INSPECT THE UNEXPECTED

Eddy current is the solution to evolving challenges in pipeline integrity, says Sylvain Cornu, Electromagnetic Engineer, NDT Global.

By providing the power of clarity to enable the best outcomes, NDT Global continually strives to push boundaries and set new standards for inline inspection (ILI), data analysis, and integrity assessment. This sentiment could not be truer with our latest technology development, ETEC™, a technology platform that creates innovative solutions and opportunities to capture new datasets during the ILI inspection process.

Operators and regulators across the energy industry, striving for green energy alternatives, are re-purposing ageing pipelines that currently transport petroleum and natural gas to pipelines that will transport hydrogen or CO_2 in the future.

By leveraging advanced technologies and measurement principles, like eddy current, pipeline operators are able to gain critical information to help understand and address any potential risks prior to injecting hydrogen into their pipelines. NDT Global's ETEC technology provides insights such as material properties, as well as direct measurement of the stresses on the pipeline. This provides operators the ability to identify areas of crack susceptibility or the potential for any other injurious features.

Geohazards

The first application of ETEC technology, ETEC Geo, provides pipeline operators facing geohazard challenges with highly accurate data and actionable insights to address geotechnical threats.

Combining eddy current with an inertial measurement unit (IMU) and a geometry tool offers a highly accurate bi-axial strain measurement, delivering the best data to detect and characterise geohazards in pipelines.

Stress, or strain measurement, is a specific application of electromagnetic measurement known for decades as magneto-elastic effect (or Villari effect). The magneto-elastic coupling principle relies on the application of a known magnetic field over a ferromagnetic material (pipeline steel) where the local magnetisation level will reflect the stress level the material is experiencing. Based on elastic properties of the material and therefore, for measurement below the yield strength, stress and strain are interchangeable parameters using the magneto-elastic coupling principle.

The ETEC Geo system utilises a minimum of 16 probes, equally spaced around the pipe circumference. This configuration allows the detection of large-scale geohazard events (1 m to several hundred metres) producing mainly axially oriented load in the pipeline. This bi-axial measurement produces a strain grid of 1 in. x 1 in., measuring both longitudinal and circumferential strain values. To fully assess geohazard events, the system is designed to work in both gas or liquid mediums and includes a combination of technologies, such as caliper measurement for high-resolution pipeline geometry (ovalities, dents, buckles, or wrinkles). The geohazard system is also equipped with an IMU to measure bending strain (or movement in run-to-run analysis) and provides pipeline mapping. The eddy current sensors, not requiring a MFL magnetiser, can be deployed as a standalone system or in combination with ultrasonic or acoustic resonance technologies.

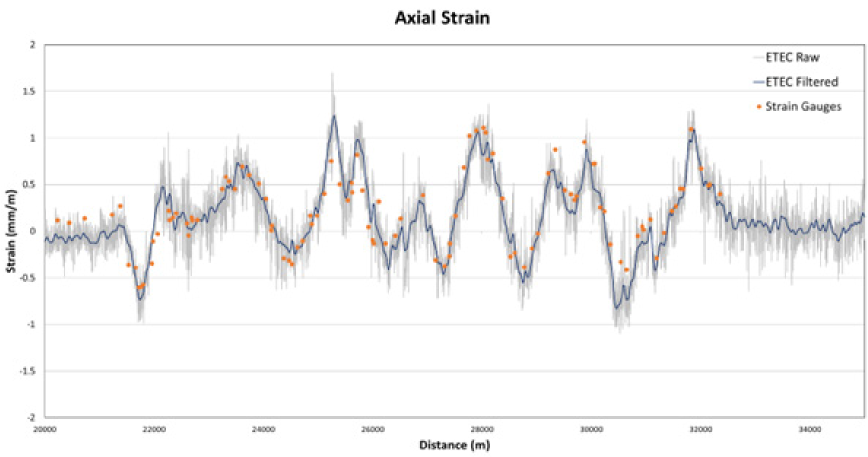

Figure 1. ETEC Geo validation result comparing strain gauge datasets provided by a pipeline operator. ETEC Geo results, axial strain, output is visible in blue and strain gauge in orange.

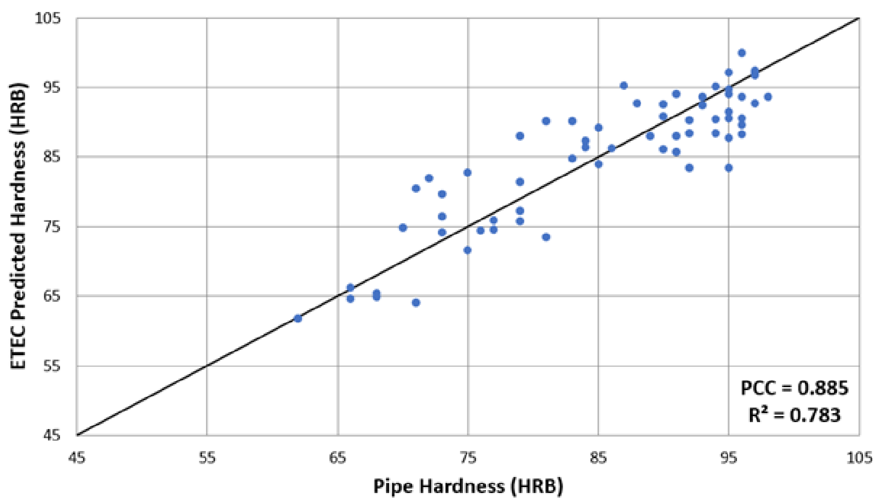

Figure 2. Unity plot showing ETEC hardness prediction.

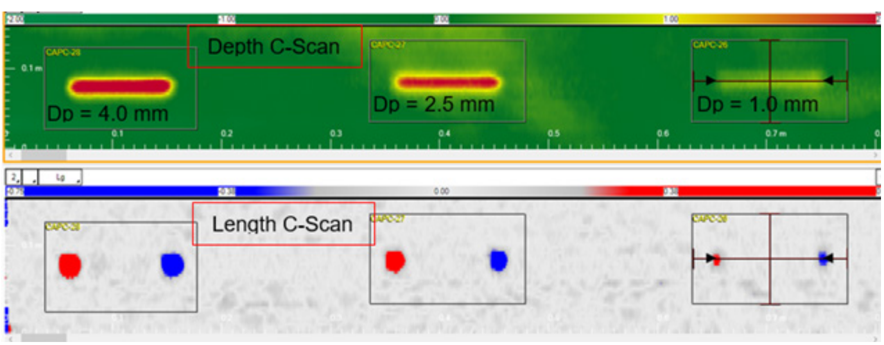

Figure 3. C-scan data showing crack length and depth from pull testing.

Market readiness

The ETEC Geo system is currently undergoing multiple validations on commercially operated pipelines which have been subjected to geohazard events. Following discussions with operators, suitable geohazard sites have been selected to evaluate the technology based on the extensive strain condition knowledge of the pipelines. A combination of stress amplitude, events with specific length, and available information (e.g. strain gauge data) make these pipelines ideal candidates to inspect.

Knowing your assets

Eddy current has been used commercially in various industries to identify differences in steel properties, such as hard spots during the manufacturing process. Pipe grade identification is another application where a measurement of the homogenous pipe properties is taken along the length of a pipe joint.

The eddy current measurement principle is capable of distinguishing material properties, making the ETEC technology a suitable candidate to measure pipe grade. Pipes can be grouped into different pipe types based on their outside diameter, wall thickness, seam weld type, pipe tally information and, more importantly, magnetic response.

The newly introduced Mega Rule requires pipe grade identification on

Figure 4. ETEC internal crack detection prototype tool.

certain pipelines in the US. ETEC can measure various magnetic properties such as yield strength, chemical composition, or hardness. As such it is likely that a pipe grade identification using ETEC will predict the pipe grade based on these various measured parameters.

To achieve true values, we completed hardness testing using a conventional mechanical indenter on a range of available pipe. Results were compared to the predicted hardness based on the magnetic response using the ETEC technology. Using adequate measured magnetic parameters, one can predict pipe hardness with a satisfactory level of confidence. Hardness is a well-known parameter that is related to ultimate tensile strength. We can define pipe grade with these measured parameters.

Material identification is not only valuable in the context of pipeline traceable records. Validating pipe grade in a pipeline is an important prerequisite for fitness for service assessments prior to converting the lines for products such as hydrogen or CO_2.

Repurposing pipelines for hydrogen transportation

Decarbonisation of our energy infrastructure is an important topic in our industry for environmental, financial, and geopolitical reasons. In Europe, the transmission of hydrogen through existing natural gas pipeline infrastructure will play a key role in this decarbonisation effort.

Introduction of hydrogen (either as a blend or pure) will introduce new pipeline failure modes, necessitating new ILI technologies. These new systems will be used to perform baseline surveys before the introduction of hydrogen and in service inspections to monitor any changes thereafter.

Cracks are a major threat to pipelines; as such the industry has devoted a great amount of effort to address the detection and sizing of cracks in the external surface of liquid and gas pipelines. On the external surface, cracks can take the form of stress corrosion cracking (SCC) in the pipe body, fatigue cracks, or defects resulting from the manufacturing process in the welds

Eddy current is one of the most suitable approaches to accurately detect and size internal surface cracks of hydrogen pipelines. Current development efforts are focused on a prototype tool to be deployed in pull test scenarios. After a successful prototype, a validation tool providing full circumferential coverage will be built and evaluated in both a test loop and operator pipelines before fully deploying ETEC for internal cracks.