WHITEPAPER / AC CORROSION MONITORING

KNOWLEDGE IS POWER WHEN PROTECTING PIPELINES FROM ALTERNATING CURRENT

Pipeline operators have realized tremendous cost efficiencies by collocating in the same corridors as high-voltage alternating current (HVAC) lines, but evolving and difficult challenges exist within these applications to protect against pipeline corrosion and safety hazards.

Oil and gas pipelines face a serious, ongoing risk of corrosion when they are collocated in utility shared right of ways (ROW) where high voltage AC (HVAC) power lines are in proximity. Whether the pipelines run parallel-to or across power line corridors, AC voltage is often induced into the pipelines causing corrosion in vulnerable assets, even if the pipelines are cathodically protected with DC current.

Paradoxically, advancements in coating technologies might be compounding the problem. As coatings have improved, defects during manufacturing and installation have declined. Although fewer, and smaller defects seems beneficial, the outcome is often the opposite for pipelines that experience induced AC voltage. Now, when current is able to leave the pipeline through a holiday (a crack or pinhole in the coating) a high concentration of current density will occur.

Current density is calculated by measuring the current that flows through an area of cross section (A/m2), so the smaller the area, the greater the current density. Unfortunately, high current density also carries a greater potential for AC corrosion in the affected area of the pipeline.

A LITTLE INFORMATION CAN GO A LONG WAY TOWARDS CORROSION CONTROL

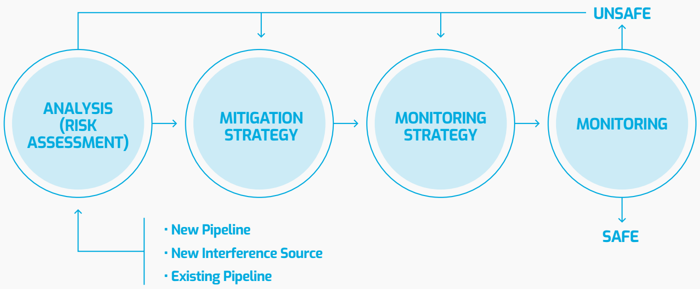
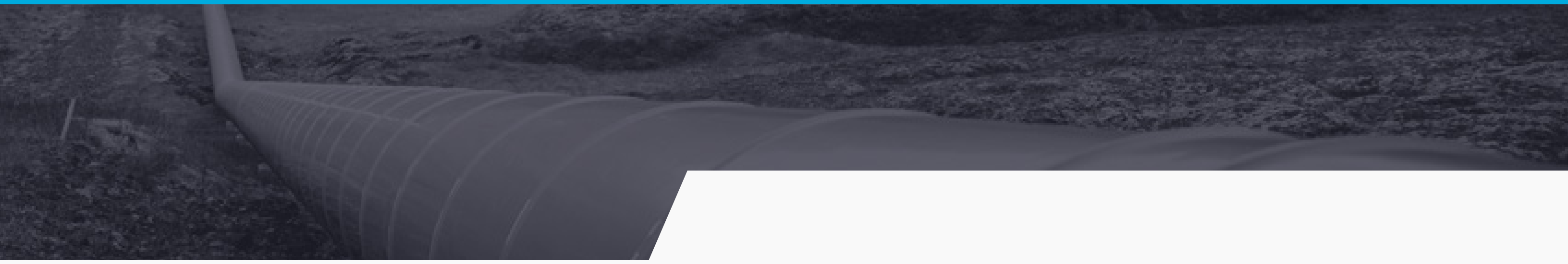


Figure 1: AC Corrosion Evaluation Process

Oil and gas pipelines are increasingly installed in shared ROWs with high voltage transmission lines. With that in mind, engineers can take steps at the design stage to measure and understand the potential risk of induced AC voltage to new pipelines, or on older pipelines that will have their ROW encroached by a new HVAC line. The power load carried by HVAC lines can fluctuate considerably throughout any given day due to the dynamic nature of electricity consumption in the communities they serve. It is critical for engineers to have a comprehensive understanding of the baseline, peaks, valleys, and cycles of the AC waveform. Ideally, these measurements should be collected at per minute or per hour intervals and a robust data logger designed for cathodic protection measurements is essential for this task.

Engineers can place a series of data loggers in the ROW to gather information about the induced AC voltage from the power system over a period of time. The data can then be retrieved and analyzed, providing key insights that will inform the design of an optimized AC mitigation system.



Polarization cell replacement (PCR) decouplers are often part of an effective AC mitigation system. These devices provide both DC isolation and AC grounding of the pipeline, enabling induced AC current, faults and lightning strikes to flow to ground, while leaving the DC cathodic protection (CP) system unaffected. This AC grounding effect also provides additional protection for pipeline coatings and helps to prevent damage from the high voltage of a fault or lighting strike.

Decouplers are also critical to optimize the CP system by preventing the protective DC current from flowing to structures that may be electrically connected to the pipeline, such as zinc or copper AC mitigation wires and safety grounding systems.

Once the design has been finalized and construction begins, pipeline operators can re-deploy the data loggers to verify that the AC mitigation system is effective at reducing corrosion risk. Once the pipeline is commissioned, operators can turn to permanent CP monitoring devices that are installed at test stations to monitor current density at coupons, which are representative pieces of the pipe material buried in the ground to estimate the effectiveness of a corrosion protection system, and the condition of PCRs.

MEASURING AC CURRENT DENSITY IS CRITICAL FOR EFFECTIVE CORROSION CONTROL

When induced AC corrosion is a concern, measuring and monitoring current density is a more effective way to anticipate corrosion risk than monitoring DC polarization of the pipeline by cathodic protection systems. However, there is a relationship between the corrosion rate that a pipeline experiences at a defect and the AC and DC current density that should be considered for effective AC corrosion control.

In 2018, the National Association of Corrosion Engineers (NACE) introduced new guidelines and procedures to guide risk assessment, mitigation and monitoring of corrosion on cathodically protected pipelines that are in proximity to high voltage AC power lines. The standard is titled NACE SP21424-2018-SG Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring, and it complements previous standards.

One of the methods mentioned to achieve AC corrosion control is controlling the timeweighted average AC current density to within specified thresholds. The standard indicates that the AC current density should be varied depending on the DC current density produced by the CP system. According to the standard, the AC current density should not exceed a time-weighted average of:

- 30 A/m2 if DC current density exceeds 1 A/m2;
- 100 A/m2 if DC current density is less than 1 A/m2.

REMOTE MONITORING EXPONENTIALLY INCREASES DATA COLLECTION

The most efficient and cost-effective way to measure and monitor these parameters is through the use of coupons equipped with remote monitoring devices installed at test stations. This equipment can reliably measure and transmit critical parameters related to induced AC voltage and electrochemical interactions with the surrounding environment. Test station remote monitors provide pipeline operators with powerful capabilities to remotely monitor AC coupons and reference electrodes in assets that are at high risk of AC corrosion. The latest designs provide multiple analog measurement channels and can accurately capture all required AC and DC parameters simultaneously, effectively eliminating the need for technicians to perform manual field measurements. Immediate benefits include the reduction of windshield time for technicians and corrosion specialists to retrieve this data, but the improvement in data quality, quantity, and ease of analysis is seen as an increasingly important driver behind leading corrosion monitoring programs.

Remote monitoring is an ideal way to measure these parameters at regular intervals—as often as every few hours—providing near real-time monitoring of the CP system and AC current density. This regular data collection is vital to build a comprehensive understanding of timeweighted average of the current density data and effectively assess the risk of AC induced corrosion.

These multi-channel devices can also be configured to measure the AC current flowing through PCR decouplers, providing further validation that the devices are functioning properly and mitigating serious corrosion that could be caused by induced AC current if a PCR was to fail and go unnoticed for many months.

Devices that offer cellular and satellite communication capabilities ensure that data can be collected from virtually any location, even the most remote, difficult to reach sites. Ideally all this data is captured, analyzed and visualized within in a cloud-based platform that can be accessed by technicians in the field in order to review measurement data, create trending graphs and generate reports in real-time.

The ability to detect spikes in AC current density and other short-lived events that may impact CP performance, such as power load transfers or faults, is another key feature that a remote monitoring device should provide. These intermittent issues can contribute significantly to AC induced corrosion, and they are extremely unlikely to be identified through annual or semiannual site inspections.

When these events occur, the device should log the incident and transmit an alert to notify operators that the reading is outside a specified threshold. With significantly more information about AC induced voltage, operators are much better equipped to make the best possible decisions about corrosion protection.

ADDITIONAL MONITORING FOR AREAS AT HIGH RISK OF AC INDUCED CORROSION

Some applications may be at higher risk of AC induced corrosion and require more intensive monitoring. Rather than add more monitoring devices, pipeline operators may have the option with their existing devices to expand the number of measurement channels when technology is available to add plug-and-play expansion modules. This approach leverages the communication capabilities of the devices that are already in place, is a much more cost-effective approach to expand existing remote monitoring capabilities, and provides the flexibility to easily adapt to applications where there are constantly evolving AC induced voltage parameters.

The versatility and robust capabilities of remote monitoring devices enables pipeline operators to quickly and cost-effectively create a reliable industrial internet of things (IIoT) network to measure and collect important performance parameters for CP coupons, AC current density and decouplers. This approach dramatically increases the frequency of data collection and provides a richer data set to inform more effective AC mitigation strategies.

CONCLUSION

AC mitigation is complex and highly variable depending on specific parameters that are sometimes unknown during design and construction, the MOBILTEX suite of remote monitoring platform solutions can deliver fitfor- purpose solutions that effectively solve the challenge and provide an adaptable system for even the most difficult CP applications. MOBILTEX remote monitoring devices include the uDL1 and uDL2 data loggers, CorTalk RMU1 + INT1 and RMU1 LITE test station remote monitoring devices, and the CorView cloud-based management platform. By leveraging these new technologies, pipelines and their support structures can be proactively protected from hazards. Future-proof solutions will dramatically reduce replacement and maintenance costs and are essential for long-term protection of the public, pipeline personnel and property.

Contact us to learn more and to discuss your monitoring requirements for induced AC voltage and CP system monitoring.

REFERENCES

1. NACE SP21424-2018, 'Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring',

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3. NACE SP0169, 'Control of External Corrosion on Underground or Submerged Metallic Piping Systems', (Houston, Texas: NACE).

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