REMOTE MONITORING:

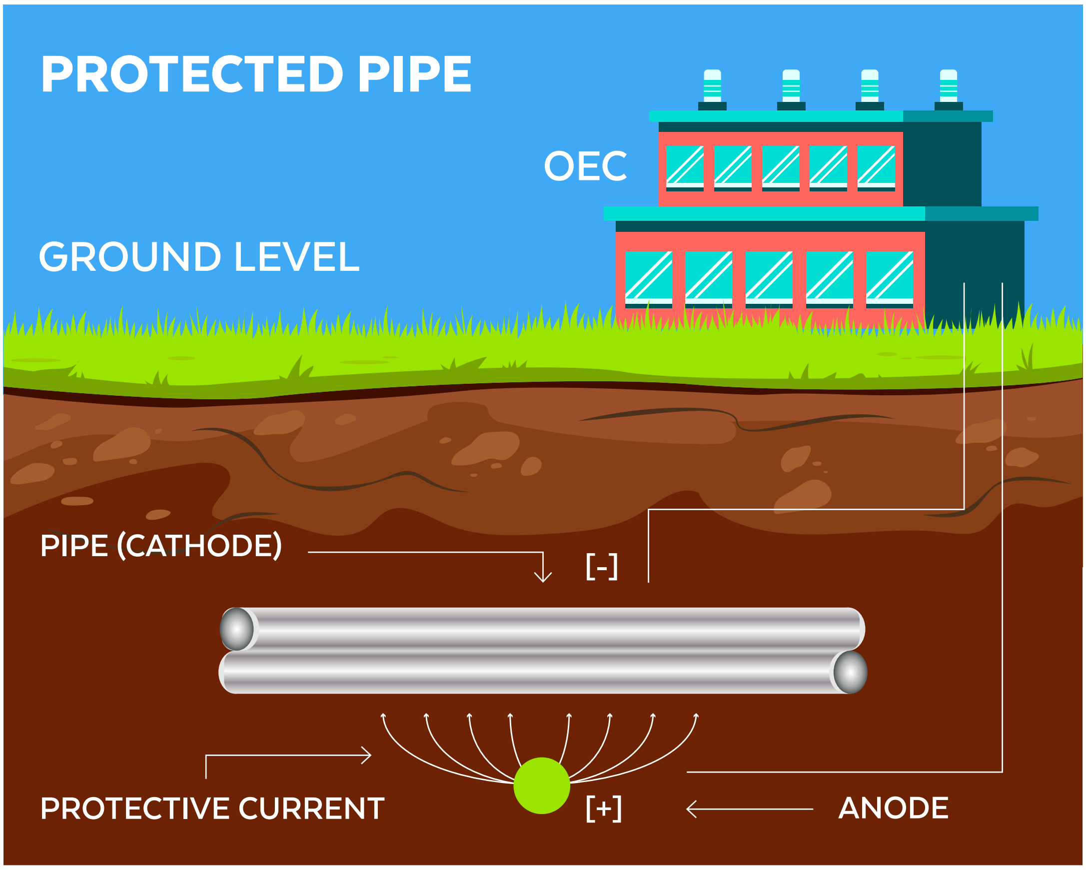
PAST, PRESENT & FUTURE

GPT Industries

Across the globe, millions of miles of metal pipes are buried underground. These essential transportation lines carry a variety of fluids ranging from water to oil and gas. However, buried pipelines face a constant threat: corrosion. Whether from the surrounding soil itself or from electric currents from nearby trains, power lines, and protective systems for other pipelines, several factors can pose a risk to pipelines. Even aboveground and underground storage tanks are vulnerable to corrosion in areas where they are exposed to corrosive soils or buried underground.

Several measures are usually employed to ensure the safe operation of buried pipelines. The first line of defense is applying a protective coating over pipelines before burying them. This is supposed to be enough to isolate the pipeline metal from the aggressive electrolytes occurring where it is buried.

Unfortunately, due to several reasons—such as deficiencies in the applied coatings and pipeline movement underground causing holidays (coating defects)—it is difficult to ensure that a pipeline coating is 100% efficient. Some defects will eventually occur in the coatings, and when they occur, corrosion in that area can worsen. This threatens the pipelines' integrity. To overcome this, a technique called cathodic protection is employed as a second line of defense.



Isolation with a cathodic protection system. (Source: GPT Industries)

What Is Cathodic Protection?

Cathodic protection (CP) is an established and highly effective technique for mitigating corrosion in buried or submerged metallic structures. It is a technique that dates back to 1824, when it was used by the British chemist and inventor, Sir Humphry Davy.

The idea behind cathodic protection is to change a pipeline's electrical properties, transforming it into a large cathode (negatively charged electrode) within an electrochemical cell. By doing so, CP disrupts the natural corrosion process that would otherwise degrade the pipeline. There are two primary methods of cathodic protection employed for pipelines.

1 Galvanic Anode CP

This system utilizes sacrificial anodes, typically made from highly reactive metals like magnesium or zinc. These anodes are strategically placed near the pipeline and connected to it electrically. As the special metal (anode) corrodes faster than the pipeline, it releases electrons that cathodically protect the pipeline. This will inhibit the corrosion process that would otherwise occur in the pipelines.

Advantages	Disadvantages
It does not require an external power source, making its installation easy and suitable for remote areas with no nearby power sources.	The low driving voltage makes it less suitable in high-resistance environments, in highly corrosive environments, or for the protection of large structures.
The installation process is simpler compared to impressed current systems (simply dig and bury the anode, and then electrically connect it to the pipelines).	Galvanic anodes are consumed more frequently than impressed current anodes, making them less cost effective for long-term operations.
It requires less maintenance compared to impressed current systems; one only needs to monitor the performance of the sacrificial anodes and replace the depleted ones.	
There is a very low probability of causing stray current problems to nearby structures.	

2 Impressed Current CP

This method employs an external power source, such as a rectifier or a solar-powered CP station, to provide direct current (DC). The DC is then distributed through anodes made from inert materials such as high silicon chromium cast iron or, more recently, mixed metal oxides. These anodes are strategically placed in the surrounding environment (e.g., deep wells or strip anodes). The impressed current creates a negative potential on the pipeline, halting the corrosion process.

Advantages	Disadvantages
The high driving voltage makes it suitable for operation in highly corrosive environments, in highly resistive environments, and for the protection of large and poorly coated structures.	It requires an external power source, making it more difficult to install in remote areas.
The controllable current output allows for precise adjustment based on corrosion conditions.	It requires more regular maintenance compared to galvanic anode CP systems.
	It could be a source of stray current interference for nearby structures.

Benefits of Cathodic Protection Systems

Cathodic protection offers a powerful toolbox for pipeline operators, offering several key benefits:

Corrosion Control: CP acts as a dependable defense system, safeguarding metallic pipelines and storage tanks from corrosion. This translates to pipelines lasting much longer, saving significant money on potential repairs and replacements.

Enhanced Safety of Operation: By preventing leaks and ruptures due to metal loss (by oxidation), CP significantly reduces the risk of environmental damage and threats to public safety that pipeline corrosion can cause.

Lower Maintenance Costs: While CP systems require regular checkups, they can substantially decrease the need for expensive repairs and replacements over the long term, leading to overall cost savings.

Adaptable to One's Needs: CP systems are versatile and can be tailored to fit various pipeline configurations, lengths, and environments, offering a flexible solution for a wide range of applications.

What Is Remote Monitoring?

While cathodic protection is essential for safeguarding buried metal structures, it requires ongoing attention to function optimally. Previously, manual monitoring involved sending technicians to remote or hard-to-reach sites, posing safety risks and incurring costs.

These physical visits were necessary to gather ON and OFF potential measurements, measure CP current outputs and make adjustments, and detect malfunctions. However, recent advancements—especially in wireless transmission—have led to the widespread adoption of remote monitoring systems (RMSs).

Specific RMSs transmit CP measurements and performance data directly to dedicated teams, eliminating the need for on-site visits. This allows technicians to monitor and manage CP systems remotely, improving efficiency and safety.

Components of a Remote Monitoring System

A typical RMS is composed of the following.

1. Field Components

These are the components installed in the field, either at test station locations or at CP transformer rectifier unit (TRU) locations.

- **Remote Monitoring Unit (RMU)**: This is essentially the workhorse at the pipeline. Installed at test stations or near the CP TRU, the RMU collects critical data related to the CP system's performance. It typically measures parameters like:
  - Pipe-to-soil potential (voltage)
  - Anode current
  - Coupon potential (if installed)
  - Rectifier output voltage and current
  - Alternating current (AC) power supply status
- **Communication Module**: This component transmits the collected data from the RMU to a central location using various options like cellular networks, satellite communication, etc.
- **Current Interruption Modules (Optional)**: These components are usually installed at CP TRUs to allow the user to remotely interrupt the output of a CP system. This will allow for measuring instant-off (I-Off) readings that are needed for a CP survey.

An external view of the Iso-Smart™ remote monitoring unit. (Source: GPT Industries)

2. Centralized Components

- **Data Acquisition System (DAS)**: This software receives and stores the data transmitted by the RMUs in the field. The DAS can perform initial processing, filtering, and organization of the data.
- **Human-Machine Interface (HMI)**: This user interface, typically a web-based platform or dedicated software, allows operators to view and analyze the collected CP data. The HMI can provide:
  - Real-time and historical data visualization
  - Alarms and notifications for abnormal readings
  - Reporting and data export functionalities

3. Additional Components (Optional)

- **Cloud Storage**: For large-scale deployments or additional redundancy, cloud storage can be integrated to store and access CP data securely.

The History of Remote Monitoring

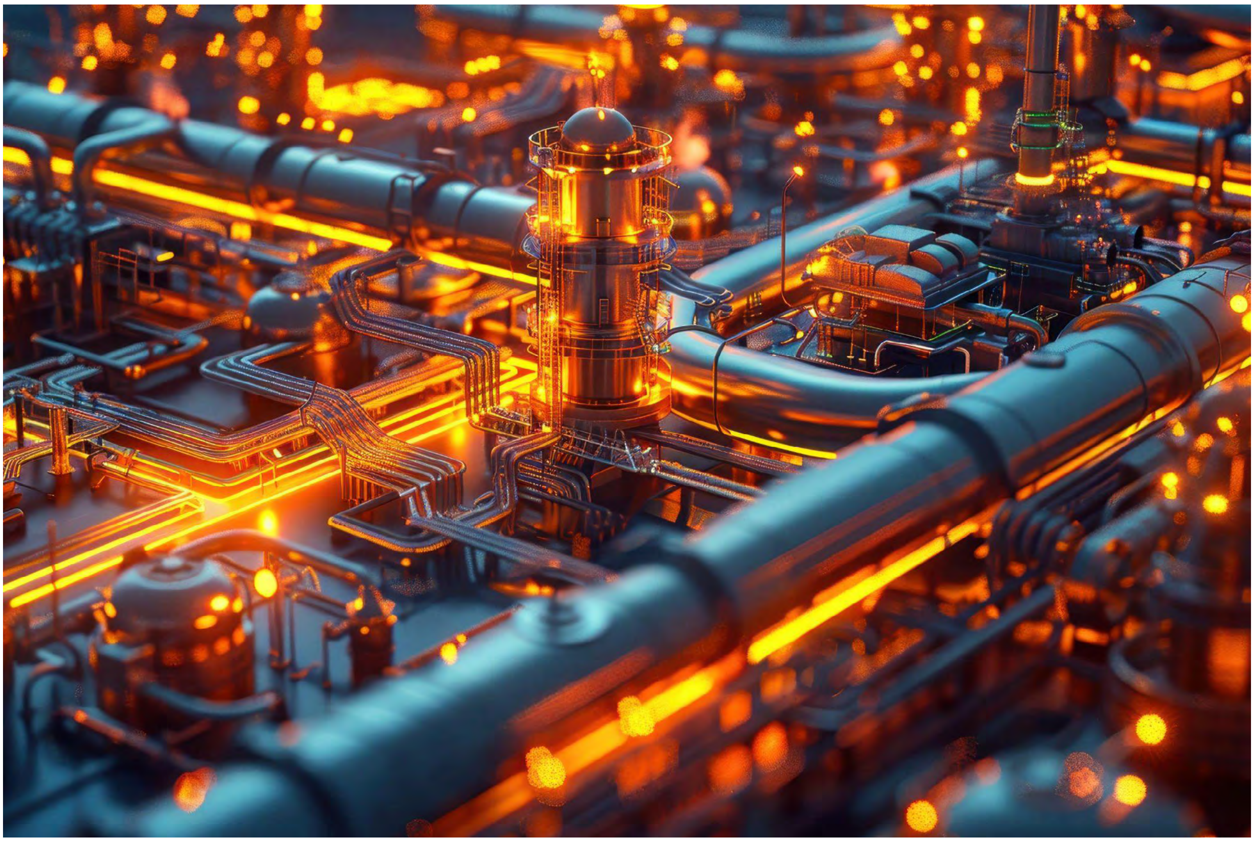
The history of remote monitoring is a tale of evolving technology and a growing need for efficiency in pipeline management. Several key milestones are worth noting in its story.

Early Days: Manual Data Collection

Traditionally, monitoring cathodic protection systems involved manual data collection. Technicians would physically visit test stations along pipelines, measuring voltage, current, and other parameters. This process was time-consuming, labor-intensive, and limited to periodic snapshots of the CP system's performance.

The Rise of SCADA Systems

The introduction of Supervisory Control and Data Acquisition (SCADA) systems marked a significant advancement. SCADA systems allowed for centralized monitoring of various industrial processes, including CP systems. However, these systems relied on basic sensors and communication technologies, which limited their widespread adoption for remote monitoring.



The connectivity of the industrial landscape. (Source: Kanin / Adobe Stock Images)

The Dawn of Wireless Technologies and IoT (Mid-2000s–Present)

The development of reliable and cost-effective wireless communication like cellular networks and satellites, coupled with the rise of advanced sensors and the Industrial Internet of Things (IIoT), opened endless possibilities.

These technologies paved the way for dedicated remote monitoring systems. Such systems are powerful and can gather a wealth of data on various parameters, including pipe-to-soil potential, bond current, and rectifier output. However, the beauty of RMSs lies in real-time reporting and instant alerts. If any measurement falls outside predefined thresholds, an alarm is triggered, allowing for immediate attention and proactive maintenance.

Key Drivers for Growth

Several factors fueled the growth of remote monitoring in recent years.

- **Increased Pipeline Networks**: The expanding network of pipelines created a growing need for efficient and cost-effective monitoring solutions.
- **Focus on Safety and Environmental Regulations**: Heightened awareness of pipeline safety and stricter environmental regulations increased the need for continuous monitoring and data collection. Actually applying an RMS has become a regulatory compliance. The Pipeline and Hazardous Materials Safety Administration (PHMSA) has mandated in its code 49 CFR Parts 192 and 195 that pipeline operators must implement robust integrity management programs. These programs emphasize that the use of advanced monitoring technology and remote monitoring is in line with PHMSA regulations.
- **Advancements in Sensor Technology**: The development of smaller, more robust, and lower-power sensors facilitated the creation of efficient remote monitoring solutions.

Past and Existing Challenges With Remote Monitoring Systems

While the concept of remote monitoring has been around for a while, its widespread adoption faced challenges. Early attempts were often hampered by the cost of equipment and having a cost-effective and reliable data transmission method. Also, some of the earlier solutions could not handle the full spectrum of measurements required for effective monitoring. In the coming section, we will present the past challenges and how they were overcome by the new technologies presented nowadays.

Measurement Flexibility

Previously, remote monitoring systems were only designed to measure the ON potential readings at test stations. Although ON readings give one an indication of how the CP system is operating, one cannot rely on them completely.

Several errors are introduced in ON potential readings, such as the IR error. To eliminate this error, I-Off readings were then adopted. In this technique, all influencing power sources are synchronously interrupted, and CP measurements are then taken. This provides a better indication of the CP system performance.

The ON potential readings data was stored in short-term data loggers that needed to be restored and data to be dumped from them periodically to check for the CP system performance. However, these old data loggers have been replaced by new, modern RMUs that are capable of measuring several parameters that give a better judgment of a CP system. These new systems are capable of measuring ON and OFF readings, as well as AC density, if a coupon is installed inside the test station. They can also measure the current and voltage output of a TRU, and alert someone if there is a power outage at the TRU that can affect the CP system performance.

Suitability of Data

Data loggers, while useful for specific purposes, are not ideal for long-term asset management of cathodic protection systems. Often designed to address temporary issues, they may require collecting and storing vast amounts of data, leading to “data overload” and making it difficult to identify trends or anomalies.

For effective CP management, a comprehensive asset monitoring system is crucial. This system should strike a balance by:

- **Providing Sufficient Data**: It should capture enough data points to ensure a high level of confidence in the system’s health, yet not overwhelm the user with unnecessary information.
- **Automating Alerts**: The system should automatically trigger alarms when critical values fall outside predefined acceptable thresholds. This allows for prompt identification and rectification of any CP system faults, preventing potential damage.

Data loggers can be valuable tools for specific short-term data collection. However, for long-term CP system management, a dedicated asset monitoring system with automated analysis and alerting capabilities is essential.

Secure and Reliable Communication

Ensuring reliable data transfer from remote CP monitoring sites to one's operational headquarters is paramount. Data integrity is critical, and any data loss can be detrimental. Here is how to achieve reliable communication.

> **Prioritizing Established Technologies**: In the past and before cellular networks were developed, companies relied on their communication systems. However, these systems proved to be unreliable due to several failures that happened and the need for a dedicated team to promptly repair those faults. Therefore, most remote monitoring systems nowadays prefer using cellular networks with their strong track record. In areas with good cellular coverage (urban areas, major highways, etc.), Global System for Mobile Communications (GSM) networks offer a cost-effective and reliable data transmission method via short message service (SMS) and, more recently, using 4G networks for delivering data promptly and efficiently. In areas where cellular coverage is not available, satellite communication becomes the preferred option even though it is generally more expensive, slower, and less reliable than GSM. Another drawback of satellite communications is that they consume more power than GSM modules; therefore, an external power source is needed to ensure uninterrupted data transmission.

Physical Robustness

Pipelines usually cross unfavorable terrains. CP monitoring systems are usually subjected to extreme weather, humidity, and dust. They need to be designed with high protection and minimum external control. A significant challenge to RMSs is the presence of lightning storms. Several operators have realized that their monitoring systems have malfunctioned after facing a thunderstorm, specifically a lightning strike. A good RMS should be capable of withstanding a surge of 30 KV of DC.

Size is another important factor to consider. Most RMUs are compact in size so that they can fit in a test station. This means that there will be no room for the large number of batteries needed to power up the RMU. Recently, lithium batteries have been introduced as they have a high energy density. However, their drawbacks include being affected by large variations in temperatures. Another recent option is solar power, which could be used to extend the battery life of RMUs.

Seamless Integration: Prioritizing User-Friendly Installation

A CP monitoring system should be designed for quick and effortless installation at both the test station and the TRU. It should integrate seamlessly with existing TRU infrastructure, avoiding the need for modifications or replacements during installation. It should also be compact enough to fit in a test station. Additionally, the system should be able to verify connections on site, enabling real-time confirmation of proper installation and functionality before final deployment.

Challenges Facing Remote Monitoring Systems

There are still several challenges that face RMSs:

Cellular Coverage: Reliable cellular coverage can still be a problem for RMSs in rural or inaccessible areas. Although satellite communication has mostly solved this issue, its power requirements and cost still hinder its widespread use.

Hazardous Area Classification: Meeting safety standards for equipment in hazardous pipeline zones can complicate and increase the cost of deploying these systems, especially when any change done to these systems (in any development phase) requires that an ATEX recertification cycle be initiated again. This recertification cycle consumes too much time and has a considerable cost in the development phase.

Data Integration and Management: It is uncommon to find a single monitoring system being used for a large network of pipelines. Having multiple monitoring systems can pose a challenge in integrating and managing the huge amount of data generated. Therefore, a robust data management strategy and infrastructure are necessary.

Cybersecurity: Due to their intentionally malicious nature, cyberattacks and hacking are a real challenge for RMSs. Robust security measures are necessary to protect against such unauthorized access and data breaches.

Corrosion Detection and Monitoring: RMSs are mainly installed to monitor corrosion control techniques such as cathodic protection. However, monitoring and identifying specific corrosion mechanisms could be challenging, requiring special expertise. Some monitoring systems overcome this problem by utilizing an electrical resistance (ER) probe to monitor and measure corrosion rate.

Vendor Lock-In and Interoperability: Switching remote monitoring providers can be a challenge for pipeline operators. Incompatibility between systems or concerns about vendor lock-in can make it difficult to adopt new or improved solutions.

Case Study: GPT's Iso-Smart™

One of the leaders in manufacturing pipeline sealing and electrical isolation products, GPT Industries, recently entered the remote asset integrity monitoring systems market with its breakthrough technology, Iso-Smart™. Based on customer needs and feedback, the Iso-Smart™ system was designed to measure several parameters ranging from simple bond testing to complete remote monitoring, such as ON and OFF CP readings, AC density, etc.

The Evolution of Iso-Smart™

Iso-Smart's™ first trials date back to late 2019, when GPT Industries decided to enter the field of remote monitoring. The first version of the system was just an isolation tester, where a proof of concept was manufactured using a basic microcontroller.

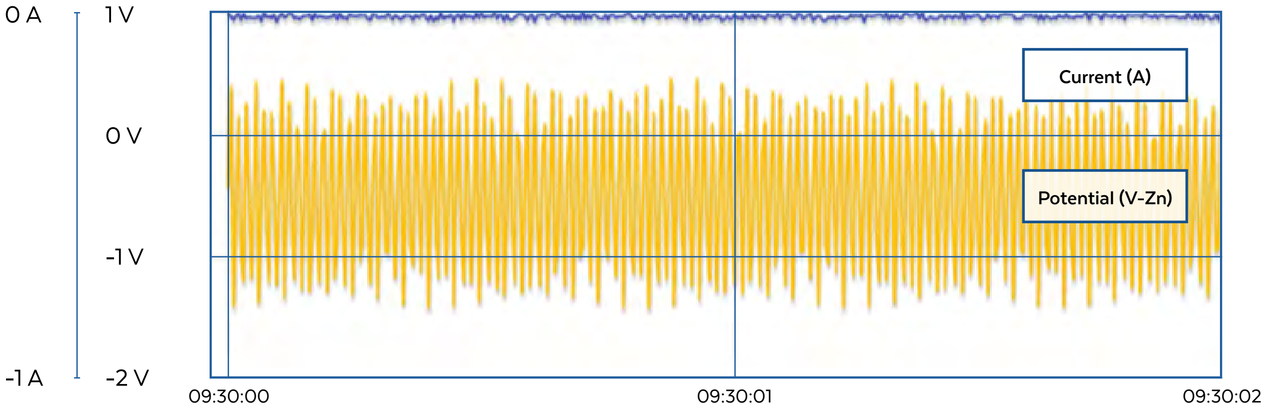
In September 2020, a more advanced system was made using a data acquisition (DAQ) input/output module. After receiving customer feedback and making some modifications, the decision was made to install the first Iso-Smart™ unit with an electric utility and natural gas delivery company in September 2021. This test site came with something unexpected: The company wanted to measure and monitor a bond—the opposite of electrical isolation, which Iso-Smart™ was designed for. However, GPT Industries managed to adapt the system successfully.

The second testing site at the same company was also done in September 2021. This time, the request was to monitor isolation in an unexpected configuration. In this case, each asset had its own CP system with its dedicated TRU. The question that arose was if the system could truly differentiate between a real shorted isolation or whether the CP readings were close to each other. The team at GPT Industries was determined to make it work, and they managed to test and prove that Iso-Smart™ was functioning properly.

The third testing site, with a corporation in the natural gas industry, was a natural fit for Iso-Smart's™ intended purpose: monitoring isolation between assets. At this site, everything went smoothly and as planned. GPT Industries now had three beta sites to collect data from, but then another question arose: "Was this data of any use?" It was decided that more customer feedback should be surveyed, and the Iso-Smart™ system should be redesigned to cover all customer needs and not just be an isolation monitoring device.

Through 2022 and 2023, the team delved deeper into cathodic protection, signal processing, and AC detection. This work not only led to significant feature additions, but also sparked a growth mindset within the team. Iso-Smart™ has evolved from a single tool to a versatile toolbox, tackling unforeseen challenges and exceeding customer needs. This is evident from the following measurements taken from GPT Industries' case studies:

Timeseries Data



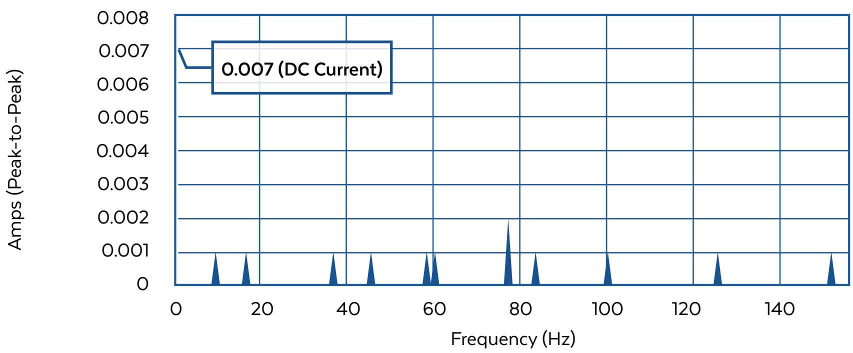
From the figure shown above, one can deduce that the current measured is coming from a DC source, as there is hardly any fluctuation in the current readings. However, this is where Iso-Smart™ comes in—where a fast Fourier transform analysis is performed to assess the signal in terms of frequency. The results of the analysis are shown below.

Current (A)

0.007 A(p-p) @ Hz
0.002 A(p-p) @ **77.15** Hz
0.001 A(p-p) @ **16.60** Hz
0.001 A(p-p) @ **9.77** Hz
0.001 A(p-p) @ **60.55** Hz
0.001 A(p-p) @ **45.90** Hz
0.001 A(p-p) @ **100.59** Hz
0.001 A(p-p) @ **58.59** Hz
0.001 A(p-p) @ **152.34** Hz
0.001 A(p-p) @ **83.98** Hz
0.001 A(p-p) @ **37.11** Hz
0.001 A(p-p) @ **125.98** Hz

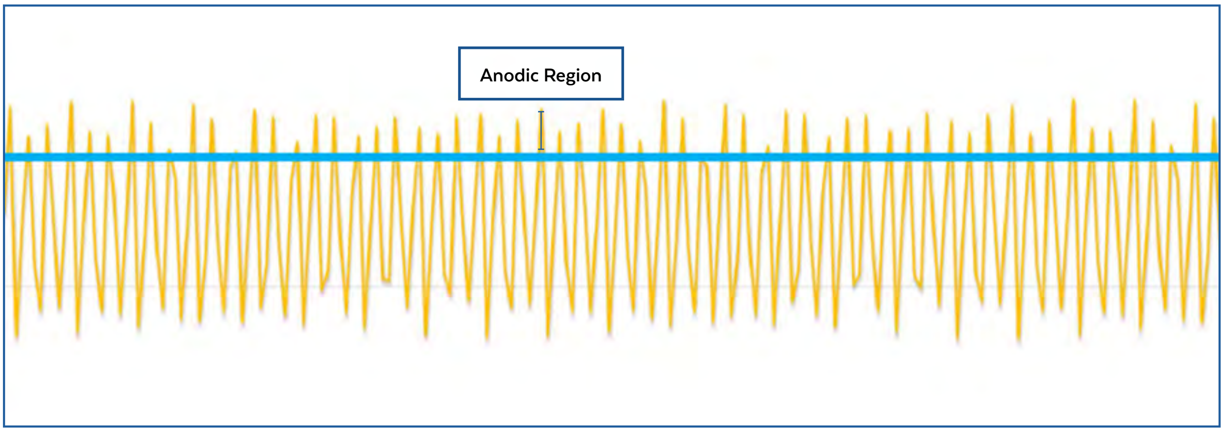
Output of AC Magnitude(s) test.

AC Current Analysis



As shown in the diagram above, the AC signal analysis emphasizes the assumption that the current measured over the asset is only from a DC source. The current measured is approximately 0.007 A. Dividing the current measured by the AC coupon area (1 cm^2) gives a current density of 70 A / m2 coming mainly from a DC source, which is most probably from a CP system.

In another example, one can see the plot of an asset's potential with respect to a reference zinc electrode where large fluctuations in the potential readings occur. The main issue here is that the readings' polarity is fluctuating with respect to an asset's open circuit potential (OCP), raising an alarm for pitting corrosion due to AC-induced corrosion.

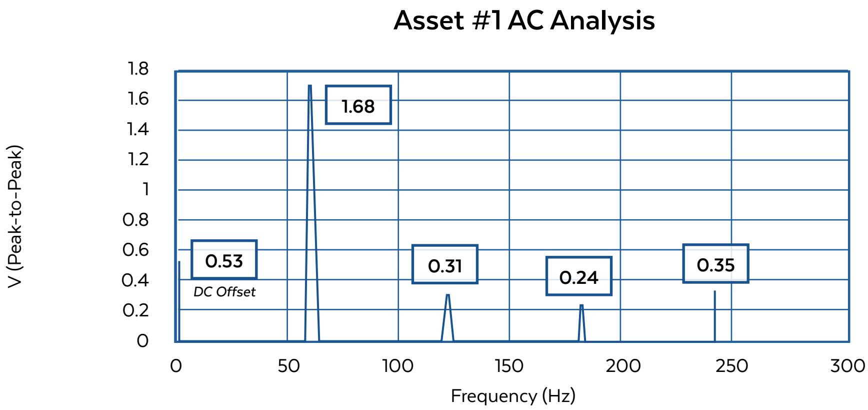


Therefore, further signal analysis is done using Iso-Smart™; the results are shown below.

Asset #1

0.53 V @ Hz
1.68 V(p-p) @ **59.57** Hz
0.69 V(p-p) @ **298.83** Hz
0.59 V(p-p) @ **60.55** Hz
0.46 V(p-p) @ **418.94** Hz
0.35 V(p-p) @ **239.26** Hz
0.34 V(p-p) @ **58.59** Hz
0.31 V(p-p) @ **120.12** Hz
0.28 V(p-p) @ **299.81** Hz
0.28 V(p-p) @ **119.14** Hz
0.25 V(p-p) @ **61.52** Hz
0.24 V(p-p) @ **179.69** Hz
0.19 V(p-p) @ **341.80** Hz

Output of AC Magnitude(s) test.



As can be seen from the signal analysis, the largest potential magnitude is captured at 60 Hz, emphasizing the fact that there is AC induced over the asset—most probably from a heating, ventilation, and air conditioning (HVAC) line placed nearby.

How Iso-Smart™ Is Different From Others in the Market

As mentioned above, a product like Iso-Smart™ could be considered an all-encompassing toolbox that monitors several features/parameters:

On Potentials

Iso-Smart™ offers a more efficient and practical way to monitor and manage CP systems. NACE Standard SP0169 states that "a structure is cathodically protected if they have a negative potential of -850 mV w.r.t Copper sulfate reference electrode." Traditionally, close interval surveys (CIS) have been used to measure pipe potential (ON potential) to ensure adequate protection against corrosion.

Iso-Smart™, however, can take continuous or scheduled readings. Moreover, Iso-Smart™ sets alarms for potential readings that fall outside a safe range, notifying operators of possible problems. It also allows for long-term data collection to identify trends and seasonal variations that might impact CP effectiveness. This data can then be used to optimize the CP system, preventing both underprotection and costly overprotection that can damage pipes.

Instant-Off Testing

Traditionally, accurate ON potentials require I-Off measurements—readings taken right after stopping the cathodic protection current. However, obtaining reliable I-Off readings can be challenging:

> Technicians use handheld voltmeters from unknown brands and with unknown accuracy.

> They visually choose a value displayed during a brief interruption, leading to inconsistencies.

> Readings are manually documented, prone to human error and variation between technicians.

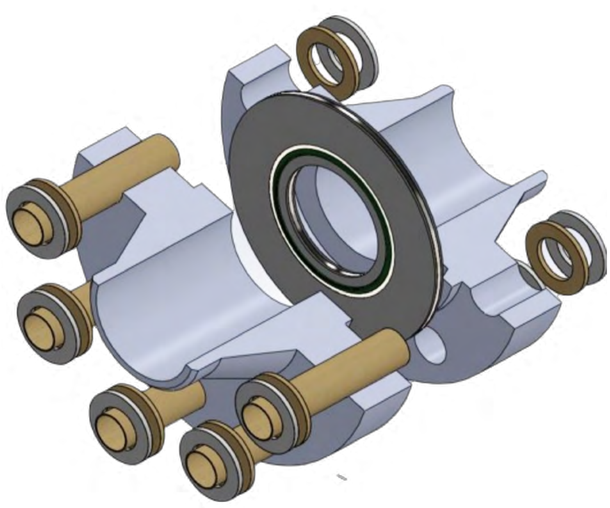
Iso-Smart™ eliminates these issues by offering precise, scheduled I-Off readings during current interruptions. This removes guesswork, inconsistency, and human error. All data is automatically stored for easy analysis, providing a more reliable picture of CP effectiveness.

Coupon Testing

A coupon is a representative sample made of the same pipeline material and buried close to it in the same electrolytic environment. When it is connected to the cathodically protected pipeline, I-Off readings can be easily measured. Moreover, if a shunt is installed in the connection, one can measure the current flowing to the coupon and calculate the current density applied to the coupon. This indicates the current density supplied to the pipeline. Iso-Smart™ has the capability to measure the I-Off and the current density of the coupons, giving the user more information that is needed to ensure that pipelines are cathodically protected to a satisfactory degree.

Isolation Testing

25%–50% of isolation flanges might fail and remain undetected during their operation, especially when they are only tested after installation and might not be tested again. Isolation kits might degrade over time due to several factors, such as a conductive media bridging over the isolation joint. Installing an Iso-Smart™ system is effective in providing continuous and precise monitoring of isolation levels. This eliminates the need to rely on manual methods such as radio frequency isolation tester devices or manual pipe-to-soil potentials. It also helps operators know exactly when changes in isolation occur, helping them to identify the cause and take timely corrective actions.



Example of a flange isolation kit.
(Source: GPT Industries)

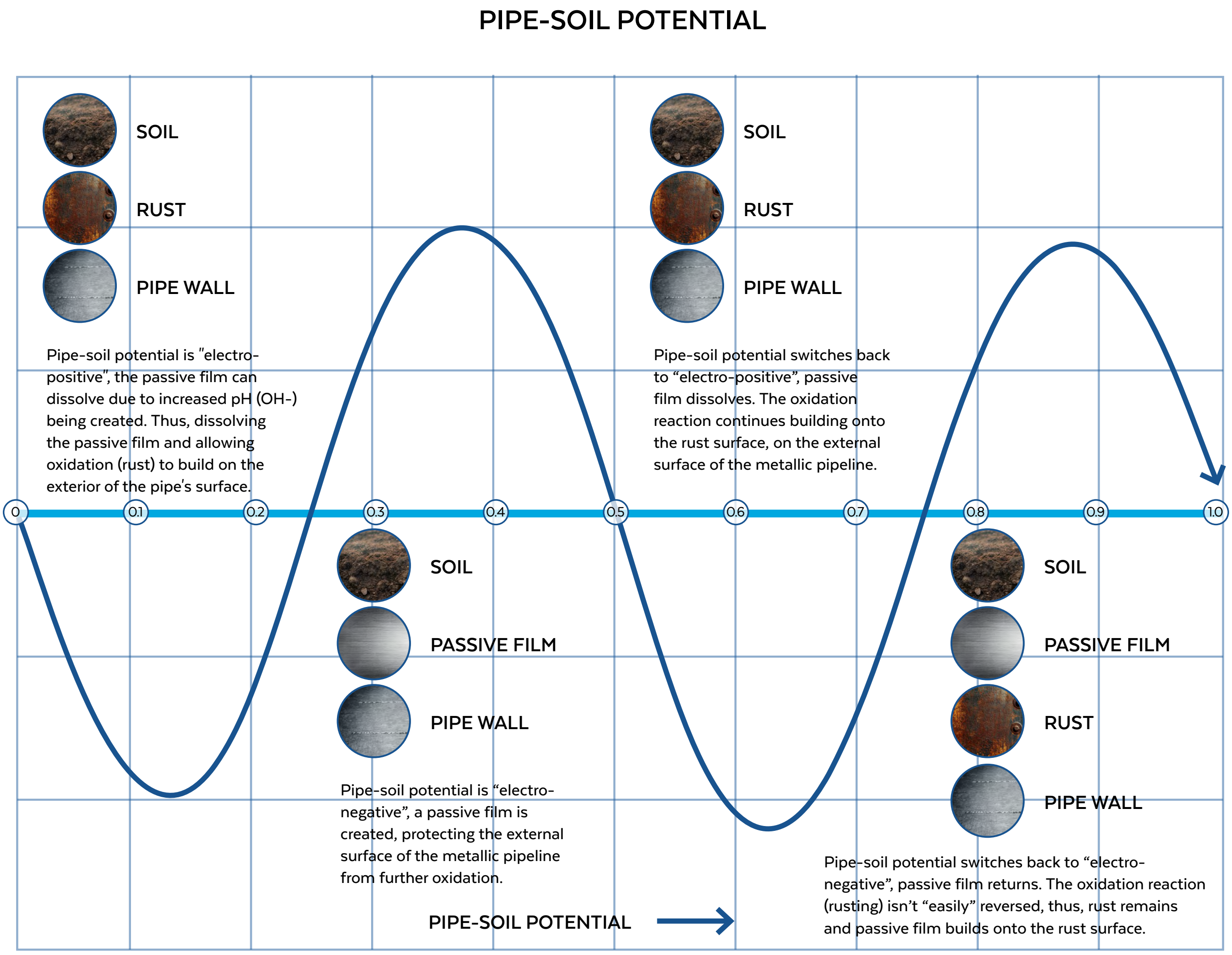
Bond Monitoring

Keeping pipelines safe from corrosion requires ensuring that critical bonds function properly. These bonds prevent electrical current from straying and causing stray current corrosion damage. The bonds need to be checked regularly, often involving external shunts for accurate current measurements.

Iso-Smart™ simplifies this process. It has a built-in, high-precision current monitoring circuit with its own shunt. This eliminates the need for external equipment and provides highly accurate readings of both the magnitude and direction of current flowing through the bond. Iso-Smart™ actually measures the voltage across its internal shunt and converts it into a current value, giving operators a clear picture of bond performance.

AC Monitoring

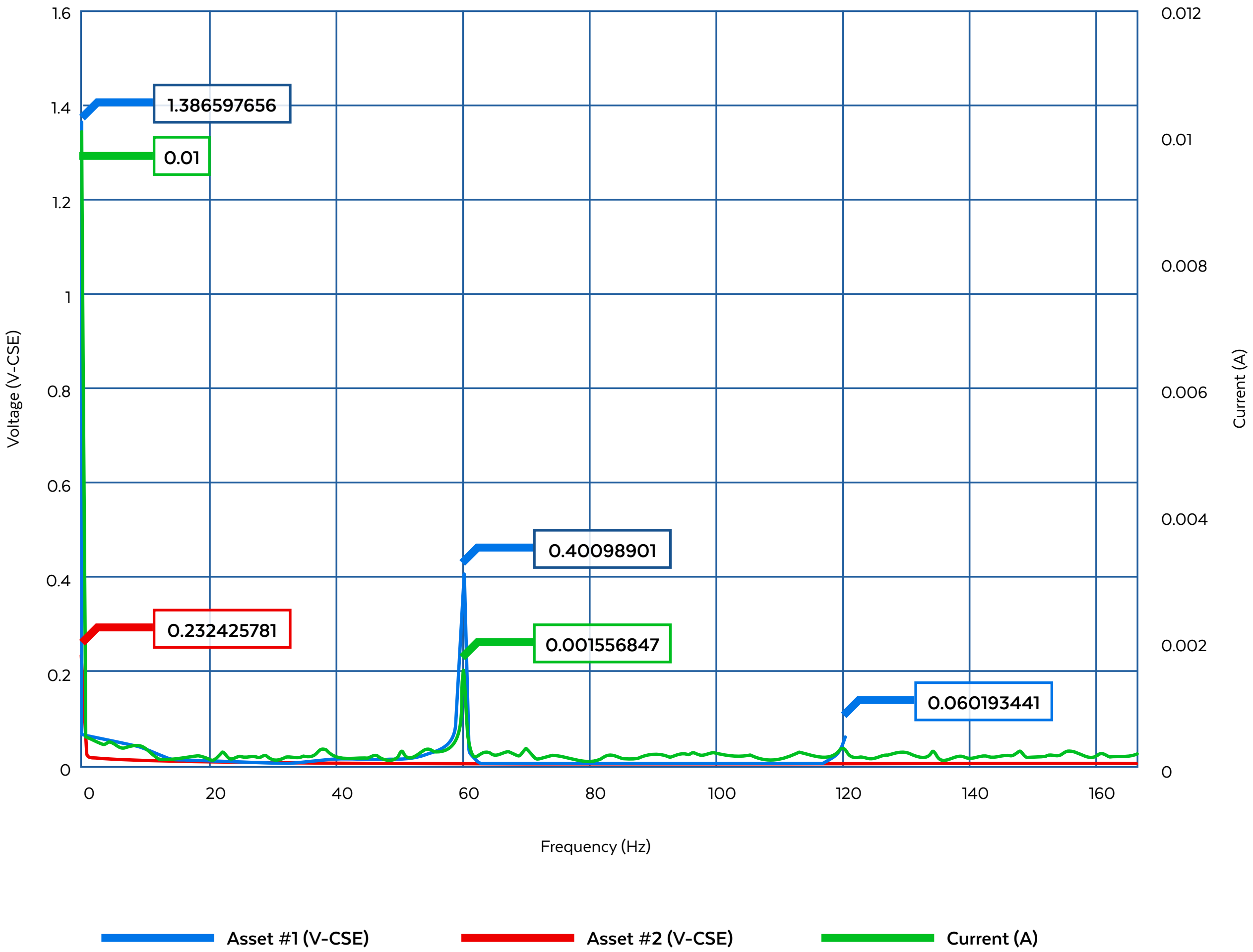
As mentioned earlier, DC is applied to the pipelines to protect them from corrosion. However, if AC is imposed over the pipelines, the pipelines can suffer from significant corrosion if a certain current density has been reached. If AC is suspected to be imposed over the pipelines, then AC mitigation techniques must be employed. The biggest challenge that pipeline operators face is how AC and DC can be differentiated in a measured signal.



Example of a "true" AC sine wave. (Source: GPT Industries)

Iso-Smart™ offers a breakthrough in AC analysis. It can measure and distinguish true AC from DC within a single signal, eliminating the need for configuration changes. Moreover, Iso-Smart™ provides in-depth signal processing that analyzes the voltage and current amplitude according to their frequency. This in-depth analysis gives pipeline operators valuable insights into the exact amount of DC and AC present in the pipeline and the potential sources of AC based on the identified frequencies.

In conclusion, Iso-Smart™ supersedes its competitors not just by detecting if AC is present; it also helps operators determine the need for AC mitigation and fine-tune existing mitigation strategies. The most significant advantage of Iso-Smart™ is that it can aid in identifying the sources of AC, helping operators to mitigate the effects of AC corrosion before any further damage could occur to the assets. This is shown in the image below, where it is evident that most AC interference comes from a 60 Hz source.



Fourier analysis for AC interference showing most of AC coming from a 60 Hz source. (Source: GPT Industries)

The Future of Remote Monitoring Systems

As technology advances, remote monitoring systems are expected to have greater capabilities. Powerful tools such as advanced analytics, machine learning, and artificial intelligence will become key players in analyzing and handling the huge amount of data collected by remote monitoring sensors. This will enable pipeline operators to optimize their maintenance strategies and resource allocation through predictive maintenance and prescriptive analysis. This, in turn, will improve the pipeline's safety and operational efficiency.

In general, the future of RMSs likely includes:

- **Integration With Cloud-Based Platforms**: Cloud storage and analytics platforms will offer improved data accessibility, scalability, and advanced analysis capabilities.
- **Enhanced Data Security**: As reliance on remote monitoring increases, robust cybersecurity measures will be crucial to ensure data integrity and system reliability.
- **Predictive Maintenance**: Advancements in data analytics could enable the development of predictive maintenance strategies based on real-time and historical CP data.

By continuing to leverage innovative technologies, RMSs will play an increasingly critical role in ensuring the integrity and longevity of pipelines while optimizing CP system performance and efficiency.

Conclusion

Remote monitoring has proved to be an inevitable tool for asset integrity management. Due to its advantages and benefits, its usage is expected to increase in the coming weeks, months, and years. Operators prefer to install these systems because of their inherent savings and advantages.

RMSs are developing rapidly—from advanced analytic software that can determine the source of AC interference to embedded ER probes that can monitor and report the corrosion rate at the area being monitored.

Advancements in communication, especially satellite communication, have helped remote monitoring manufacturers install their devices in areas that were previously considered unsuitable for an RMS.

All these advantages will allow remote monitoring systems to play a pivotal role for pipeline operators to proactively mitigate risks and ensure the safety and integrity of their valuable resources.

Industries