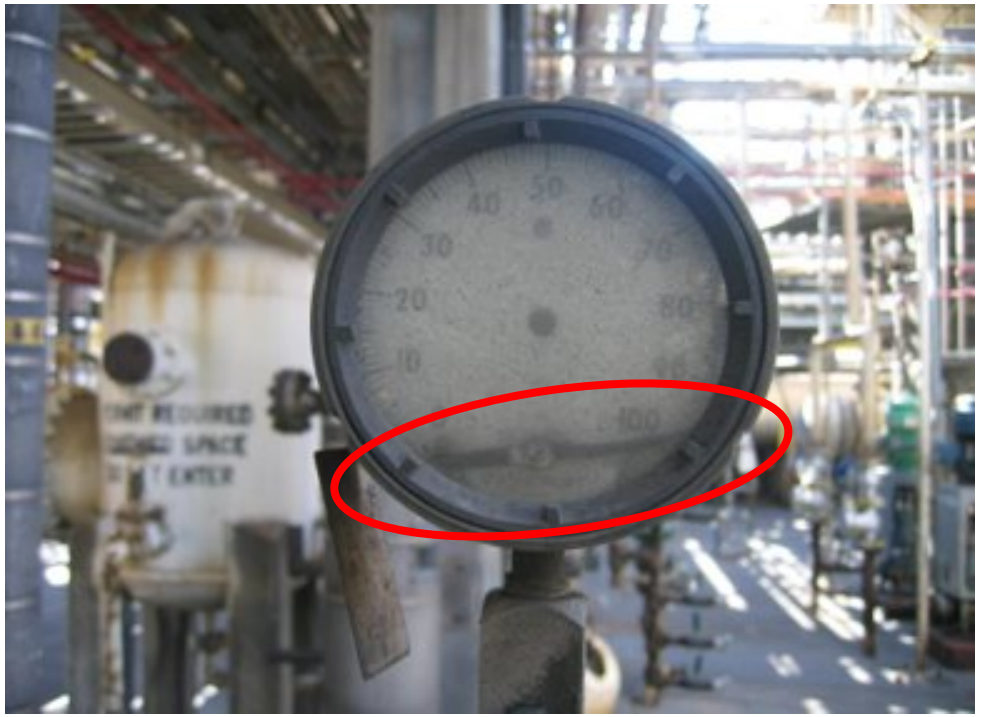
Normal Link

Crack in Tube

Common Pressure Gauge Failures and Solutions

Failure – Mechanical Vibration

- Pointer has fallen off due to severe vibration
- Dust on inside of window from wear of internal components



What Causes Gauges to Fail?

Mechanical Vibration = Solution

Common Pressure Gauge Failures and Solutions

Solution – Vibration

- Liquid-filled gauge – dampens vibration to movement, Bourdon tube and internal components. Lubricates moving parts and eliminates or reduces resonant frequency.
- Available case fills are Glycerine, Silicone, Halocarbon and Fluorolube

What Causes Gauges to Fail?

Pulsation

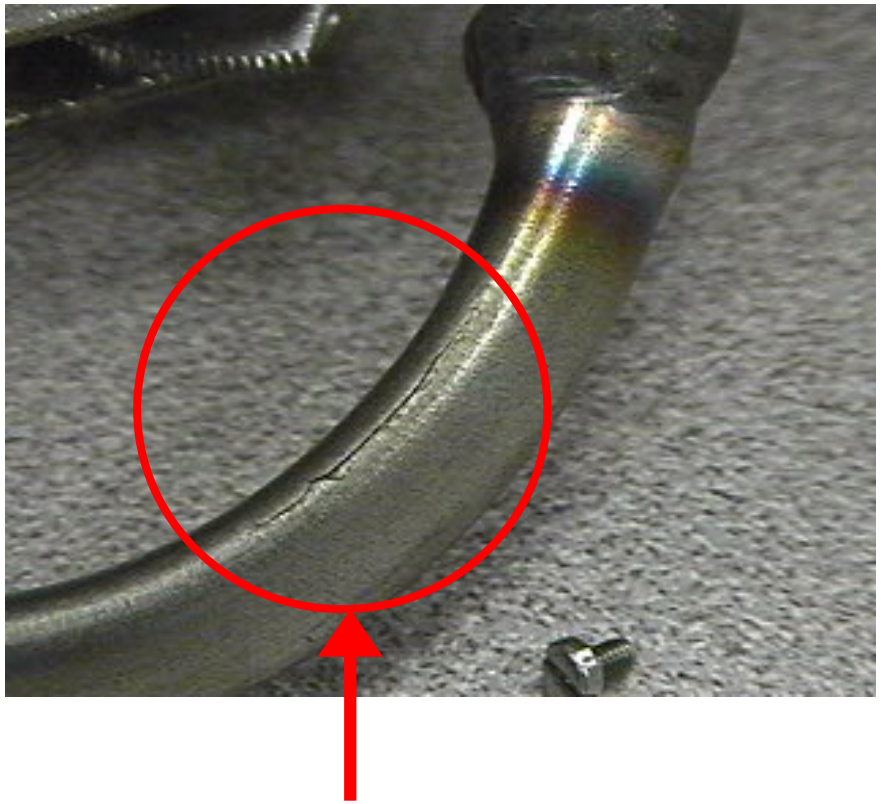
Common Pressure Gauge Failures and Solutions

Failure – Pulsation

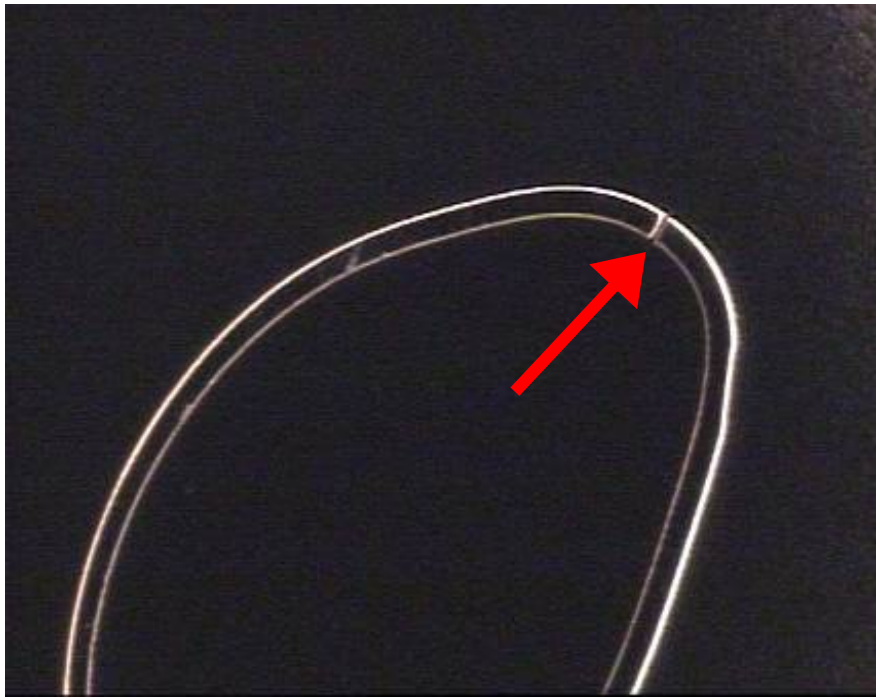
- Caused by media rapidly cycling the gauge
- Increases wear on components and Bourdon tube
- Difficult to read pressure due to pointer flutter
- If the pointer pulsation increments are greater than 5% of full scale value, you must intervene to prevent damage to the gauge.
- Types of pulsation
  - Centrifugal – high frequency, low amplitude; causes extreme pointer movement, usually contained to small pressure increments
  - Reciprocating – low frequency, high amplitude; causes rapid pointer movement, may fluctuate over larger pressure increments

Common Pressure Gauge Failures and Solutions

Failure – Dynamic (cyclic) Load From Pulsation



Bourdon Tube Split



Magnified Cross Section

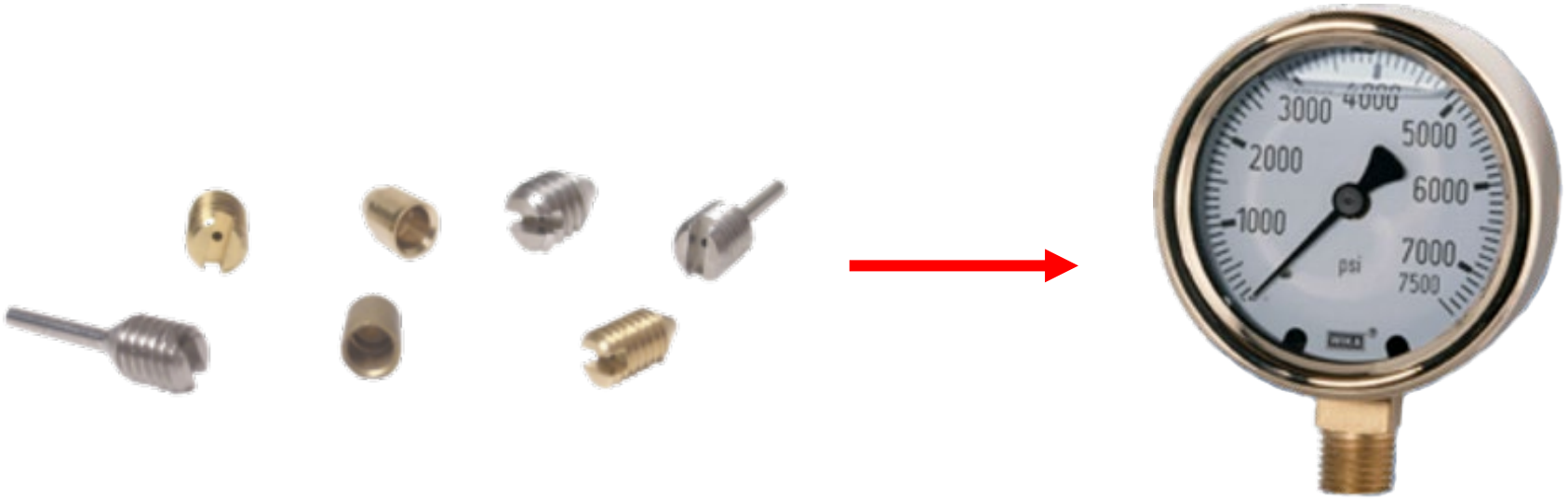
What Causes Gauges to Fail?

Pulsation = Solution

Common Pressure Gauge Failures and Solutions

Solutions – Pulsation

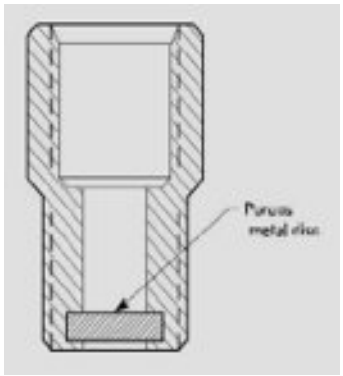
- Socket restrictor – Allows pressure to equalize slowly. Economical and low cost solution
- Liquid filled case – Dampens pulsation. Lubricates and cools moving parts



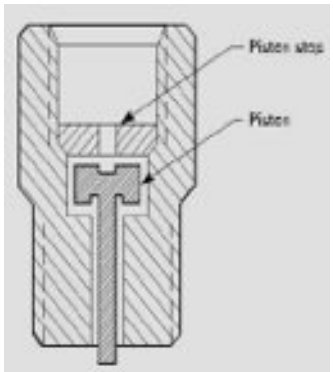
Common Pressure Gauge Failures and Solutions

Solutions – Pulsation

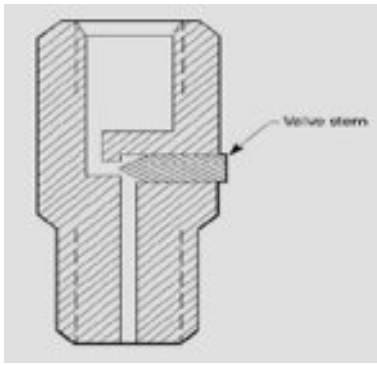
Porous Snubber



Piston Snubber



Adjustable Snubber



Common Pressure Gauge Failures and Solutions

Solutions – Pulsation

- A liquid-filled case and a restrictor will resolve most pulsation problems, but extreme pulsation requires accessories.
- Needle valves and gauge cocks can be used to throttle down pressure pulsations.

Block & Bleed Needle Valve

Multi-Port Needle Valve

Mini-Needle Valve

Gauge Cock

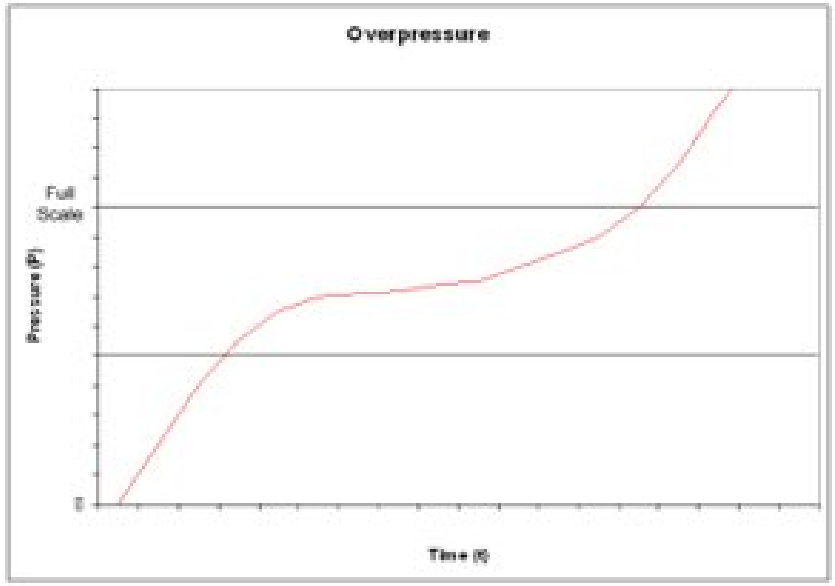
What Causes Gauges to Fail?

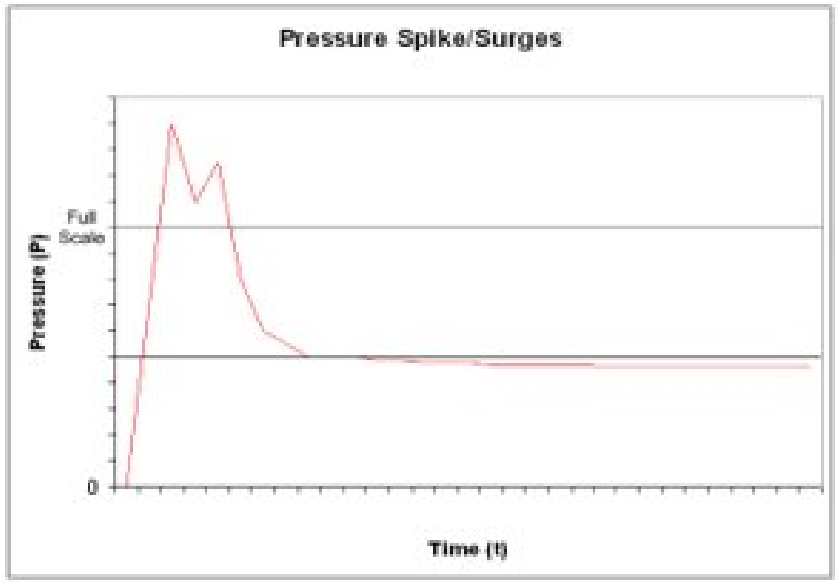
Spikes and Overpressure

Common Pressure Gauge Failures and Solutions

Failure – Spikes and Overpressure

- In general, an overpressure failure is caused by the application of a pressure greater than the rated capacity of the measuring element.
- In some cases ultra fast (*msec*) pressure increases can cause the pressure element to fail well before its “rated” rupture pressure.





Common Pressure Gauge Failures and Solutions

Bourdon Tube Failure – Spikes and Overpressure

Bourdon Tube Warped & Split

What Causes Gauges to Fail?

Spikes and Overpressure = Solution

Common Pressure Gauge Failures and Solutions

Solutions – Spikes and Overpressure

- At a predetermined pressure, the overpressure protector "shuts-off" pressure to the gauge, preventing damage to the sensing element and protecting the calibration.
- The set-point is externally adjustable. WIKA overpressure protectors also feature a piston valve which is designed to dampen system pulsation.

What Causes Gauges to Fail?

Temperature Extremes

Common Pressure Gauge Failures and Solutions

Failure – Temperature

- Ambient temperatures are just as important as process media temperatures

What Causes Gauges to Fail?

Temperature Extremes = Solution

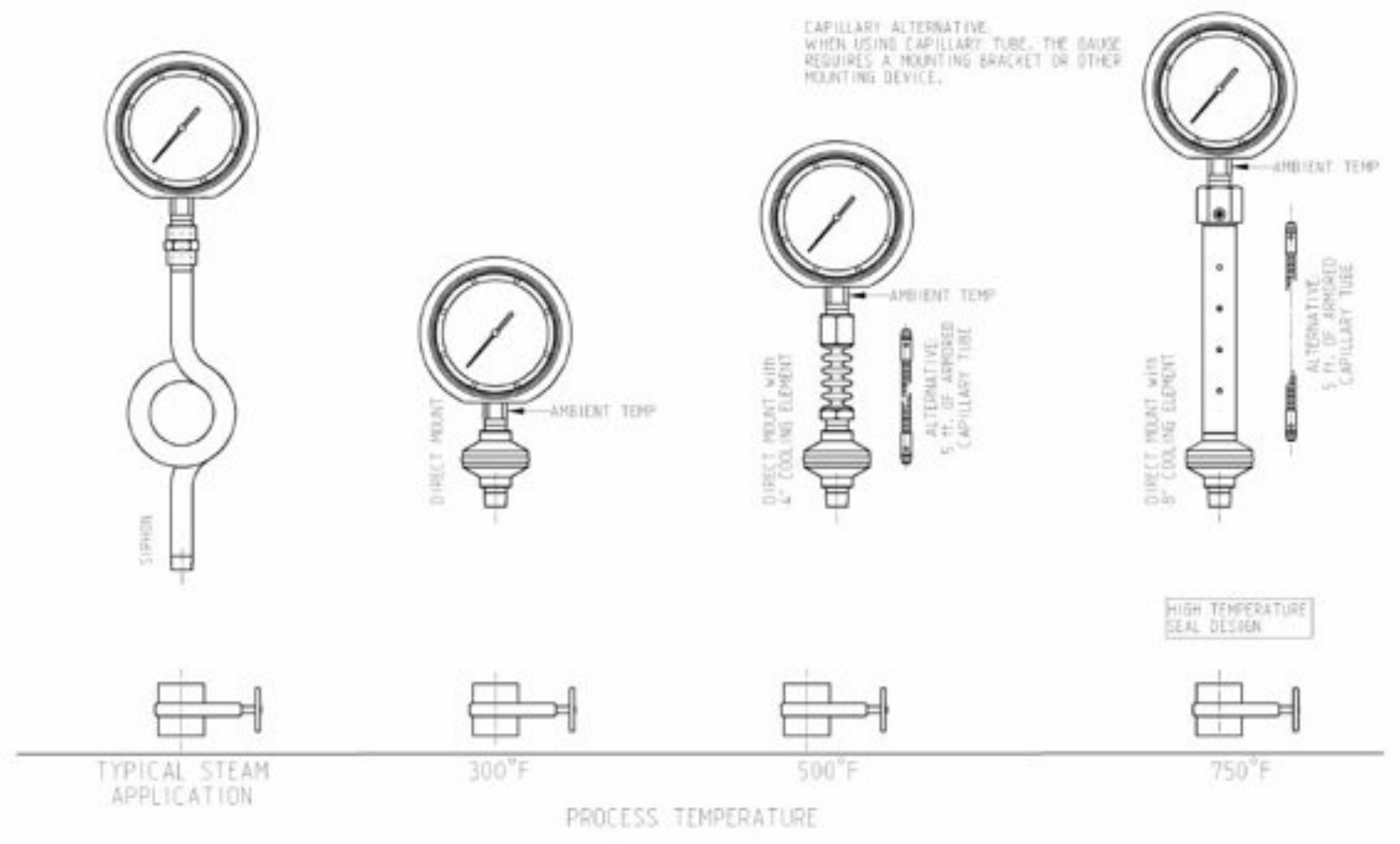
Common Pressure Gauge Failures and Solutions

Solutions – Temperature

- Ensure that ambient and media temperatures are within allowable temperature limits of the gauge
- Excessive temperature applications may require the use of accessories or diaphragm seal solutions
- In addition to stainless steel gauge:
  - Long pipe (6” to 12”)
  - Siphon
  - Cooling element
  - Cooling tower
  - Capillary
  - Diaphragm seal

Common Pressure Gauge Failures and Solutions

Solutions – Temperature



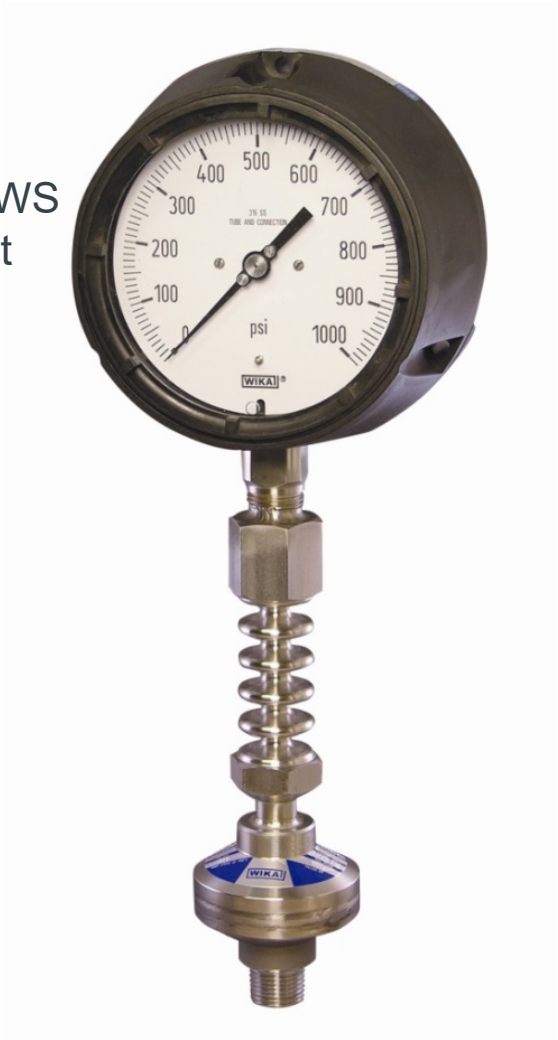
Common Pressure Gauge Failures and Solutions

Solutions – Temperature

M93X.D1

Process gauge with AWS

Process gauge with AWS and cooling element



Common Pressure Gauge Failures and Solutions

Solutions – Temperature- Steam

- Prevent steam and "water hammer" from reaching gauge internals
- Must be filled with water upon installation
- Actual temperature reduction is a function of process pressure

Coil – For Horizontal Applications

Pigtail – For Vertical

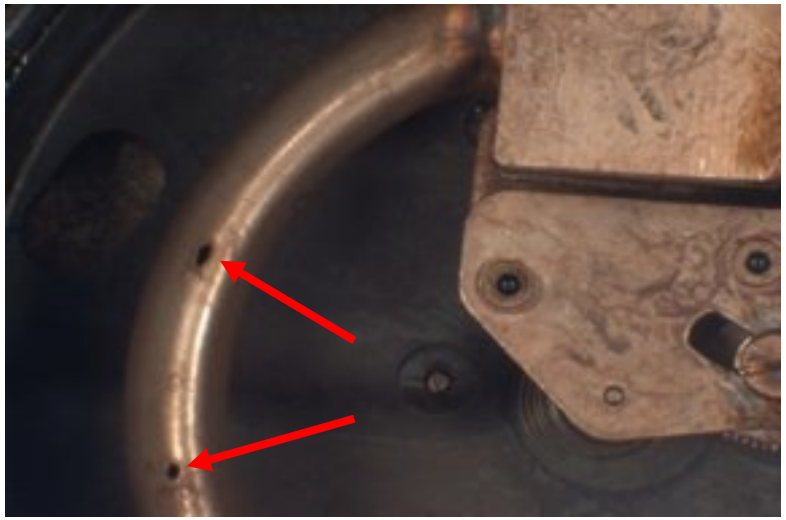
What Causes Gauges to Fail?

Corrosion

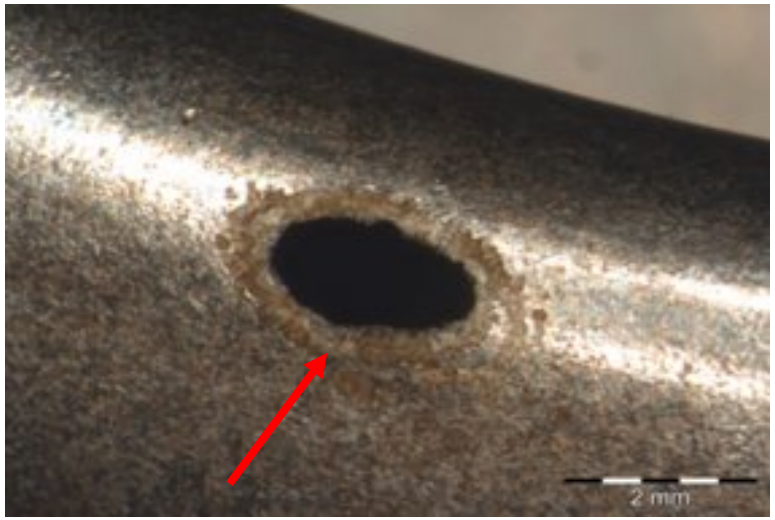
Common Pressure Gauge Failures and Solutions

Failure – Corrosion

- Corrosion failure from media attacking the wetted parts material of the pressure gauge



Holes in Bourdon tube



Holes in Bourdon tube

Common Pressure Gauge Failures and Solutions

Failure – Corrosion

- Corrosion failure not only occurs from media attacking the wetted parts, but also from corrosives in the environment attacking the case, window and gauge internals.

Corroded Dial

Fogged Window

What Causes Gauges to Fail?

Corrosion = Solution

Common Pressure Gauge Failures and Solutions

Solution – Corrosion

- Ensure that the wetted parts material, case material and internals of the gauge are compatible to the process media and atmospheric conditions
- Excessively corrosive media applications may require the use of diaphragm seal solution

What Causes Gauges to Fail?

Clogging

Common Pressure Gauge Failures and Solutions

Solution – Clogging

- Media does not have to be aggressive or hostile to require the use of diaphragm seals
- For Example: Chocolate - when warm and molten it will flow. However, when cooled it will become a solid.

What Causes Gauges to Fail?

Clogging = Solution

Clogging Solution

- Clogging problems and highly viscous or clogging media may require the use of a diaphragm seal.

What Causes Gauges to Fail?

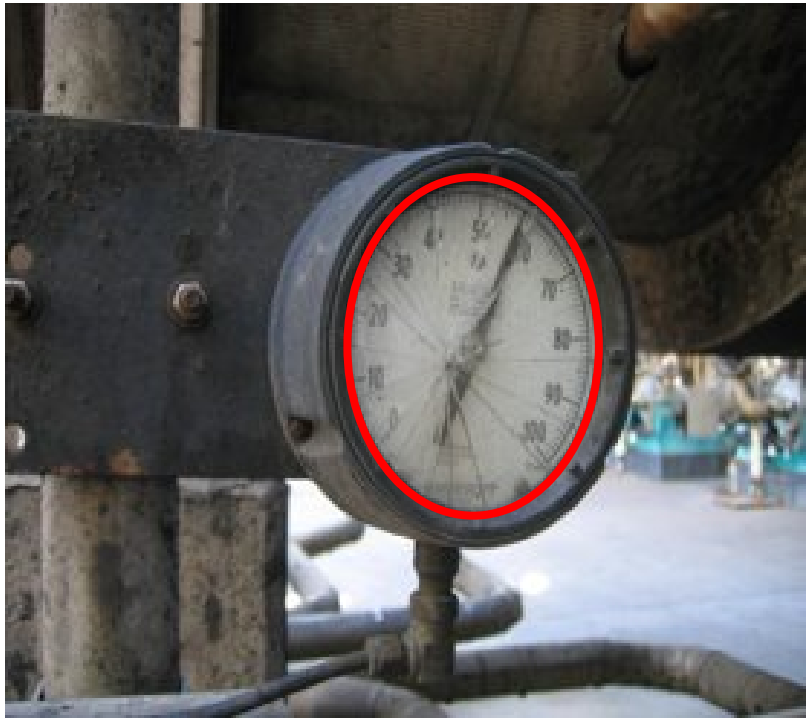
Mishandling and Abuse

Common Pressure Gauge Failures and Solutions

Failure – Mishandling/Abuse

Cracked Case

Broken Window



What Causes Gauges to Fail?

Mishandling and Abuse = Solution

Common Pressure Gauge Failures and Solutions

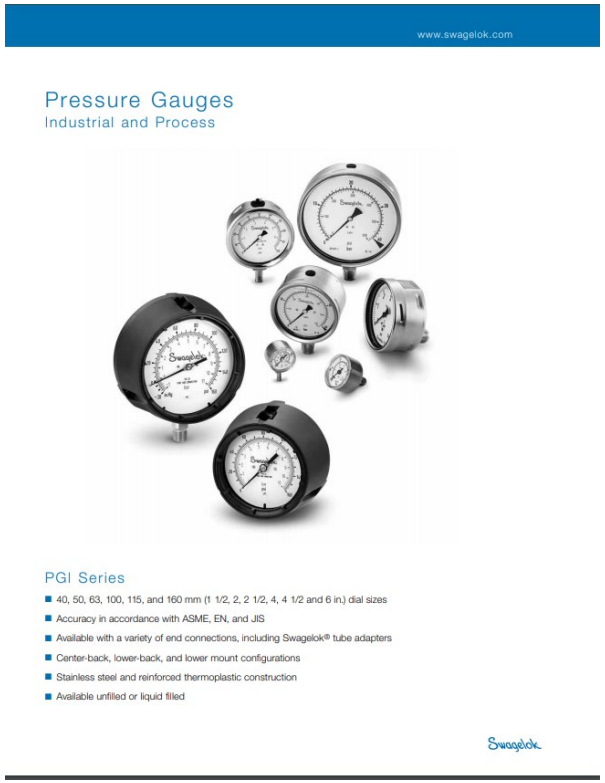
Solution- Mishandling

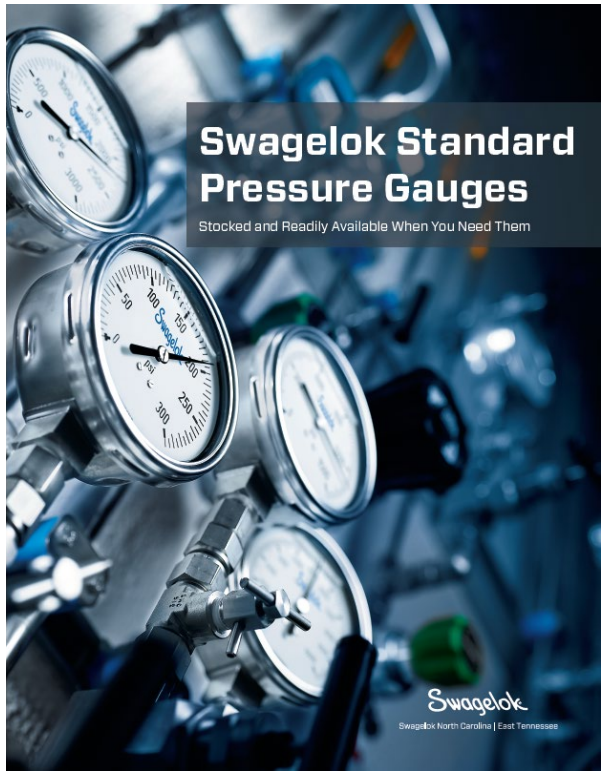
- Use the wrench flats to install the gauge – do not tighten by grabbing the sides of the case and turning
- Most all gauges feature 4-sided wrench flats for easy installation
- Utilize protective cases

How to Specify a Pressure Gauge

- Size
- Temperature
- Application
- Media
- Pressure
- End Connection
- Delivery

Available Resources and Services for You





Gauge Catalogs

Onsite Surveys and Audits

Join Us for Our Next Tech Talk

Safe Valve Selection
Wednesday, December 9th
11:30 am to 12:00 pm