

Rosemount Pressure and Temperature Products Overview



PRESSURE, TEMPERATURE & CORROSION RELATIONSHIP

- Increase in **PRESSURE** results in increase in corrosion. The reason for this is that the main types of corrosion in oil and gas systems are caused by the presence of CO₂ and H₂S – most commonly CO₂ in the North Sea. CO₂ when dissolved in water forms carbonic acid (H₂CO₂) - increases in pressure therefore also result in increases in the H₂CO₂ concentration and therefore the corrosion rate.
- There is a rule of thumb that the corrosion rate of metal doubles for every 10 degC increase in **TEMPERATURE**. This is a bit of generalization and doesn't necessarily hold true for all types of corrosion but it's a good way of highlighting the relationship between corrosion and temperature and therefore the value in being able to accurately monitor / trend temperature if you are looking to gauge when the corrosion in your system could be increasing / decreasing.

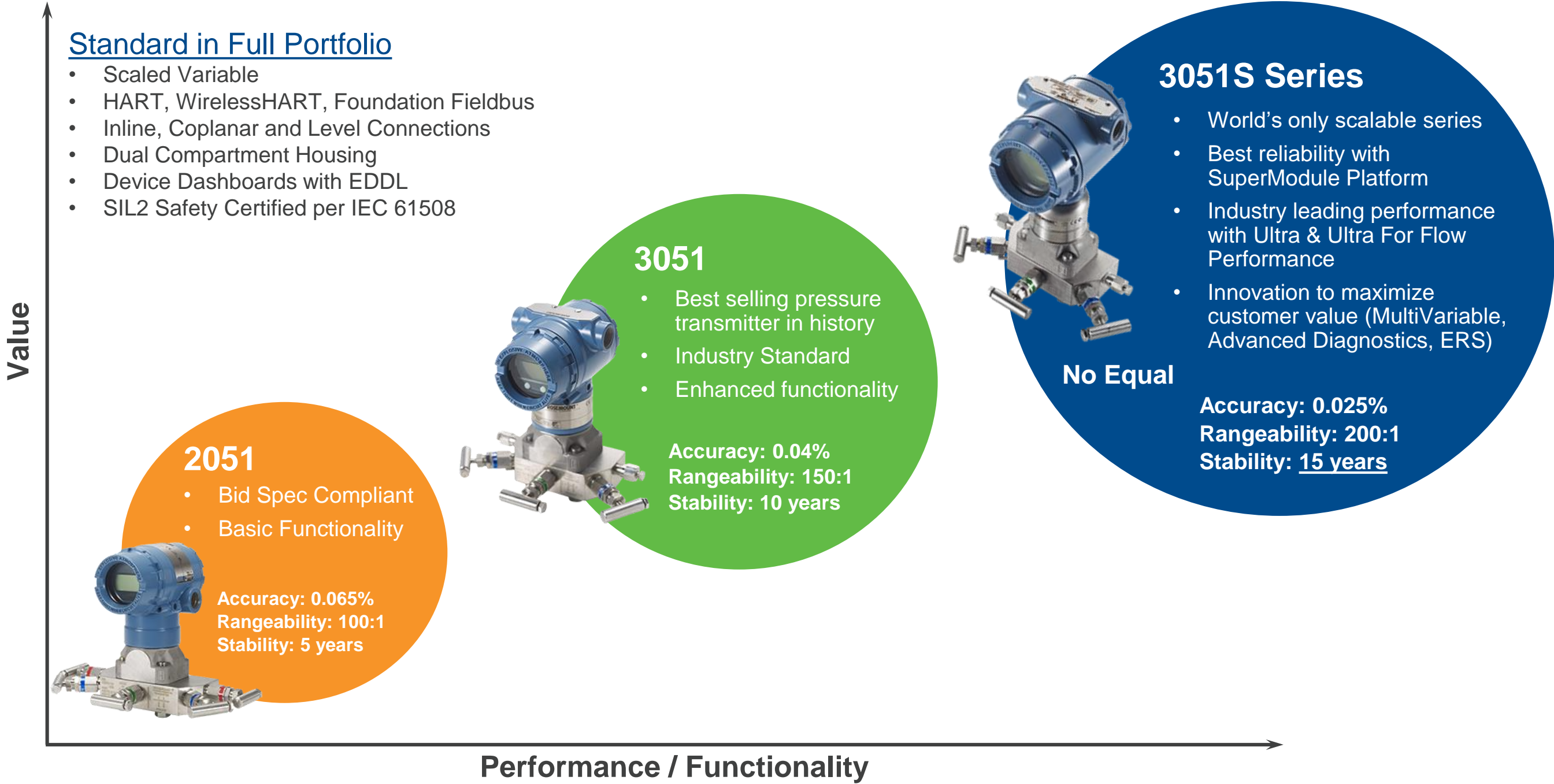
Pressure Products

Emerson is Your Best Source for Pressure Measurement Instrumentation

- **A history you can rely on**
 - Millions of transmitters installed
 - Largest supplier in the world
- **Most capable product portfolio**
 - Superior Pressure, DP Flow, and DP Level Solutions
 - Innovative technologies
 - Advanced diagnostics & measurement
- **Customer focused**
 - Local Sales, Service, and Field Specialists
 - Global Manufacturing
- **Enabling you to be more competitive**
 - Maximizing productivity
 - Improving Quality
 - Reducing Costs
 - Enhancing Safety



Rosemount Pressure Offering is Designed to Meet All Application Needs



Rosemount 3051S

Rosemount 3051S: The Only Transmitter You'll Ever Need



Performance

Reference Accuracy:	0.025 %
Total Installed Performance:	0.1%
Stability:	15 Years
Warranty:	15 Years
Rangeability:	200:1
Safety Certified Diagnostics:	SIL 2/3

Capabilities

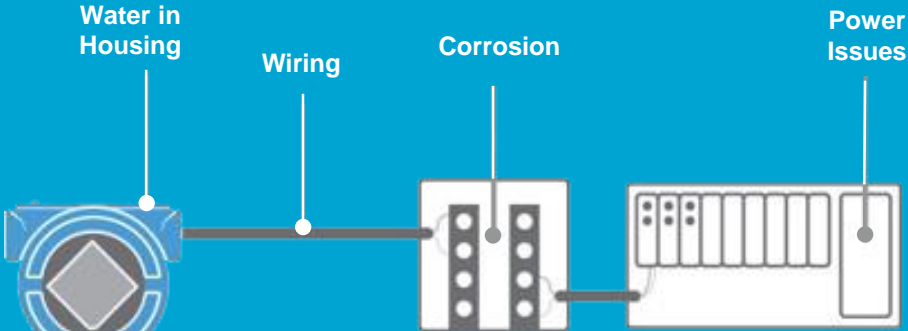
Pressure Ranges:	0.1 in.H ₂ O to 10,000 psi (0,25 mbar to 689 bar)
Process Temperatures:	-102 °F to +698 °F (-75 °C to + 370 °C)
Variables™:	DP, P, Temperature, Level, Volume, Mass & Energy Flow
Protocols:	HART®, WirelessHART®, Foundation™ Fieldbus
Diagnostics:	Complete coverage from your process to the host

Full Diagnostics: From The Process To The Control Room



Loop Integrity

Detect Electrical Loop Issues that Cause On-Scale Failures



Transmitter Health

Comprehensive Transmitter and Safety Certified Diagnostics

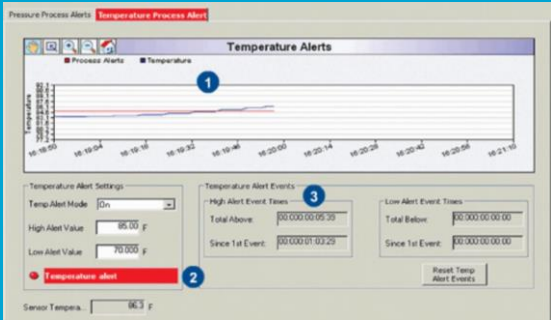
- Enhanced SIS Coverage
- Diagnostic and Event Status Logs
- Customizable Service Alerts



Process Intelligence

Spot and Diagnose Process Problems Before They Impact Production

- Plugged Impulse Lines
- Process Changes
- Process Transients



Rosemount 3051

Rosemount 3051 Capabilities and Enhancements

Enhancements

Improved Performance

- 0.04 % Reference Accuracy
- 150:1 Rangedown
- Low Temp (-60°C)

Functionality

- Scaled Variable
- Selectable HART 5/7
- Low Flow Cutoff
- Process alerts



Capabilities

- Power Advisory Diagnostics
- Local Operator Interface
- WirelessHART
- Safety Certification
- External Button Options
- Ultra Low Copper Housing Option

Industry's Broadest Offering of Pressure, Level and Flow Solutions



New Capabilities Simplify Commissioning and Maintenance

Local Operator Interface (LOI)

The LOI features straightforward menus and built-in configuration buttons so you can commission without complicated training or tools



External Buttons

External Buttons are sealed from transmitter electronics allowing for **Configuration in Hazardous Areas.**

External Buttons configurations:

LOI Operation (M4)

Used for LOI navigation

Digital Zero (DZ)

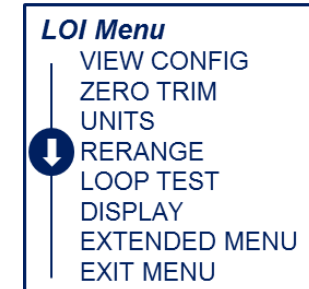
Compensate for mounting position effects

Traditional Analog Zero & Span (D4)

Re-range transmitter with applied pressure



LOI Menu



Intuitive, easy to use LOI menu enables one minute commissioning

Internal Buttons

When external button options are used for other functions, the internal buttons are always available to operate LOI.

Security

Multiple levels of security have been implemented so you can confidently control device configuration changes.



Safety Goes Beyond Certification – Rosemount 3051 Has Comprehensive Diagnostics

Sensor & Electronics Diagnostics

Real time internal component monitoring ensures measurement data reliability

Process Alerts

Proactive notification of process excursions allowing you to take preventive action



Power Advisory

Power Advisory monitors the integrity of electrical loop notifying you of on-scale failures. Available with safety certification.

Safety Certification

Easily meet safety requirements with SIL2/3 Certification (IEC 61508)

Rosemount 2051

Rosemount 2051 Capabilities and Enhancements

Enhancements

Improved Performance

- 0.065 % Reference Accuracy
- P8: 0.05% Ref. Acc.
- 100:1 rangedown
- Low Temp (-60 °C)

Functionality

- Scaled Variable
- Selectable HART 5/7
- Low Flow Cutoff
- Process alerts



Capabilities

- Local Operator Interface
- WirelessHART
- Safety Certification
- External Button Options

Offering of Pressure, Level and Flow Solutions



Rosemount Wireless for Pressure



Rosemount Wireless Pressure Offering

All Products Provide

- 10-year power module life
- Scaled variable functionality
- Integrated flow, level and pressure solutions



Rosemount 2051 Wireless

- 0.065% span
- 5-year stability
- Polymer housing
- Internal antenna



Rosemount 3051 Wireless

- 0.04% span
- 10-year stability
- Polymer housing
- Internal antenna
- Process alerts



Rosemount 3051S Wireless

- 0.025% span
- Ultra / Ultra for Flow
- 15-year stability
- 15-year limited warranty
- Aluminum / SST housings
- Expanded wetted materials
- External antenna options
- Process alerts

New to Market Capabilities Deliver Increased Reliability, Personnel Safety and Product Longevity

Designed to ASME B40.1 Specifications

WirelessHART® Protocol

Analog Display – 4.5” (115 mm)

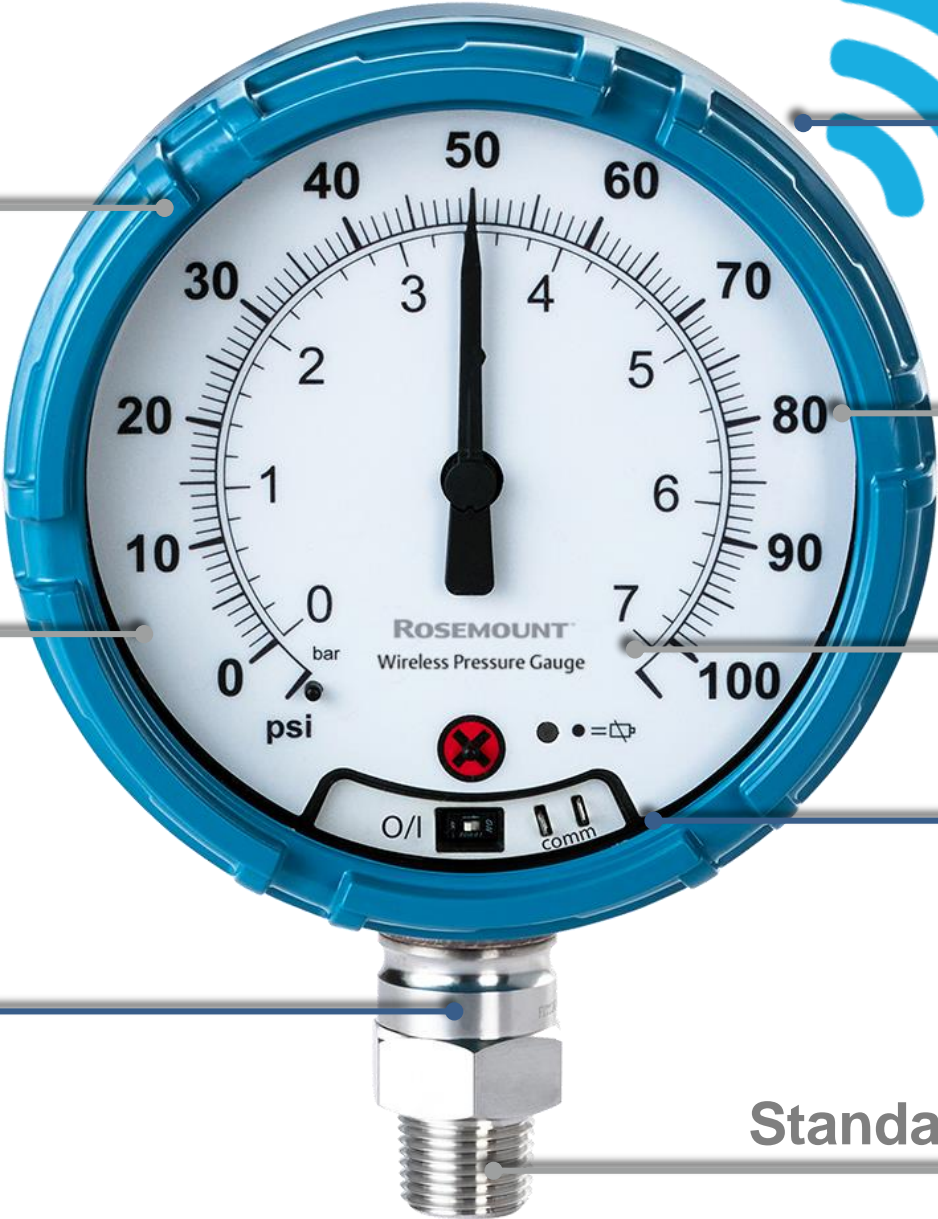
Accuracy – Grade 2 (0.5% of Span)

Scales – Single / Dual

Local Status Indication

Industry Proven Pressure Sensor Technology

Standard Process Connections

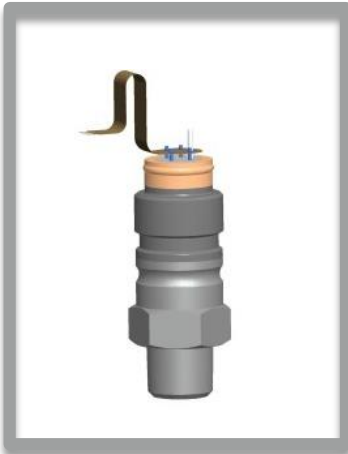


Robust Product Design and Decreased Number of Mechanical Components Extend Product Longevity

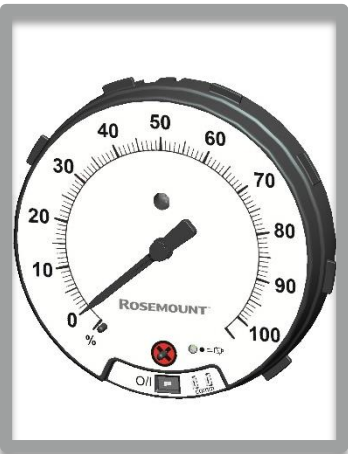
Robust Design + Piezoresistive Pressure Sensor

Reduced Mechanical Components - Standard

- Designed to maintain structural integrity across various process pressure fluctuations
- No case filling required
- Components:



Solid State Sensor



Electronics Radio/Antenna



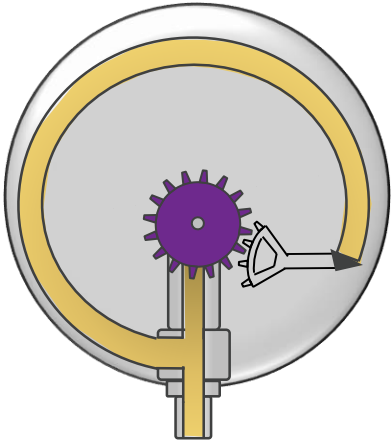
Pressure Reading

10-year installed life

Bourdon Tube

Mechanical Components + Linkages

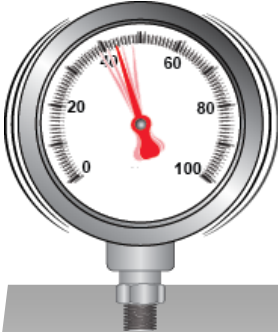
- Vibration and Pulsation wear components



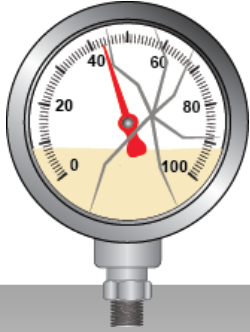
Components

- Tube
- Linkages
- Pins
- Gears

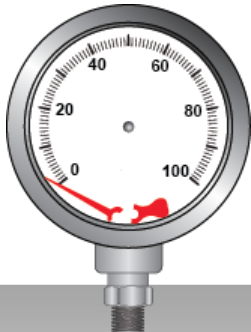
- Potential Risks:



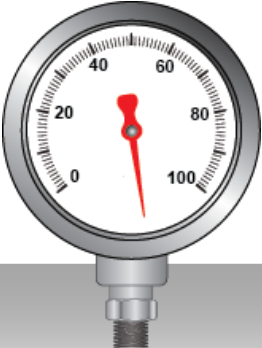
Violent Shaking



Cracked Glass or Casing



Disconnected Dial

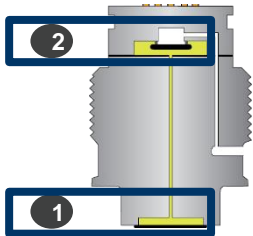


Loose Dial

The Rosemount Wireless Pressure Gauge Helps You...

Reduce maintenance challenges with industry-proven sensor technology

Multiple Isolation Barriers



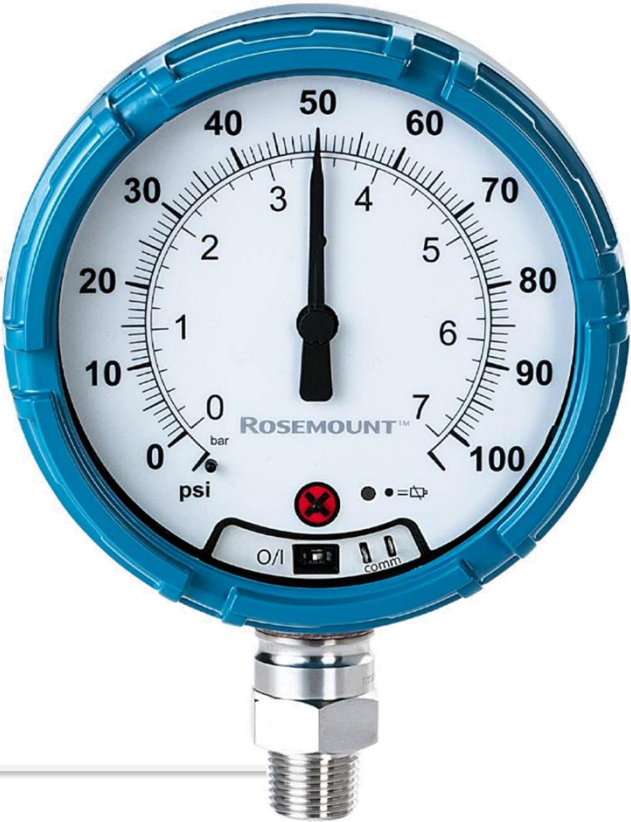
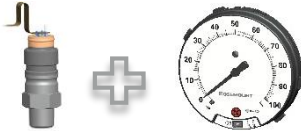
High Overpressure Resistance

Up to 150x of Scale Range

Burst Pressure Limits

Up to 11,000 psi (758 bar)

Reduced Mechanical Components



Improve personnel safety with enhanced gauge quality and reliability

Robust Product Design

10-year installed life

Brand

ROSEMOUNT™

Status Indication



Battery Life



Verify pressure readings without leaving the control room

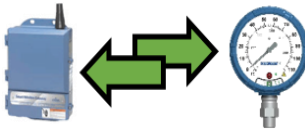
Personnel Safety



Data Reporting



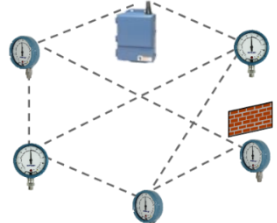
Data Availability



Access Remote Locations



Process Insight



Temperature Products

SENSORS AND THERMOWELLS



THERMOWELLS



GENERAL USE
SENSORS



HIGH TEMPERATURE
SENSORS



PROFILING
SENSORS



NON-INTRUSIVE
SENSORS

TRANSMITTERS



HIGH DENSITY MEASUREMENT



SINGLE POINT MEASUREMENT

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ROSEMOUNT TEMPERATURE

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Rosemount Single Point Temperature Transmitter Offering



Rosemount 648

- WirelessHART
- IS Power Module
- Configurable Alerts
- LCD



Rosemount 3144P

- Single or Dual Sensors Input
- HART & FF
- Hot Backup
- T/C Degradation
- Min/Max Tracking
- Sensor Drift Alert
- Transmitter-Sensor Matching
- Dual Compartment
- SIL 2 certified
- LCD



Rosemount 644

- DIN A and Railmount
- HART, FF & Profibus
- Transmitter-Sensor Matching
- LCD & LOI
- SIL 2 certified
- Single & dual sensor input
- Hot Backup
- T/C Degradation
- Min/Max Tracking
- Sensor Drift Alert



Rosemount 248

- DIN B and Railmount
- HART & WirelessHART



Rosemount 148

- Head mount
- PC Programmable



- Quality
- Reliability
- Performance
- Complete Point Solutions



Transmitters: Improve Reliability

3144P



The premier transmitter for safety, control, and reliability

Field Hardened Dual Compartment Housing

- Fully Potted Electronics
- Completely Isolated Cavities
- Self Draining Conduit Entries
- Superior EMI/RFI Resistance

Safety Certified

- SIL 2

5 Year Stability

Dual Sensor Capable

Diagnostics Suite

- Hot Backup
- Sensor Drift
- Thermocouple Degradation
- Min/Max Logging
- Statistical Process Monitoring

Transmitter Sensor Matching (Callendar Van Dusen)

Integral Transient Protection

Rosemount 644 Provides Added Functionality

Expanded Functionality

- Dual sensor inputs
- SIL 2 Safety Certified to IEC 61508
- Advanced diagnostic offering
- Enhanced accuracy and stability
- Advanced LCD display with Local Operator Interface
- Integral transient protection
- Large, 3-conduit junction box
- Selectable HART Revision (5 and 7)

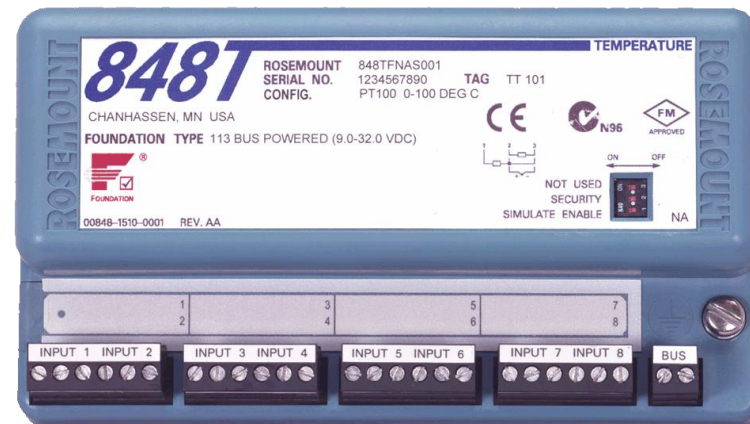


High Density Measurement

Rosemount 848T Family *The First Choice Solution for High Density Applications*

- Heat Exchangers
- Bearing Temperatures
- Distillation Column and Reactor Profiles
- Boilers
- Tanks

Rosemount 848T Foundation Fieldbus



Rosemount 848T Wireless



- Quality
- Reliability
- Performance
- Complete Point Solutions






Temperature Innovation



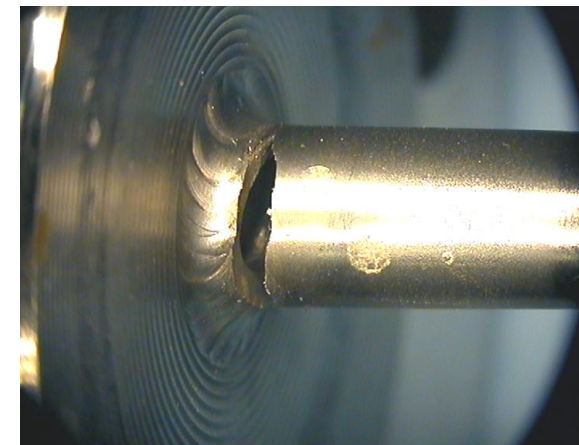
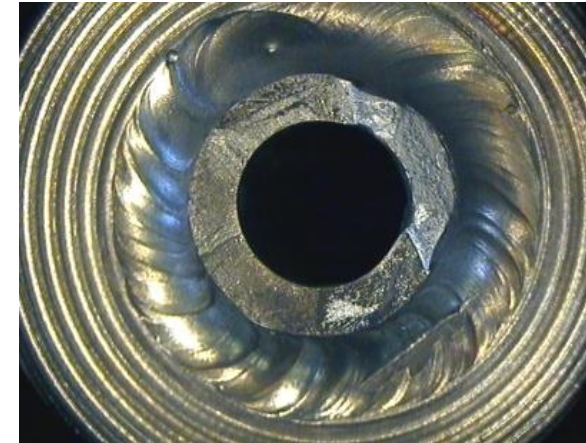
Emerson's Approaches to Improving Safety and Reliability for Thermowells



<p>3) Eliminate</p>	<p><u>Eliminate thermowells altogether</u> and reduce the risk of process leaks and thermowell failure to zero</p>	 <p>Rosemount X-well™ Technology</p>
<p>2) Suppress</p>	<p><u>Suppress effects</u> on the thermowell induced by process conditions</p>	 <p>Rosemount Twisted Square</p>
<p>1) Prevent</p>	<p>Utilize known process parameters, product designs, best practices & calculations</p>	 <p>Thermowells & Thermowell Calculation Software</p>

Thermowells: A Critical Part of Temperature Measurement

- Thermowells are the KEY barrier between the process and the sensor and instrumentation
- Thermowells can fail
 - Vibration fatigue
 - Bending stress
 - Process pressure
 - Corrosion and erosion
 - Other mechanical and chemical stresses



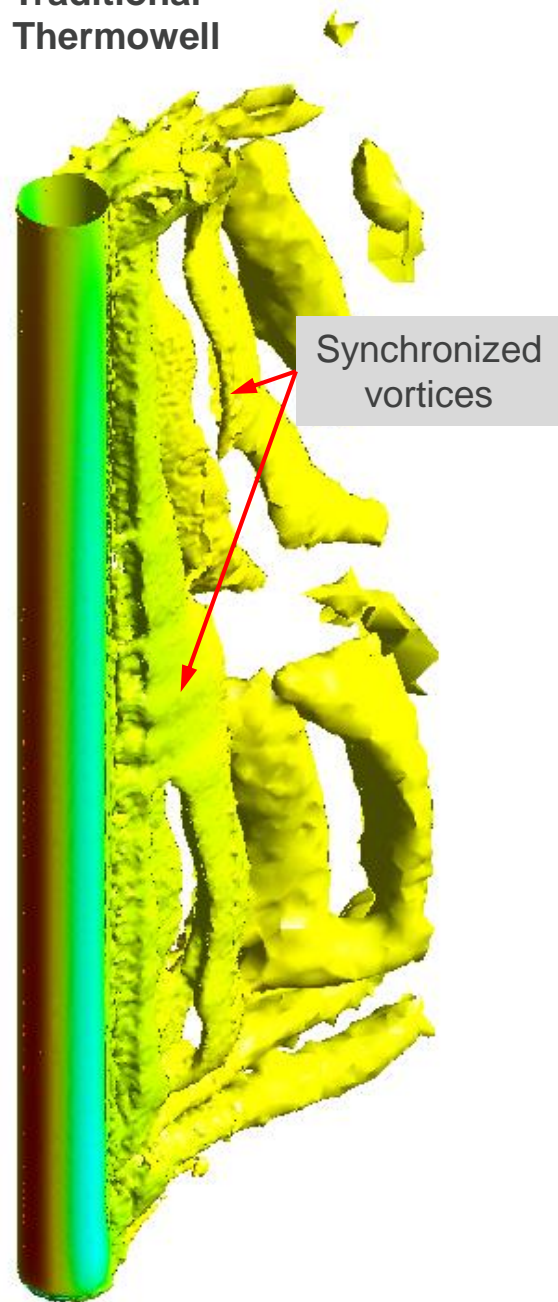
Rosemount Twisted Square Thermowell

- Revolutionary patented design that improves reliability and reduces risk
 - Eliminates over 90% of dynamic stress (primary source of thermowell fatigue failures)
- Great solution for thermowells that do not pass ASME PTC 19.3 TW evaluations
- Simplifies design effort by reducing iterative calculations
- Available in a wide variety of mounting styles, materials and process connections



Twisted Square™ Eliminates Over 90% of Flow Induced Vibration

Traditional Thermowell



Synchronized vortices

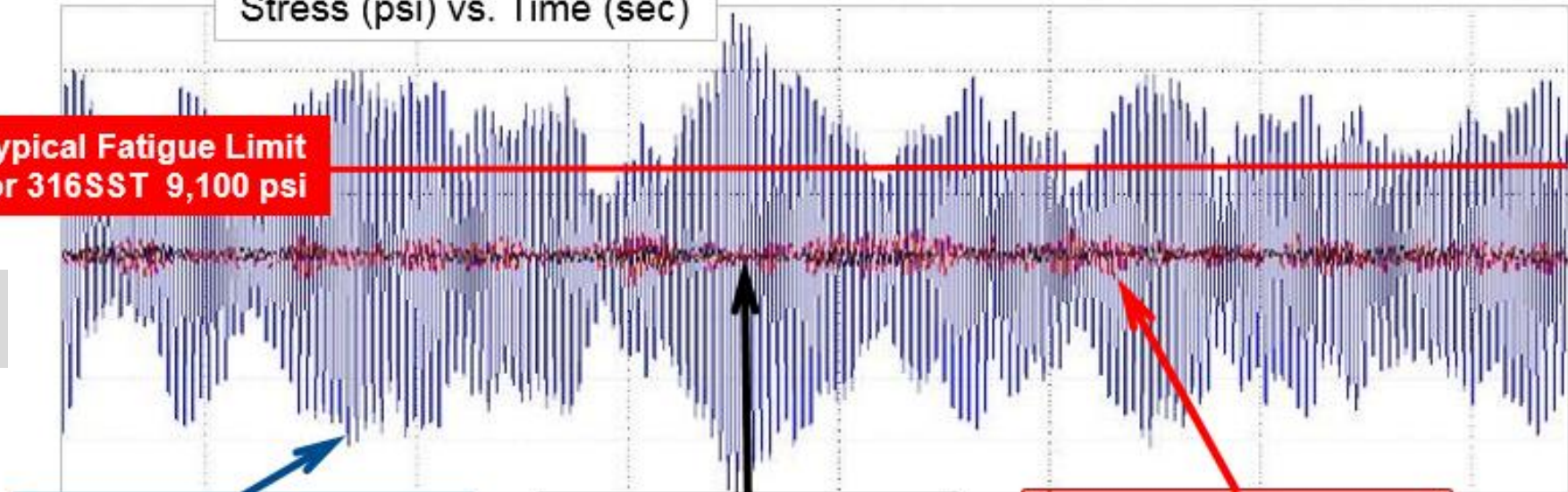
Twisted Square



Vortex disruption

Stress (psi) vs. Time (sec)

Typical Fatigue Limit for 316SST 9,100 psi



Traditional t-well
15 ft/s flow velocity
Max Stress: **21,550** psi
Mean Stress: **10,390** psi

Twisted Square
15 ft/s flow velocity
Max Stress: **1,200** psi
Mean Stress: **400** psi

Twisted Square
25 ft/s flow velocity
Max Stress: **3,050** psi
Mean Stress: **920** psi

- Traditional thermowell
 - Ribbons of vortices to synchronize and shed along entire span
 - Alternating low pressure cells apply destructive forces on thermowell
- Twisted Square
 - Twisted separation point prevents vortex synchronization
 - Balanced side-to-side forces due to disruption of alternating pattern

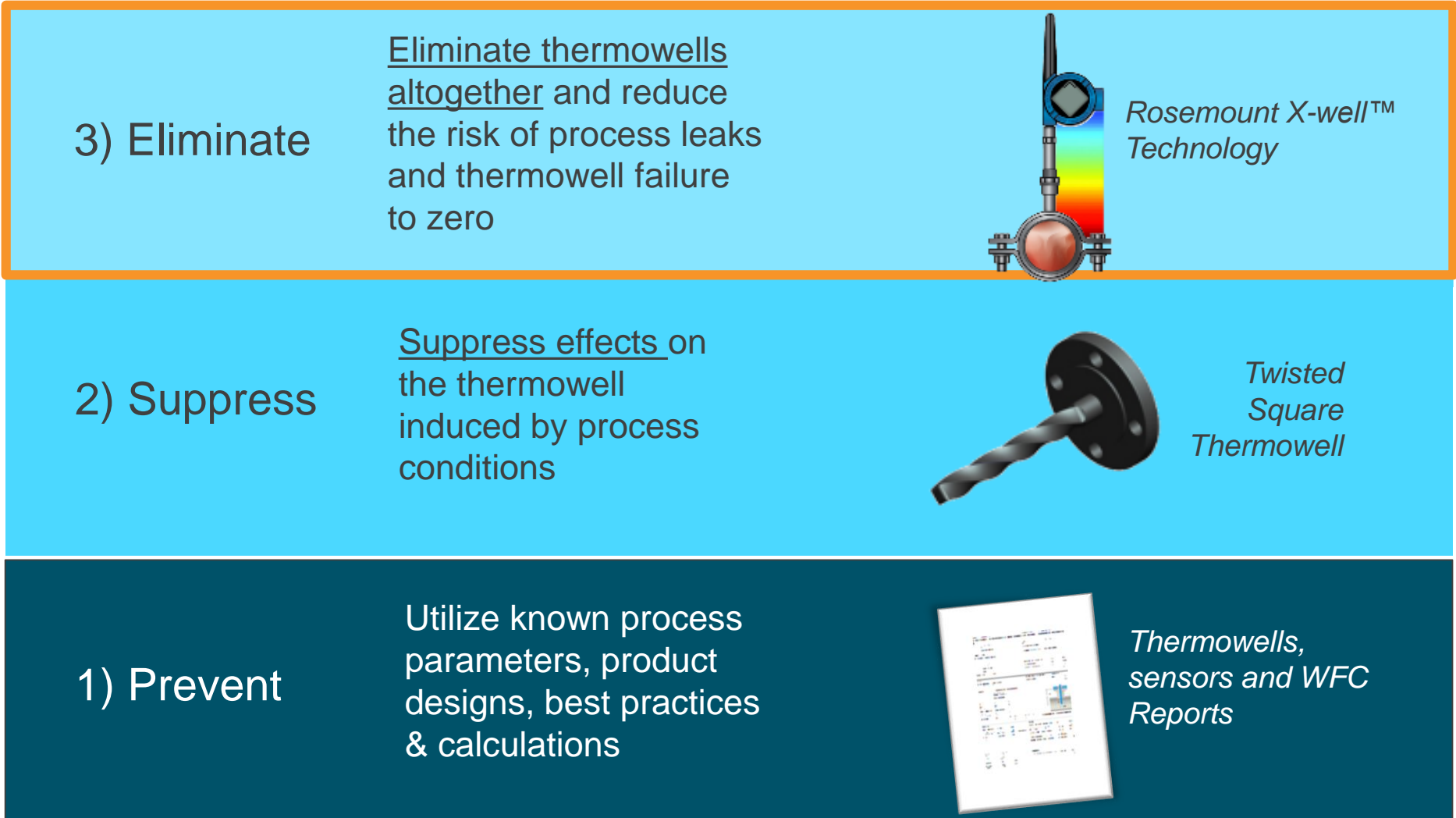
Rosemount Twisted Square Thermowell Benefits

- Reduces design effort for thermowell calculations
 - Fewer required inputs than PTC 19.3 TW-2016
 - Use worst case scenario for robust design
- Perfect solution for applications with changing process conditions
- Design thermowell to allow for future expansion
- Pain-free retrofit option
 - Avoids complicated and expensive field modifications to pipe
- Allows for longer thermowells at higher velocities
- Design one robust thermowell to be used in different applications
- Reduces inventory
 - Use the same thermowell size for more of your temperature points
- Available with the full offering of Rosemount Sensors and Transmitters factory assembled



Emerson's Approaches to Improving Safety and Reliability for Thermowells

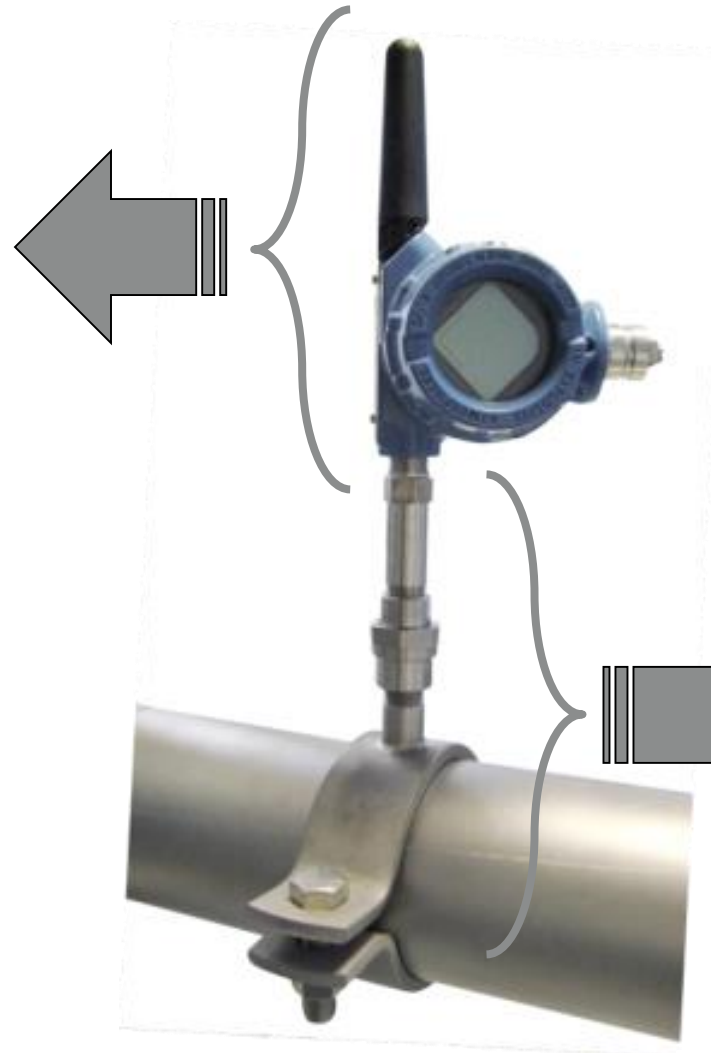
Levels Of Protection



Non-Intrusive design eliminates the need for WFC's

Rosemount Wireless Temperature Transmitters

- **Easy** to communicate temperatures from the field
- **Fast** installation and commissioning within minutes
- **No wires**
- Available “Extended Range” antenna



Rosemount Pipeclamp Sensors

- **Easy** to add new temperature measurements
- **Fast** installation within minutes
- **No process intrusions**

Current Temperature Measurement: Traditional Surface Sensor Assembly

Surface temperature

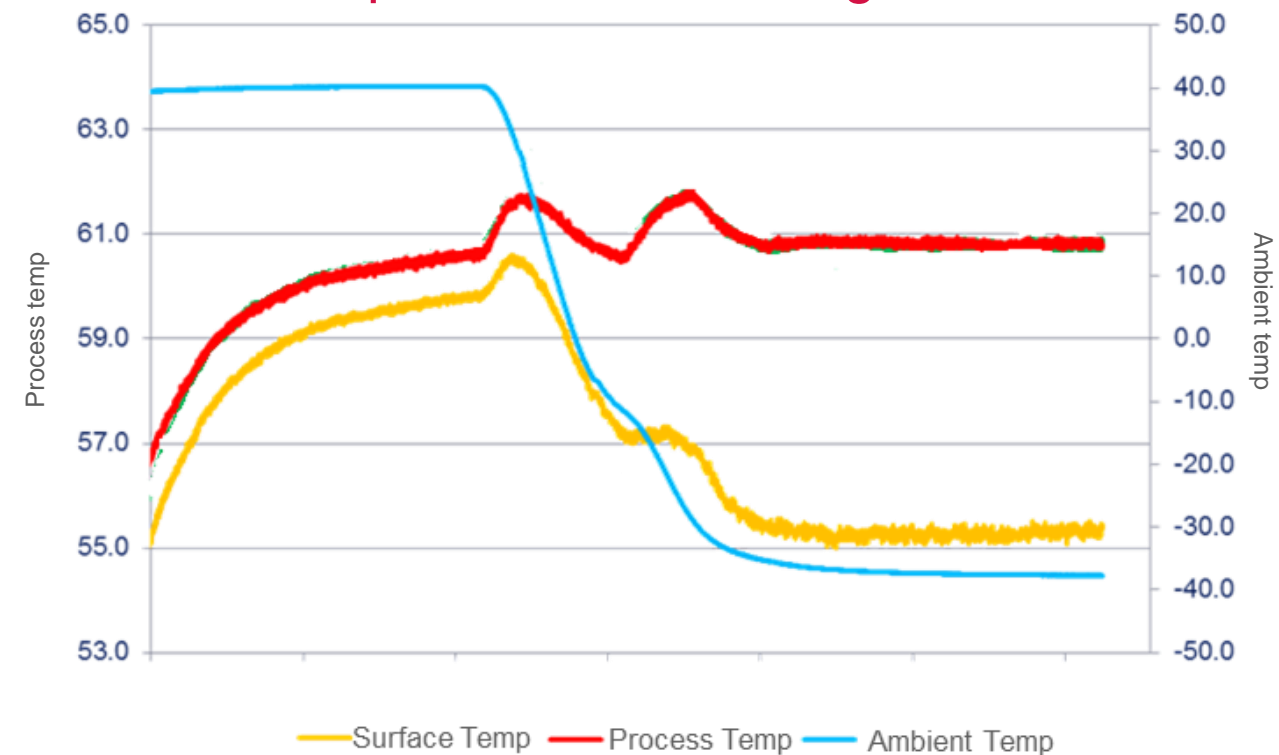
No leak point

No wake frequency calculations

Easy install

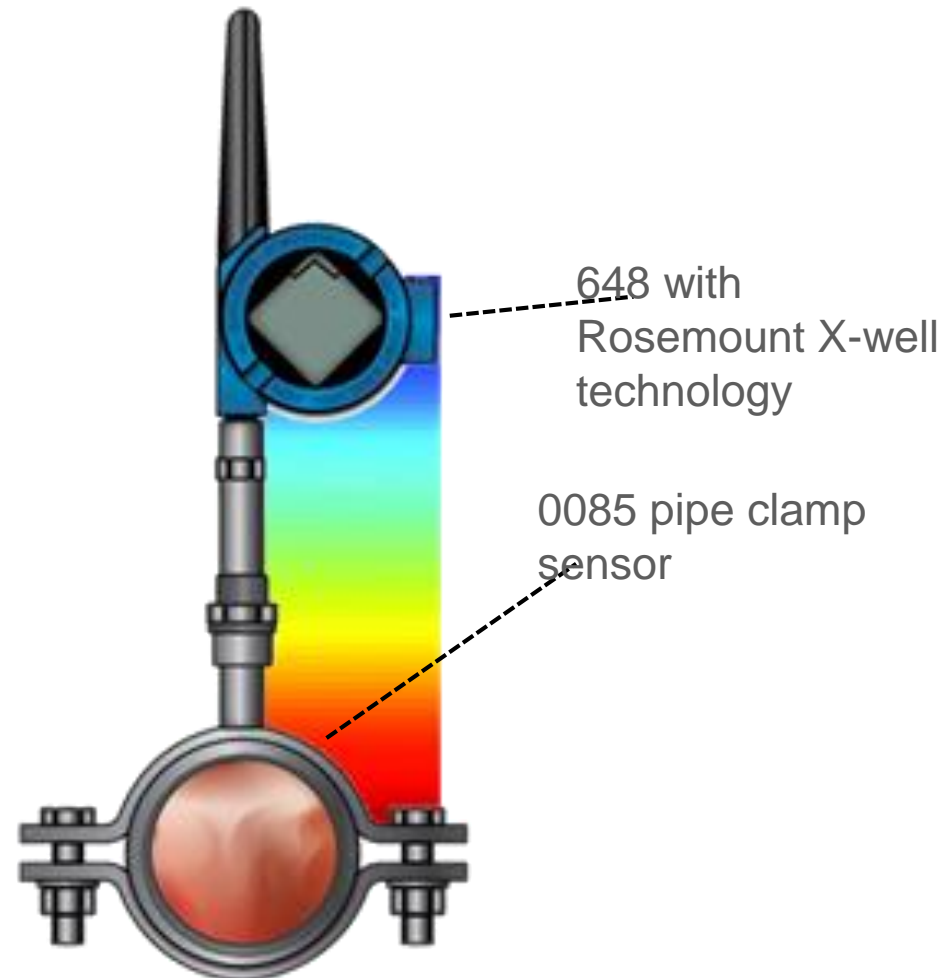


- No pipe penetration required
- Simplified design considerations: no wake frequency calculations
- Applicable for small pipe applications
- Applicable for viscous processes
- Reduced maintenance/no process shutdown
- **HOWEVER...surface temperature does NOT give an accurate or repeatable representation of how the process is behaving**

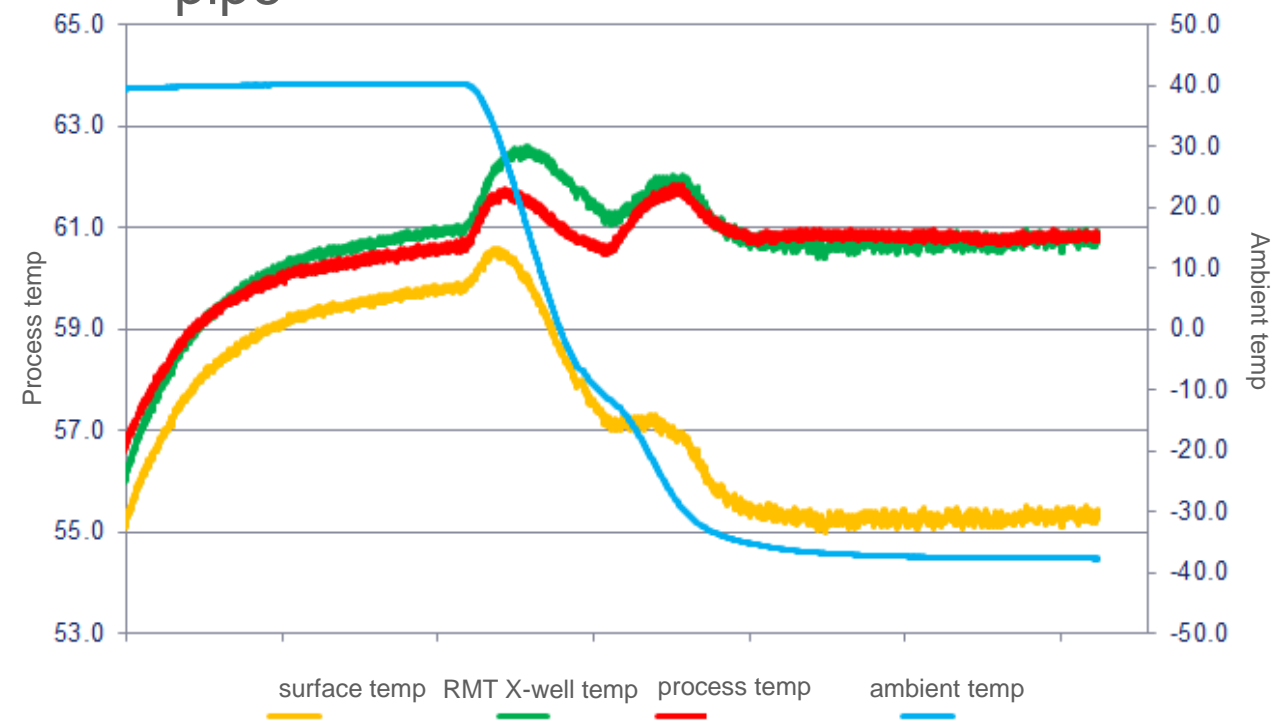


Introducing Rosemount X-well Technology! A New Way To Measure Temperature

Accurate process temperature
No leak point
No wake frequency calculations
Easy install



- Complete point solution for measuring process temperature without the requirement of a thermowell or process penetration
- Process temperature calculated via Rosemount X-well thermal conductivity algorithm which takes into account thermal conductive properties of the temperature assembly and process pipe

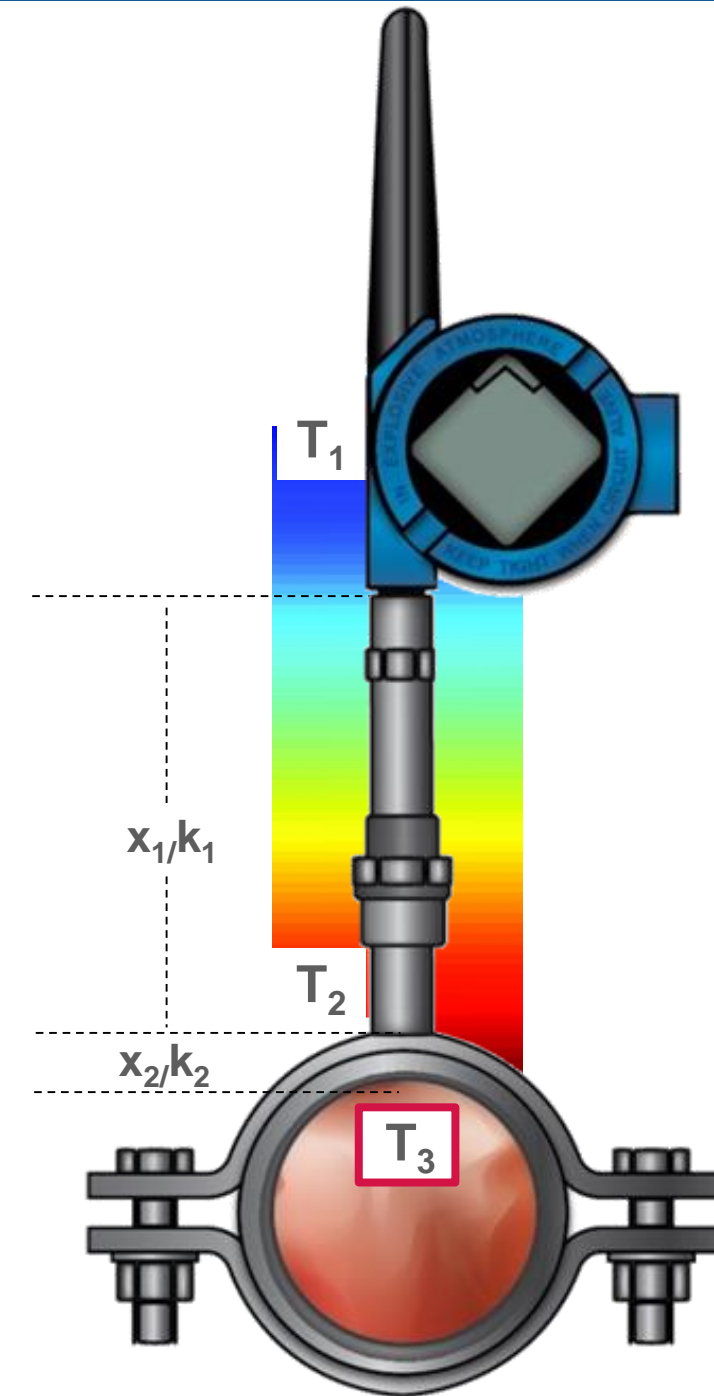


How Rosemount X-well Technology Works

- By measuring ambient (T_1) temperature and pipe surface temperature (T_2)

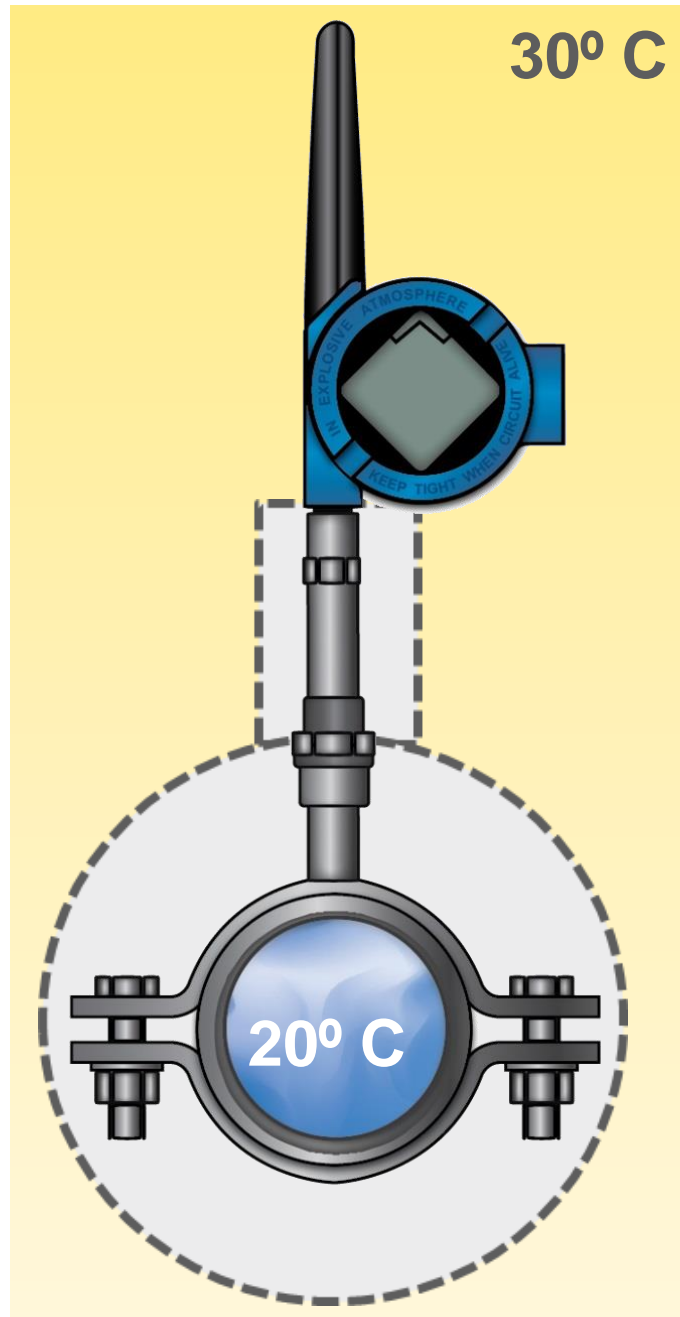
And combining that with...

- An understanding of the temperature measurement assembly's thermal conductivity properties....
- User supplied information on their process piping...
 - Pipe material
 - Pipe schedule
- Rosemount X-well Technology can calculate and extrapolate the process temperature inside the pipe (T_3)



Total System Accuracy Comparison #1

Process Near Ambient Temperature



648+Thermowell+RTD

Worst Case Error
 DA+ ATE+SE
 0.225 °C + 0.045 °C + 0.19 °C
±0.46°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + SE^2}$
 $\sqrt{0.225^2 + 0.045^2 + 0.19^2}$
±0.30°C

648+X-Well

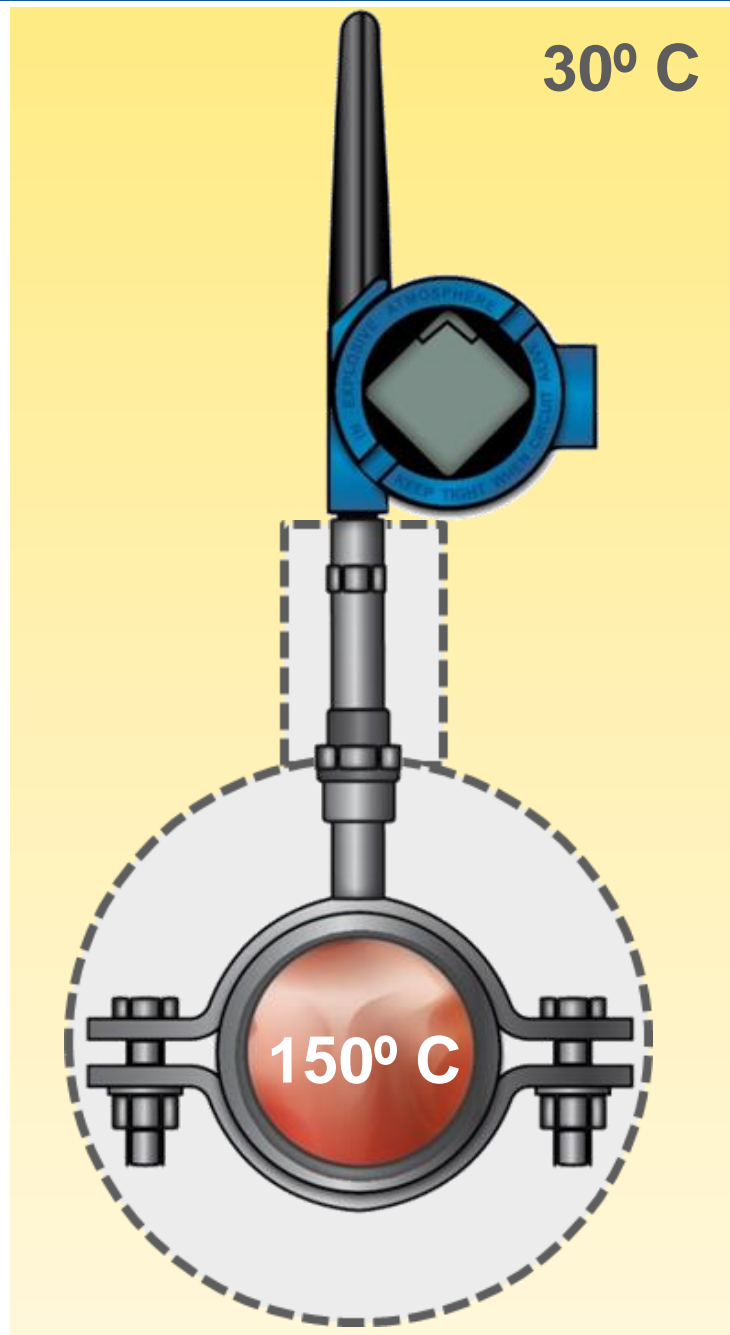
Worst Case Error
 DA+ ATE+ PTE+SA
 0.29 °C + 0.058 °C + 0.10 °C + 0.19 °C
±0.64°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + PTE^2 + SA^2}$
 $\sqrt{0.29^2 + 0.058^2 + 0.10^2 + 0.19^2}$
±0.37°C

When process and ambient temperature are similar
Rosemount X-well accuracy ~ traditional thermowell accuracy

Total System Accuracy Comparison #2

Process Differs From Ambient Temperature



648+Thermowell +RTD

Worst Case Error
 DA+ ATE+SE
 0.225 °C + 0.045 °C + 0.45 °C
±0.72°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + SE^2}$
 $\sqrt{0.225^2 + 0.045^2 + 0.45^2}$
±0.51°C

648+X-Well

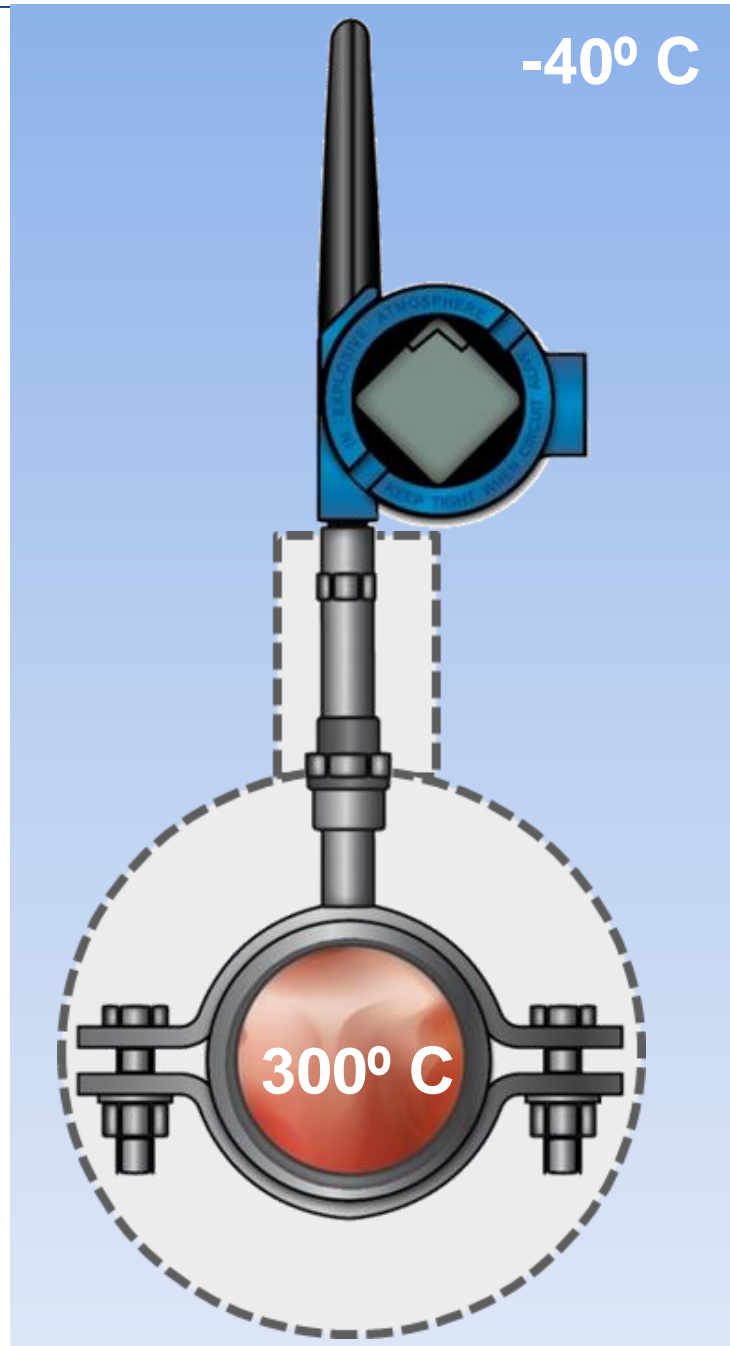
Worst Case Error
 DA+ ATE+ PTE+SA
 0.29 °C + 0.058 °C + 1.2 °C + 0.45 °C
±2.00°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + PTE^2 + SA^2}$
 $\sqrt{0.29^2 + 0.058^2 + 1.2^2 + 0.45^2}$
±1.32°C

When process and ambient temperature differ
Rosemount X-well accuracy becomes slightly less than
traditional thermowell accuracy
TPE less than 1% of process temperature

Total System Accuracy Comparison #3

Rosemount X-well Worst Case Scenario



648+Thermowell +RTD

Worst Case Error
 DA+ ATE+SE
 0.225 °C + 0.27 °C + 0.75 °C

±1.25°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + SE^2}$
 $\sqrt{0.225^2 + 0.27^2 + 0.75^2}$

±0.83°C

648+X-Well

Worst Case Error
 DA+ ATE+ PTE+SA
 0.29 °C + 0.348 °C + 3.4 °C + 0.75 °C

±4.79°C

Total Probable Error
 $\sqrt{DA^2 + ATE^2 + PTE^2 + SA^2}$
 $\sqrt{0.29^2 + 0.348^2 + 3.4^2 + 0.75^2}$

±3.51°C

When process and ambient temperatures are at opposite ends of X-Well sensor limits, Rosemount X-well will be at its most inaccurate **TPE less than 1.2% of process temperature**

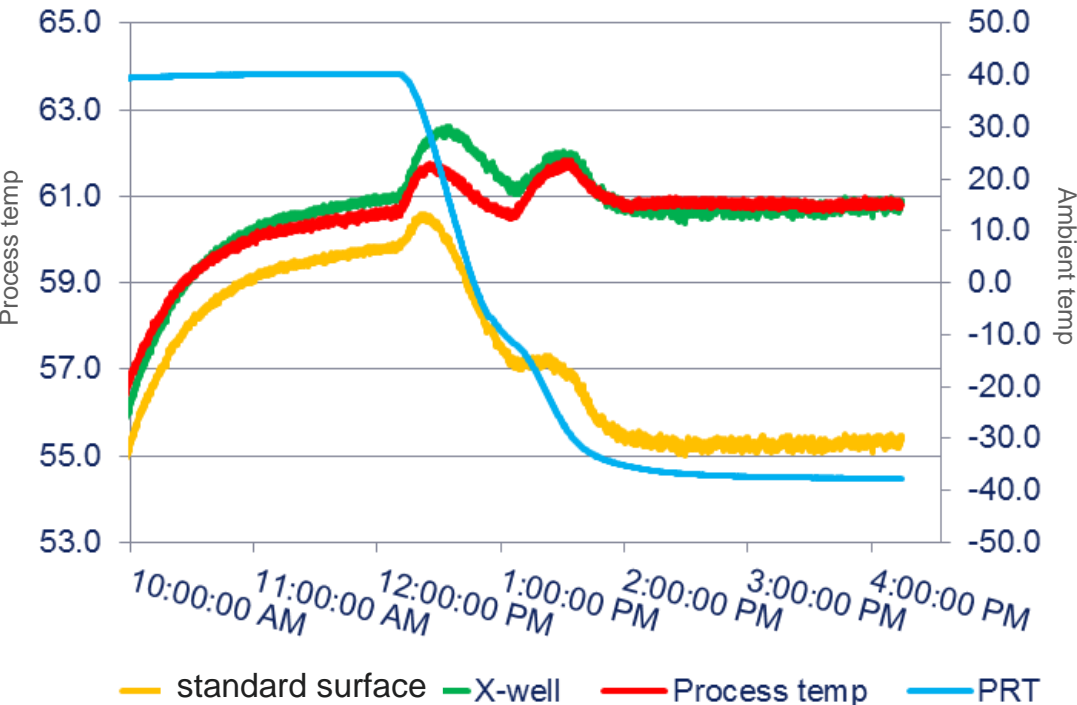
Accuracy Calculator available



Rosemount X-well Performance Under Various Conditions

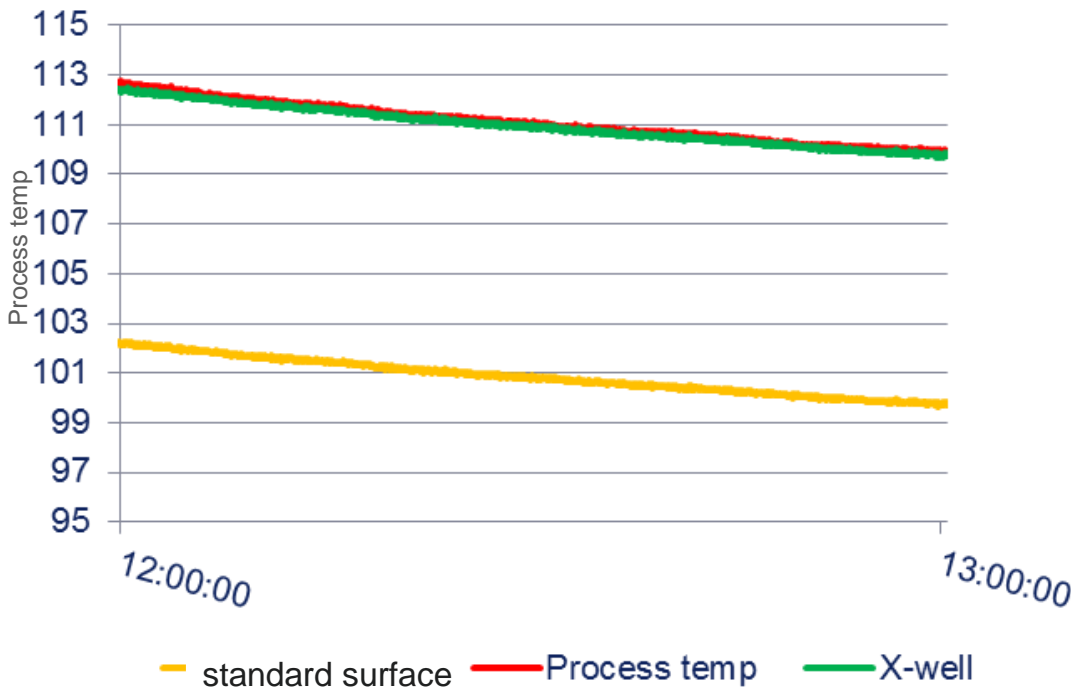
Changing Ambient

- Water loop
- Carbon steel pipe
- Process temp 60 °C
- Ambient temp changes from +40 to -40 sharply
- Error w/out correction up to 5 °C
- **Error w/ X-well < 0.2 °C**



Large Ambient and Process Delta

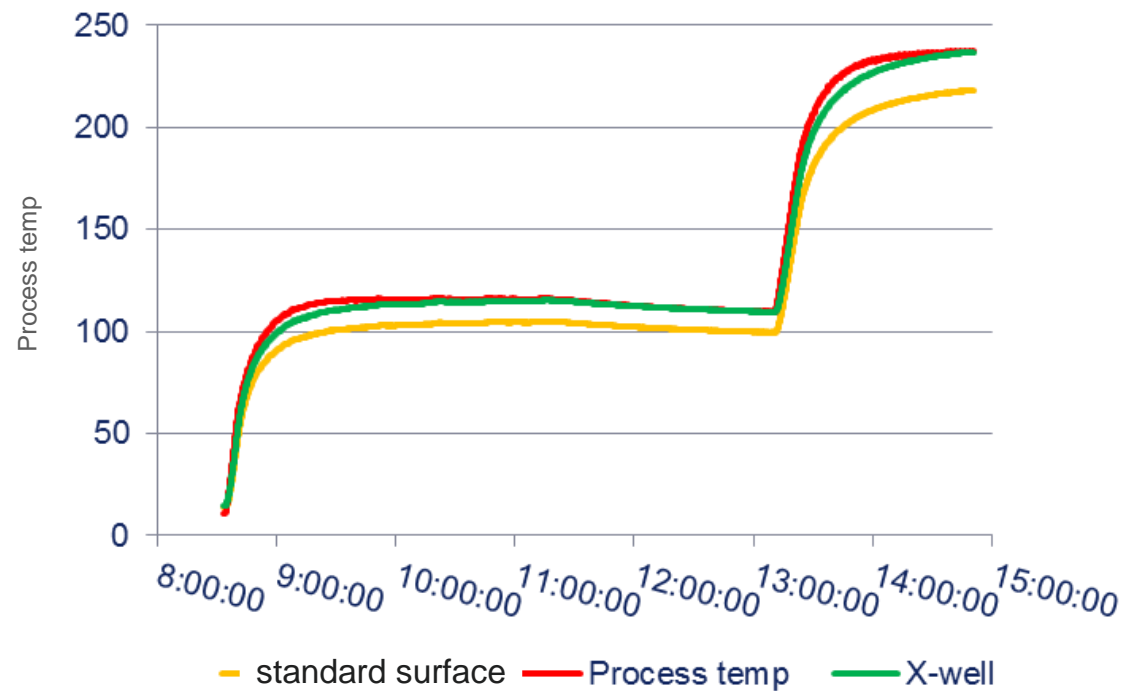
- Process temp 111 ° C
- Ambient temp -40 ° C
- Error w/out correction up to 10 ° C
- **Error w/ X-well < 0.5 ° C**



Rosemount X-well Performance Under Various Conditions

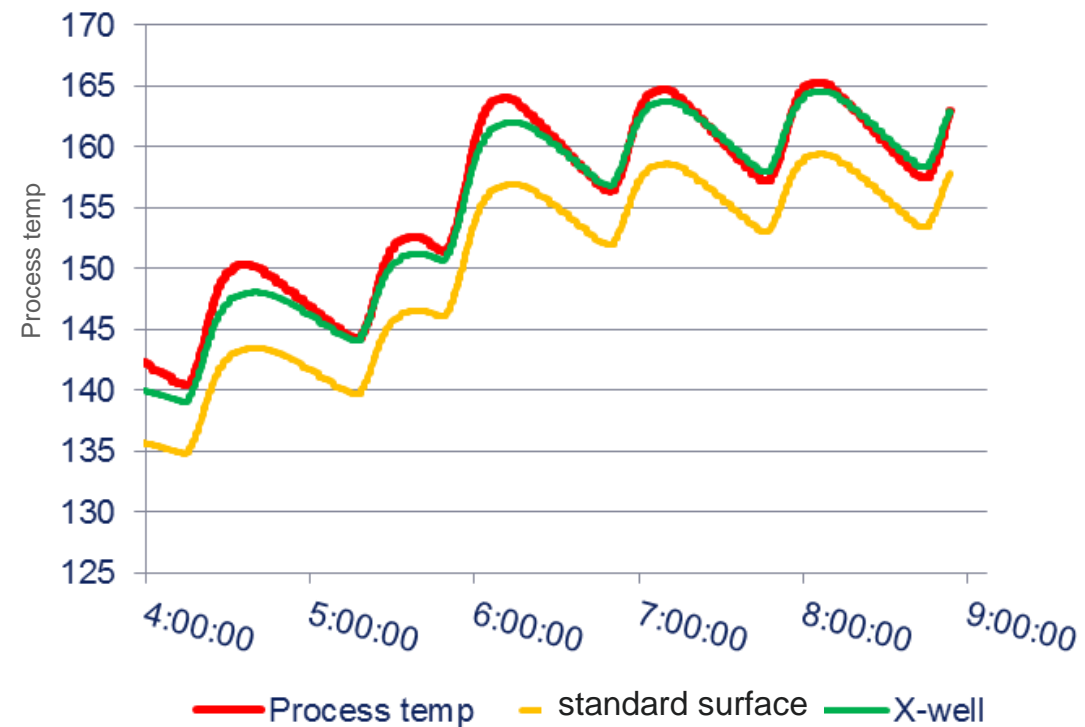
Changing Process

- Process temp 110-230 ° C
- Ambient temperature 23 ° C
- Error w/out correction up to 10 ° C
- **Error w/ X-well < 0.5 ° C**



Unstable Process- Large Ambient and Process Delta

- Process temp smoothly increases from 140 to 165 ° C
 - Ambient temperature 23 ° C
 - Error w/out correction is about 8 ° C,
 - **Error w/ X-well < 3 ° C**
- (non stable process)



Questions
