

White Paper

How to Specify a Corrosion or Erosion Monitoring System

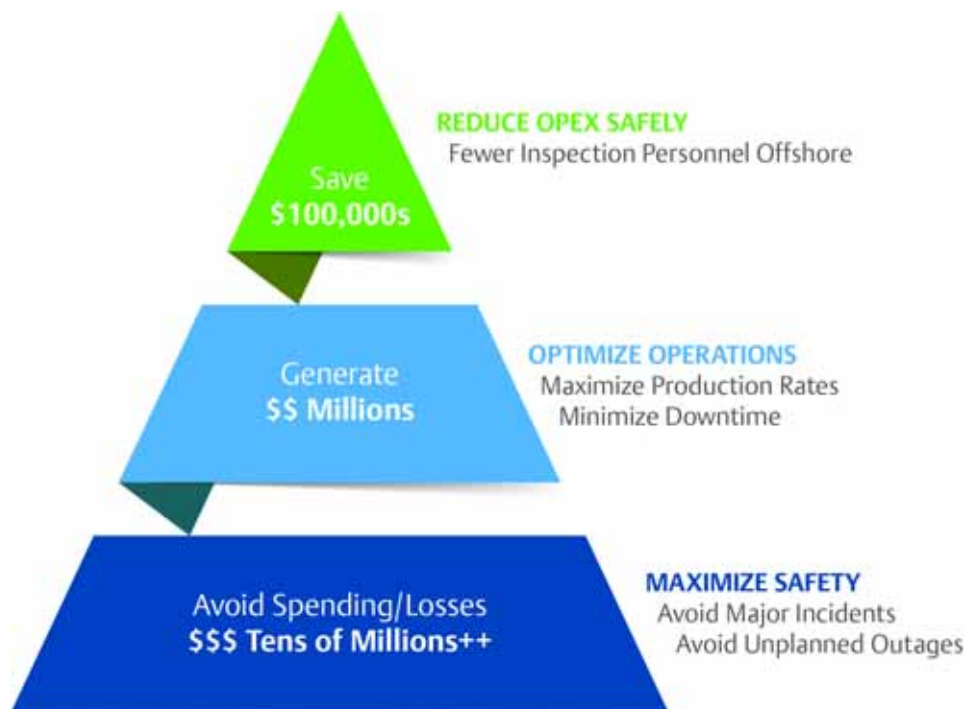


How to specify a corrosion or erosion monitoring system

Introduction

Online corrosion and erosion monitoring systems are fast becoming industry best practice in oil and gas. These systems can deliver the missing piece of the information puzzle that is traditionally lacking to inform a large range of operational decisions. The right monitoring system will deliver the quality and frequency of integrity measurements in real time to the desks of those who need the information to better operate the asset. The wrong system will deliver useless measurements, require extensive training and expertise to install or operate, require extensive maintenance, or fail in service. This white paper will help you specify the best corrosion or erosion monitoring system for your application, resulting in genuine value-add to your operational performance and a system payback in weeks to months. The common thread when specifying a monitoring system is to rely on field experience and references over laboratory tests or partner promises that are not backed up by real field evidence.

Figure 1. The Value of Deploying the Right Integrity Monitoring System

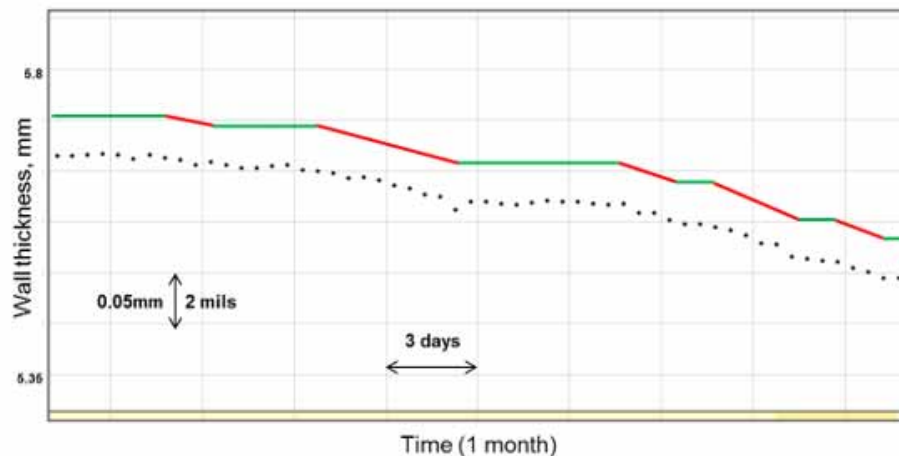


Measurement quality: the most important factor

A monitoring system that does not produce actionable data is not worth the investment. At the other end of the spectrum, a monitoring system that delivers the desired quality and frequency of measurements will deliver a payback time of just weeks to months. Noting that intrusive probes can only infer the damage that is occurring to the actual equipment wall, systems that directly measure wall thickness offer more valuable insight and do not carry the safety issues and high installation and maintenance costs associated with intrusive equipment.

For monitoring purposes, an ability to detect and measure a wall thickness loss is generally more important than the absolute accuracy of a single measurement. Beware of partners who quote "resolution" and "accuracy" without real supporting data from the field as evidence. Some partners quote resolution as the number of decimal places that the thickness measurement is recorded to; the actual measurement repeatability is likely to be substantially worse than this. Others quote results from data collected under controlled laboratory conditions, which will not be achievable under real field conditions. Ask to see real field data where wall loss has been detected and measured as a means to determine how small a metal loss is measurable and how quickly that loss would be detected in the data. Also ask to see real field experience that the measurement quality will not degrade over time, for example, as piezoelectric transducers that are in permanent contact with hot metalwork age and introduce distortion into the recorded signals.

Figure 2. Real Field Data Delivered by Rosemount™ Wireless Permasense System



Ease of extracting value from the data: data visualization and analysis

A monitoring system is likely to deliver a step-change in the frequency of integrity measurements that you receive when compared to traditional manual inspection. A monitoring system will only deliver value to your operation if the system users can:

- View the data from their desks in real time
- Quickly visualize, analyze, and understand the data
- Use the data to inform operational decisions

A system where real time measurements and historical measurements are available for viewing and analysis in an easy to use data management interface at desk is best. Systems that offer browser-based data viewing are more flexible for a range of system users to use concurrently than those that require specific software applications to be installed on each user's computer.

Look for data visualization platforms that have been designed specifically for the data being delivered and with feedback for visualization and analysis features from real system users. Features—such as corrosion rate analysis and classification, multi-sensor data plotting, and reporting—make the data easier to integrate into your daily operations, delivering value from the outset.

Partner expertise in helping you specify the solution, supporting installation and use

Look for partners with genuine application knowledge, not just expertise in their own product. These partners will help you specify the right solution. Those with plenty of operating experience will also be able to offer industry best-practice amassed from their experience to date. The best partners have customer support teams who have actual industry experience, who can see things from your perspective and who understand how to address the challenges you face when specifying, installing, and utilizing a corrosion or erosion monitoring system.

Look for partners who offer ongoing customer support after you have purchased the monitoring system; to help you install the system to a high working standard, keep it working in top condition, and to help you extract value from your new monitoring data. Partners who are actively investing in improving their offering may also provide ongoing upgrades to the monitoring system, meaning that you are able to benefit from new features (for example, improvements in the data visualization and analysis software that do not exist when you originally purchase the system). The partners who invest in research and development (R&D) and customer support functions are much more likely to remain in business and be there to support you as you continue to integrate your monitoring data into your daily operations.

Robustness against internal surface roughness

Certain corrosion mechanisms, for example, microbial attack, naphthenic acid corrosion or sulfidation corrosion, create rough or pitted internal surfaces. Standard ultrasonic wall thickness measurements are extremely sensitive to internal surface roughness and this can confuse the wall thickness measurements that are delivered by

the monitoring system. The issue arises when this noise effect masks the wall thickness loss in the measurements, or when this noise effect shows an apparent thickness increase. Some corrosion monitoring system providers have researched this effect in detail and engineered proprietary signal processing that separates the effects of internal surface roughness from wall thickness loss. These advanced signal processing methods take advantage of the historic data delivered by the sensor to adapt and deliver wall thickness measurements that are immune to the effects of internal surface roughness. This makes the data provided considerably quicker and easier to interpret and affords a significantly wider user base since an understanding of ultrasonic physics is not required to make sense of the data or derive value from it.

Detection of the onset of corrosion

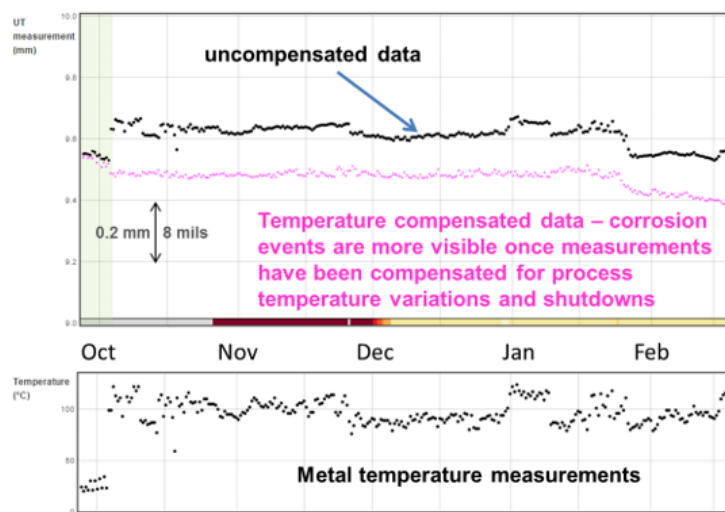
Micro-changes in internal surface condition of the pipe or vessel can be used to detect the onset of corrosion, before any wall loss even occurs. Look for systems that offer this advanced detection capability in addition to wall thickness measurements, as this will deliver an unparalleled sensitivity and detection capability to very small corrosion or erosion events. Users of these systems have reported these micro-changes in internal surface condition as measured by their corrosion monitoring system correlate with extremely small changes in the underlying corrosion variables in a refinery – for example, TAN and sulphur content of the processed crudes.

Compensation against other field variables: material, temperature

The various measurement techniques used by corrosion and erosion monitoring systems are often undesirably affected by other process variables, which can add noise to the measurements. Look for systems that can factor-out these other variables, making the data more reliable and easier to understand. For example, electrical measurements are grossly affected by temperature, and measures must be taken to avoid this unwanted effect. Electrical resistance measurements can also be affected by the electrical conductance of the fluid.

Ultrasonic wall thickness measurements are also affected by the pipe material and operating temperature since these affect the speed at which the ultrasound travels in the metal that is being measured. Look for wall thickness measuring systems that offer the functionality to reliably compensate for these field variables. In particular, the metal temperature must be measured by the sensor at each measurement point, at exactly the same time as each ultrasonic wall thickness measurement is acquired, if the operating temperature is to be accurately compensated out of the wall thickness measurements.

Figure 3. The Importance of Compensating Ultrasonic Wall Thickness Measurements



Equipment suitability

Intrusive or non-intrusive?

Intrusive probes or coupons require a hole to be made in the side of the piping/vessel so that the probe can be placed in contact with the fluid. Intrusive probes/coupons measure the damage to a sacrificial element of the device that is placed within the fluid and therefore measure the fluid corrosivity. They do not measure actual equipment integrity or the impact of the fluid corrosivity on that equipment. Damage rates to the equipment are inferred from the corrosivity measurements. Since probes/coupons are sacrificial, they need to be replaced (anywhere between every few weeks and every few years – depending on the probe sensitivity and fluid corrosivity experienced in service). Retraction and replacement of probes is a dangerous activity, requiring dedicated safety procedures and specifically skilled personnel. Even with these measures in place, many safety incidents are reported annually.

Non-intrusive wall thickness measurement devices do not require a hole in the process equipment and measure the actual equipment integrity and the damage caused to it by corrosion and erosion.

Hazardous area zoning requirements

Most oil and gas facilities/assets are zoned as hazardous, since there is the possibility of flammable gases in the local environment that could be ignited by “normal” electronics.

Consider the location of the desired monitoring locations and the associated hazardous area rating. Some partners use the explosion-proof protection concept (putting normal electronics inside metal explosion-proof enclosures), which cannot be installed in Zone 1 (ATEX) or Class 1 Div 1 (US) areas which, in most oil and gas facilities,

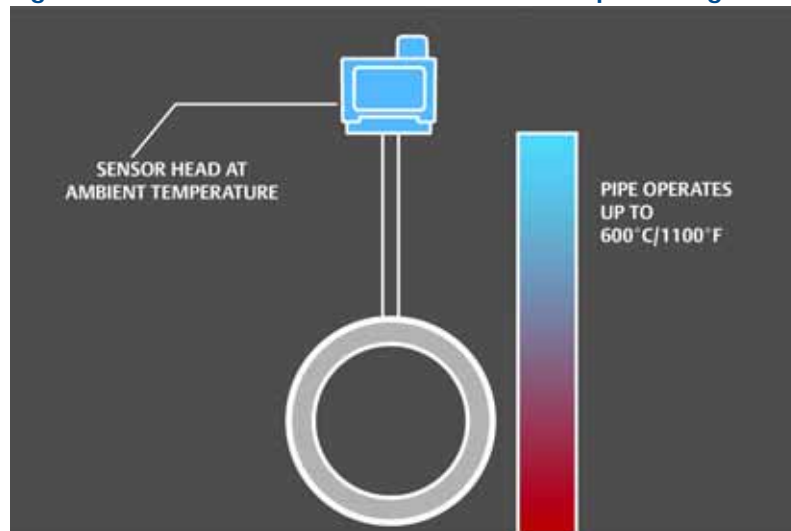
will preclude many desired monitoring locations. Instead, use devices that are designed as intrinsically safe and are therefore certified for installation in the most hazardous of locations (Zone 0, Class 1 Div 1).

It is worth noting that hazardous area classification of processing facilities can change over time and has become more stringent in the past 10 years. Therefore, it is recommended to always buy Zone 0 equipment so that the equipment does not have to be removed if the zoning requirement should become more stringent in the future.

Temperature of service

Different parts of the facility will likely operate at a range of temperatures. In addition, there may be times when the temperature of the equipment in a given location deviates substantially from the design temperature, such as when steam-cleaning the equipment. It is important that the monitoring equipment can handle any temperature that the location will operate at in the foreseeable future, to avoid damage to the monitoring equipment or loss of measurement integrity. Ask the partner for field references that the monitoring equipment will continue to function through the range of temperatures of interest for an extended period of time. Do not rely on laboratory tests that show short-term robustness of the equipment.

Figure 4. Rosemount Wireless Permasense's Unique Waveguide Technology



Installation flexibility

Look for monitoring equipment that can be installed across a wide range of locations and operating conditions without the need to specify each and every device for each location. For example, devices that can be installed in Zone 0 hazardous areas can be installed in any hazardous area. Devices that cover the full range of operating temperatures will present fewer logistical challenges than those that only work in a small subset of operating temperatures. Devices that can be installed on the full range of pipe sizes and vessels, without the need for custom made mounting solutions for each location will, again, present fewer logistical challenges than those where the exact field conditions must be specified for each location. Systems that provide their own

data retrieval infrastructure (for example, *WirelessHART*[®]) require fewer pre-checks of infrastructure availability than, for example, cellular data retrieval, which will only function in areas with good cellular coverage.

Ease of system installation

Remember to factor in the installation costs of the monitoring equipment to the total cost of ownership. The installation cost for any intrusive probe in locations where there a specific mounting flange is not already part of the fixed equipment will far outweigh the cost of the probe itself. For non-intrusive systems, the primary installation costs will be associated with gaining access to the desired locations (reduced if the installation is scheduled while staging/scaffold is already in place – for example, during a unit turnaround) and cabling. Look for systems that do not require any cabling in the hazardous area, for example, between transducers and associated electronics equipment. Such requirements will hugely increase the installation cost as well as the maintenance costs as cables are likely to be damaged in service.

Field robustness

Oil and gas facilities are extremely challenging environments for electronic instruments. Field references from similar operating conditions are the only suitable evidence that the monitoring system will survive and continue to measure reliably, under real field conditions. Choose a partner that can supply field evidence and references that the equipment is robust against real field conditions. Having to replace or re-install all of the monitoring equipment every few weeks or months is not cost-effective, especially if monitoring locations are difficult to access.

Ongoing maintenance costs

There is no point in installing a cheap sensor system that requires replacement or re-installation every few months because devices fall off the pipe work (as is almost guaranteed with epoxy-bonded transducers). The cost of access and reactive maintenance will quickly outweigh any initial cost savings on the equipment. Require a monitoring system that has proven operational robustness in the field with minimal maintenance, such as replacement of batteries every shutdown/turnaround (when there will be access to the sensor locations anyway). In addition, look for systems where the battery can be replaced in hazardous areas without the need for electrical permits as this will save time and money when carrying out this field maintenance.

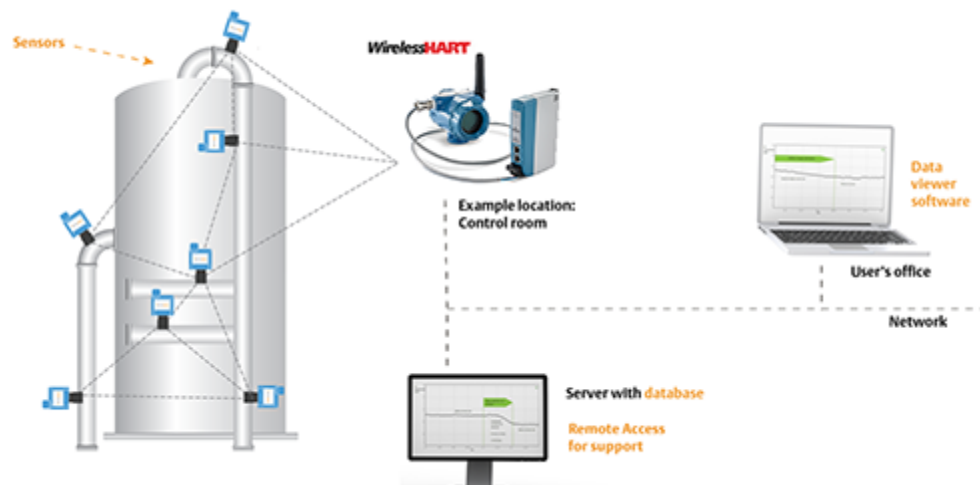
Data retrieval method

Various data retrieval methods are available to retrieve the data from the sensors that are distributed across the plant/asset:

- Cabled, e.g., 4-20mA, Modbus[®] etc., into DCS
- Industrial wireless mesh; for example, *WirelessHART*
- Cellular/GSM communication
- Satellite communication, such as Inmarsat, Iridium[®]

Cabling is extremely expensive, especially in hazardous areas where wireless data retrieval from the field devices is the preferred solution. Industrial wireless mesh protocols, most notably *WirelessHART*, are now best practice for monitoring solutions. There are no additional data retrieval costs once the system has been installed, and no radio license is required. In addition, the creation of a wireless mesh, where the monitoring devices communicate and relay information between themselves and the gateway, offer extremely robust data retrieval in industrial processing environments, particularly where line-of-sight between all measurement devices and gateways is not often possible.

Figure 5. Typical Wireless Mesh System



Cellular communication is only possible where there is good cellular coverage, and data retrieval will involve an ongoing cost that must be factored into the system lifecycle cost. In addition, different monitoring locations will require cellular data contracts with different suppliers creating logistical management challenges. Satellite communication offers true flexibility, providing near global coverage. Satellite backhaul is especially useful when there is no existing IT infrastructure to tap into, as is the case for older, unmanned production platforms. Satellite communication equipment costs can be expensive, so specify a system that does not require a satellite communication link for each sensor. Satellite communication will incur an ongoing cost. Look for partners who can manage this subscription as part of their offering.

Personally owned data

Ideally, the monitoring system's database will reside on your facility's server, rather than a partner's server. Hosting the monitoring system database server makes it considerably more straightforward to export this data into other historians, for example, Pi. Combining corrosion and erosion monitoring data with other recorded process data can offer valuable insights into the root causes of the corrosion or erosion events that occur in your facility.

Conclusion: require real field evidence that the monitoring system will add value to your operations

Field experience from other installations is absolutely key in gaining the required confidence that the monitoring system:

- Can be readily installed in your operating environment
- Will continue to function in your operating environment, requiring little or no maintenance
- Delivers the quality and frequency of data to enable enhanced operational decision making (for example, the system delivers value and will quickly pay back the investment to purchase, install, and maintain the monitoring system).

Do not rely on laboratory tests or unsubstantiated claims. Choose a corrosion and erosion monitoring system with a proven track record of delivering data that has transformed other customers' operations and profitability.

For more information on Rosemount Wireless Permasense Corrosion Sensors, see emerson.com/permasense.

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