Harness the power of data analytics with ROSEN

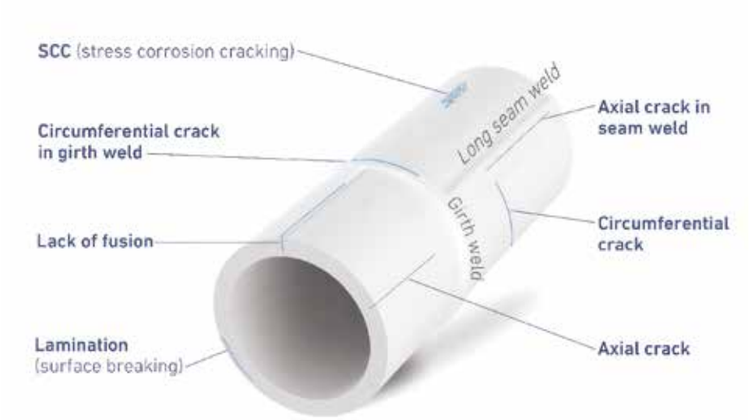
ROSEN Senior Engineer Alex Hazeltine and Principal Engineer Erwin "Erk" Gamboa discuss how data analytics can be used for advanced integrity management of pipelines with cracking.

Pipeline integrity management is critical within the oil and gas industry, where failures can lead to severe environmental, economic and human consequences.

The progress made in advanced in-line inspection (ILI) tools and data analytics fuelled by the ROSEN Integrity Data Warehouse (IDW) has revolutionised the integrity management of pipelines with cracking.

These dual aspects of integrity management not only enhance the detection and characterisation of cracks but also helps inform integrity management activities, ensuring the safety and efficiency of pipeline operations.

The ROSEN IDW is a data repository that is used to store, discover, and understand high quality historical ILI and pipeline information datasets from tens of thousands of pipelines that ROSEN has inspected over multiple decades across the globe.



Typical cracking threats.

The cracking challenge

As the global pipeline network ages, the threat of cracking (particularly stress corrosion cracking (SCC) and fatigue) becomes more prominent. Cracking mechanisms are often complex and can be challenging to both inspect and manage. A good understanding of the cracking mechanism, careful consideration of the inspection technology, data analysis, field verifications and integrity responses are required to ensure effective management of the cracking threat.

A recognised effective method for the management of cracking threats is ILI. Ultrasonic (UT) ILI tools are typically used for liquid lines, while electromagnetic acoustic transducer (EMAT) ILI tools are used for gas lines.

Combining multiple datasets for comprehensive insights

Effective integrity management of pipelines integrates data from various sources, offering a comprehensive view of pipeline integrity and highlighting key focus areas. Key data sources (such as those found in the ROSEN IDW) include:

- Historical ILI data: Analysing past inspections to identify trends in pipeline integrity. Considering multiple ILI technologies that are not directly used for crack detection but for inspecting other pipeline threats can help improve the understanding of cracking susceptibility along the line. Historical datasets may include:
  - Corrosion or coating disbondment surveys that can identify locations with conditions suitable for other electrochemical attack mechanisms (such as SCC)
  - Geometry and bending strain inspections that can report areas of local (dents) and global (bending strain) changes in stress; areas of increased stress are more susceptible to cracking.
- Verification and laboratory data: Destructive and non-destructive testing data is needed to determine the specific cracking mechanism present, allowing more targeted management strategies.
- Operational data: Understanding key parameters such as pressure, temperature, flow rates, and product composition is crucial for understanding possible and existing cracking threats and how to manage them.
- Environmental monitoring: Data from environmental systems (including cathodic protection) integrated with inspection data help understand conditions contributing to crack formation and growth.
- Geospatial analysis: The integration of terrain and environmental data helps to identify external factors influencing pipeline integrity, which is crucial for pinpointing high-risk areas and tailoring inspection and maintenance strategies.

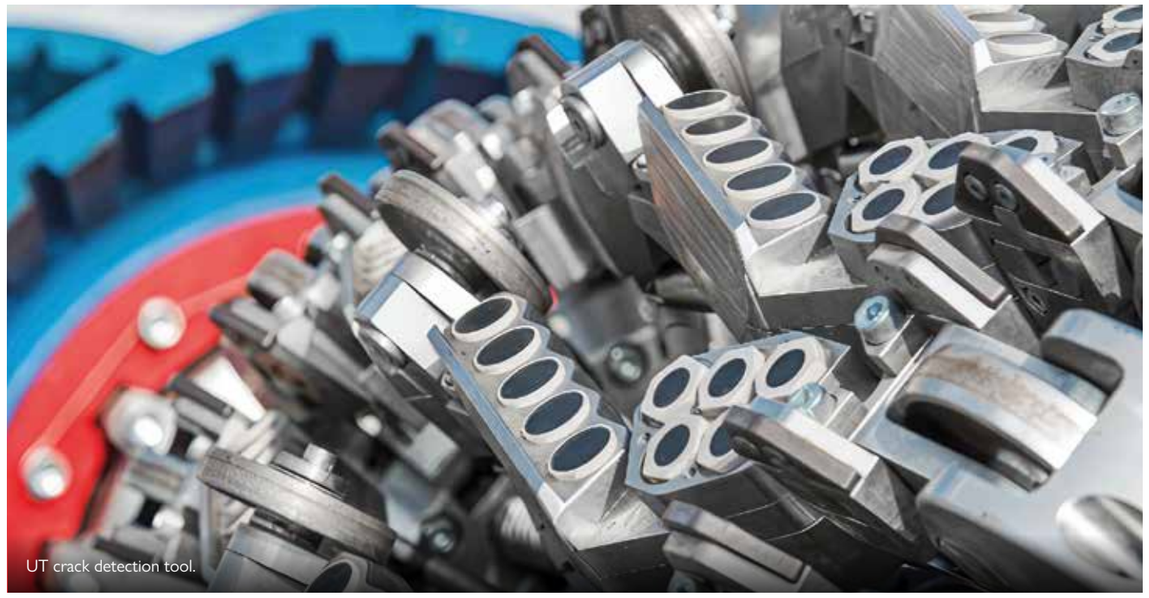
Availability of high-quality data is crucial in providing confidence in data analytics insights; sufficient high-quality data is often unavailable for many pipelines across the globe. Work is ongoing within ROSEN to further leverage the vast amount of data within the IDW to fill these data gaps based on datasets from similar pipelines.

The role of data analytics in integrity management

A combination of data analytics techniques and high-quality data sources, such as the ROSEN IDW, can support a robust framework for managing pipeline cracks, providing value throughout the integrity management cycle:

- Susceptibility and predictive modelling: Aggregating data from multiple sources to focus efforts on the locations most likely to contain cracks.
- Improved ILI performance: Refining ILI signal evaluation algorithms and strategies for each pipeline improves detection and feature characterisation capabilities. Additionally, combining ILI technologies can greatly improve confidence in feature identification.
- Enhanced integrity decision-making: Access to detailed, up-to-date information allows pipeline operators to make informed decisions regarding maintenance schedules, resource allocation, and safety measures. The application of data analytics and utilising a combination of ILI technologies can greatly improve confidence in an ILI's performance (detection and identification); improved confidence can result in substantial savings in effort and costs of in-field verification activities. Data analytics provides actionable insights that enhance the overall efficiency and effectiveness of integrity management programs.

Images: ROSEN



UT crack detection tool.

EMAT crack detection tool.

Challenges

Despite its benefits, integrating data analytics into integrity management programs presents challenges, such as ensuring recent relevant robust data, integrating data from disparate sources, and requiring specialised expertise. Implementing data analytics can be resource-intensive, requiring significant investments in expertise and training.

Future outlook

Advancements in sensor technology, machine learning algorithms, and data processing capabilities are expected to further enhance the effectiveness of decision support systems at all levels. Continued research and development will be required in addressing current limitations and unlocking the full potential of data analytics for ensuring pipeline safety and reliability.

Conclusion

Data analytics represents an emerging opportunity to move the needle in pipeline integrity. Leveraging data analytics allows accurate detection, predictive maintenance, and monitoring of cracking threats, ultimately enhancing pipeline operations' safety, efficiency and profitability. As technology continues to evolve, integrating data analytics into integrity management practices of pipelines with cracking will play a pivotal role in safeguarding pipelines for years to come. **P**

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