The Choice is Right

Selecting the right technologies lets you find the needle in a haystack

In a Nutshell:
Find the needle in the haystack – or better yet – find the pinhole in the pipeline. Although high-resolution magnetic flux leakage (MFL) technology seems to have become the standard in-line inspection (ILI) technology and has a very high success rate in detecting corrosion in pipelines, there are situations when this robust power horse reaches its limits. This article describes a situation where the collection of medium characteristics and the type of features present meant an even more precise approach was needed for a small diameter transfer pipelines.

Find the right technology for the job
The medium being transported (crude oil) had a water cut running at the bottom of the pipeline and contained suspended solids; together, these can create corrosion in the form of a channel (channeling corrosion). This "shape" of corrosion is difficult to measure properly with MFL-A, as this technology does not perform well for the detection of general wall thinning. It best detects sharp edges, and, especially for axial magnetic flux leakage (MFL-A) technology, channeling corrosion is not easily identified, because this feature would be longitudinal. The result can be an undetected feature, which may cause a leak. To mitigate this risk for the small diameter pipeline, although it had been inspected using standard MFL technology, ultra-resolution data on all features was not collected – however it needed to be clear that there were no so called 'pinholes' present, and if there were that they could be addressed. These features are tiny holes, less than 10 x 10 millimeters in size and very difficult to detect. Choosing the right technology can be difficult, as each has its advantages. For the detection of channeling corrosion, UT is actually most adequate. It is, however, restricted by its sensitivity to debris and would not be best for the coming inspection. What about MFL-C? That would do a better job at detecting the longitudinal features along the pipe wall, but it would still not be precise enough to identify any pinholes. After considering all the options, **ROSEN Group** experts concluded that a combination of two technologies would be the best approach. This would be MFL-A Ultra and internal eddy current (IEC).

MFL-A Ultra: Making the invisible visible
The choice for MFL-A Ultra became clear with the performance specifications, since it would be able to detect any pinhole features in the pipeline. For the development of MFL-A Ultra, new sensor elements were developed. These were optimized for a 1-millimeter (0.04-inch) axial resolution and 1.6-millimeter (0.063-inch) circumferential resolution, more than doubling the resolution of current standard MFL technologies and essentially moving from individual data points to true imaging, an example of which can be seen in Figure 1 below.

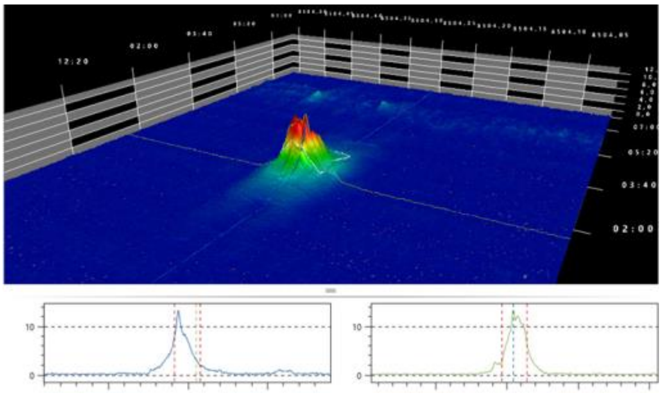

Figure 1: With the Ultra resolution, true pipeline imaging becomes possible

In addition, the mechanics and electronics of the new sensor elements were adapted. Traditionally, sensor carriers are placed on one sensor ring and located at least 2 millimeters (0.08 inches) apart due to mechanical constraints. To achieve the desired resolution, however, two sensor rings had to be mounted side by side and the carriers attached in a slightly offset fashion. Because of the high sensitivity of the sensors and the now offset physical location, two data sets needed to be generated – one measuring closer to the front and one closer to the back of the magnetic field. Using image-processing algorithms, these sets were then normalized in order to create one triaxial magnetic image for the pipeline. Figure 2 shows the data sets before and after normalization, with the separated data sets from each sensor ring on the left and the combined image on the right.

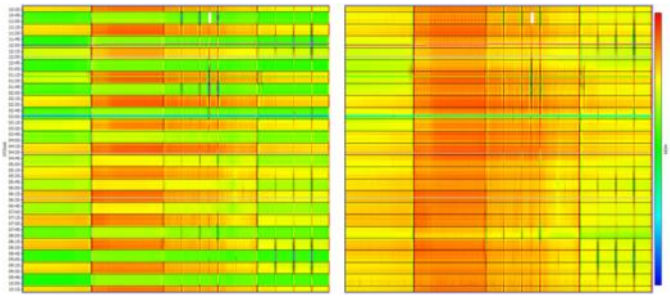

Figure 2: With two sensor rings, complete wall coverage is possible

The combination of the three elements – highly sensitive sensors, dual-sensor rings and image-processing algorithms – allows for full ultra-resolution circumferential coverage and the detection of the smallest pinholes.

IEC: The trusted companion

In this case, IEC was used for support. Although MFL -A Ultra is optimal for detecting pinholes, its axial magnetization means lower sizing accuracies for long circumferential features in comparison to using circumferential magnetization. Therefore, the combination with IEC best addressed axial channeling corrosion in this pipeline. This technology allows for the detection of surface corrosion. Based on electro-magnetic induction, eddy current testing involves placing a cylindrical coil, which carries an alternating current close to the pipeline. The current in the coil generates a changing magnetic field and thus produces eddy currents in the pipe wall. To collect data, the variations in the phase and magnitude of these currents are monitored by using a second coil or by marking changes in the current that flows in the primary coil. The IEC signal gives additional information about the length and width of a detected feature and as such significantly improves depth sizing.

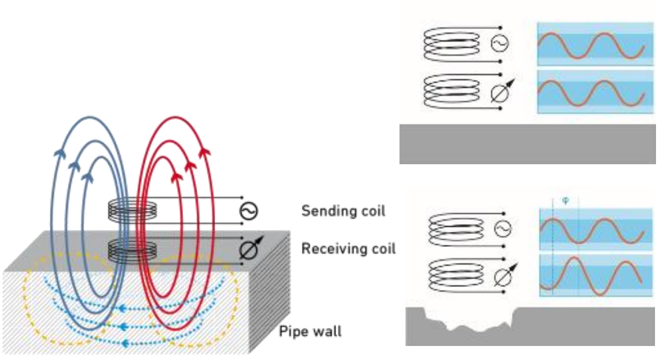

Figure 3: Variations in the electrical conductivity or magnetic permeability due to the presence of flaws will change the flow patterns of the eddy currents, and there will be a corresponding change in the phase and amplitude of the measured current.

After all was said and done and the data was col-lected, field verifications allowed the feature-sizing approach to be corroborated, verifying this process.

But WHY?

The well-thought-out choice of technologies goes a long way in identifying the threats present as well as those that are most relevant to the structural integrity of a pipeline. In this case, choosing the very precise MFL-A Ultra technology coupled with the supporting IEC technology to address any presence of axial channeling ensured the precision of the Ultra performance and, consequently, allowed for less conservative evaluation criteria, as doing so offers a much more accurate diagnosis. Ultimately, this equips operators with a much better understanding of the status of their pipelines, which in turn enables them to make better decisions for their future integrity.