In-line inspection (ILI) companies use ILI tools, also referred to as “smart pigs,” to provide in-depth and accurate information to operators regarding the status of their pipelines. These tools have been commercially available for decades, and have been subject to continuous improvement based on research and development throughout this period. Demand for these intelligent ILI products continues to develop as the consumption of petroleum products and natural gas increases, the number of active pipeline networks continues to grow, the aging of pipelines, amongst many other factors.

For any pipeline operator, ongoing integrity management programs play an integral role in maintaining the safety of their pipeline. As cracking in pipelines presents one of the primary causes for potential pipeline failures, it is necessary for pipeline inspection companies to continually research and develop new ways to combat these threats. The following is an examination of the foundations and future of pipeline crack inspection.

Removing Limitations with Higher Resolution

Identifying potential areas fit for enhancement in the inspection industry is at the forefront of the ongoing research and development undertaken by NDT Global. As part of this plan for continuous improvement, the company identified the potential for higher resolution in crack inspection as a development to better mitigate the risks associated with cracks or crack-like anomalies in pipelines. NDT Global understands the importance of the relationships it has with its customers and how imperative it is for these relationships to encourage open and ongoing dialogues. The feedback the ILI company receives from these relationships is integral for the execution of such research and development plans.

The design of ILI tools for crack inspections sees sensors populated around the body of the ILI tool. Continuous improvements in underlying electronics enabled the implementation of state-of-the-art technology regarding data recording, data processing and data storage.

Using the pulse-echo mode, these sensors trans-
mit 45-degree shear waves into the pipe wall and receive reflections obtained from cracks or crack-like reflectors. While the amplitude of the so-called “corner reflection” saturates for deeper cracks, the use of the indirect reflection that comes from the opposite wall — aka, the indirect crack echo (ICE) — allows for depth sizing covering crack depths above the saturation level.

To safely record ICE signals, one requirement is a higher circumferential resolution resulting in a smaller sensor distance in the circumferential direction, which in turn decreases the deviation of the measurement. This means that one feature detected repeatedly presents minimal differences between the measurements. In turn, this increases the reliability of the tool, as at least one sensor will run in the optimal position to detect the feature. Standard crack inspection tools have circumferential resolutions that may prevent reliable recording of such ICE signals. By developing higher-resolution crack inspection tools, with a significantly higher number of sensors, the capabilities for depth sizing greatly improves. Consequently, NDT Global recently introduced an Enhanced Sizing capability for depth sizing over the entire wall thickness range (WT).

NDT Global also recently launched a new tool fleet extension with double the amount of sensors, decreasing the space between them. The new highest resolution crack inspection service provides greater insights and analysis regarding the status of a pipeline. It brings with it an increased probability of identification (POI), which in turn enables a better chance of discrimination between different feature types. By doubling the number of sensors, these new generation of tools will increase the probability of detection (POD) of cracks. Due to the presence of more sensors and an increased axial resolution, this new service provides up to four times data from a run that can be analyzed.

Incremental Data for Decreased Costs

With more data available, the ability, knowledge and experience of a data analysis team comes to the fore. Following the completion of an ILI run, the data analysis team receives the raw data. The additional data made available with an increased number of sensors puts the analysis team in a better position to analyze the data and create feature reports with higher confidence. The collective knowledge of NDT Global’s data analysis team means that with this POI, operators understand better the status of their lines. Consequently, the increased data affords analysts a greater opportunity to discriminate between different types of defects. This in turn results in a reduction of the number of redundancies in the final report delivered to the operator.

By providing such high levels of measurement accuracy, NDT Global offers operators levels of assurance regarding the status of their pipeline. The receipt of such detailed inspection results provides operators with a heightened confidence in knowing the true state of their pipeline. The accuracy of the data is paramount to help reduce the risks associated with managing pipeline integrity.

Highly accurate data provides analysts the information they require to present in-depth reports to pipeline opera-
tors. Such information places operators in a better position to improve their ability to maintain critical assets in a cost effective and proactive manner. This allows the operator to adapt any originally planned allowances in order to save money by reducing any unnecessarily planned digs. These savings have long-term effects in relation to operators' integrity management programs, allowing them to prioritize where they distribute their financial resources.

By increasing the resolution with which a tool conducts an inspection, NDT Global offers more accurate and in-depth information to its customers, giving them a clearer insight into the status of their pipelines. More accurate data allows integrity management programs to better inspection, monitor and prioritize cracking threats in pipelines. It ensures remediation resources are correctly targeted to features that need intervention, when they need it. The introduction of high-resolution tools is a step towards ridding the industry of pipeline failures due to unidentified cracks or crack-related threats.

**Confronting Circumferential Cracking**

Over the last two decades, there has been a focus on corrosion and axial cracking as the primary threats to pipeline systems. However, circumferential cracking, while not observed as frequently, poses significant threats to pipelines. Circumferential cracking arises due to various factors, several of which are outlined below.

In recent years, there have been increased observations of circumferential cracking adversely affecting pipelines. In some cases, initial integrity digs discover circumferential crack-like indications in conjunction with slope movement, for example. There have also been instances of circumferential crack fields identified in areas of slighter, or non-moving, slopes. Most likely, this is due to residual stresses from construction practices, occurring in conjunction with bends in a pipeline. However, geotechnical rankings do not necessarily always correlate to crack severity or density.

One systematic factor behind circumferential cracking is a pipeline passing through a mountainous terrain. Segments that vary in elevation are actively monitored utilizing strain gauges. The reasoning for operators identifying these segments relates to their susceptibility to topographical effects. In cases of severe pipeline movements, buckles or wrinkles may appear. In such instances, circumferential cracking occurs due to stress accumulation in combination with susceptible pipe steel, coating and environmental conditions.

To combat threats associated with these defects, ILI tools that utilize the same ultrasonic shear wave technology as in axial, but circumferentially oriented, such as NDT Global's ultrasonic circumferential crack inspection tool, the Evo Series 1.0 UCc. In contrast to magnetic flux leakage (MFL) tools, ultrasonic crack detection tools do not require calibration, whereas MFL tools do, especially for varying wall thicknesses. Onboard reference sensors measure medium properties such as pressure, sound velocity, attenuation and temperature, ensuring that the tool operates within optimum settings.

Although cracks that are circumferentially oriented tend not to be as frequent as axially oriented ones, the experience in identifying and sizing such threats that NDT Global's team possesses put it in a position to comprehend, analyze and deliver comprehensive information regarding a pipeline. An experienced team of data analysts correlates information from previous runs. This ability to acquire, analyze and provide insights about collated and accurate data enables them to consider how pipelines behave when exposed to different form of cracks.

**Complete Crack Inspection Services Offering Complete Integrity Management**

For a pipeline integrity management program to be truly successful, operators must have confidence in the infor-
information they have been given. To identify and manage threats to their pipeline, they need to have access to not only relevant, but also accurate and complete data. It is imperative, therefore, for inspection services to put operators in the best position possible to understand and characterize threats. Having access to such accurate data provides operators with the confidence to reduce risks to their pipeline.

The close working relationships NDT Global has with its customers puts the company in a positive position to research, develop and execute such developments for the industry. With a universal goal of reducing the number of pipeline failures due to integrity defects, this collaborative dynamic will continue to flourish. Awareness among operators surrounding the benefits of regular inspection and maintenance of pipelines continues to grow, fueling continuous research and development to enhance ILI tools and the accompanying services.

The scope of all of NDT Global’s research and development projects aims to continually enhancing its range of ILI tools for improved pipeline integrity management programs. All of which helps operators manage their remediation programs in a manner that better enables them to avoid unnecessary costs or reducing operational costs, resulting in potentially significant financial and environmental savings.

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