Improved eddy current technology for inline inspection of heavy wall gas pipelines

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Pipelines containing heavy wall thicknesses—predominantly offshore pipelines— can face a primary threat of internal corrosion. Performing a standard MFL inspection on such lines is challenging, and sometimes even impossible, due to internal diameter (ID) restrictions, extreme wall thickness, multi-diameter pipeline setup, the requirement to clearly discriminate between adjacent features, etc. In addition, general pipeline thinning cannot be accurately sized with standard MFL-A tools alone. A viable option would be the use of ultrasonic testing (UT) technology. However, as UT requires a liquid medium, it is not a desirable solution for use in gas pipelines.

In order to overcome the limitations of the previously mentioned inline inspection (ILI) technologies, ROSEN has developed the RoCorr IEC Service, which utilizes Eddy Current (EC) technology. This service can additionally be combined with any other desired sensor technology, including MFL, to further increase the reliability of subsequent integrity assessments.

Tool description

"Following a well-proven high-resolution caliper tool design[1], the internal eddy current (IEC) sensor carriers are mounted on an ILI tool by spring-loaded arms for smooth guidance along the pipe's inner surface. The EC measurement method is essentially contactless. Mechanical displacements of the sensors in radial direction due to geometry changes of the line are additionally monitored by angle measurements of the individual suspension arms"[2]. Thanks to the use of two sensor planes, 100% coverage is guaranteed. An ILI tool that combines both IEC and MFL technologies is shown in Figure 1. The front unit consists of high-resolution MFL technology, the second unit utilizes a combination of high-resolution geometry sensors and IEC probes.

Tool performance

The IEC standalone tool always delivers an internal metal-loss and geometry evaluation with 100% coverage in one run. The metal-loss features are measured in absolute terms, which enables the tool to function regardless of the wall thickness. Pits with diameters of at least 10 mm and minimum depths of 1.0 mm can be detected. Internal shallow defects with a maximum depth of 10 mm are sized with high accuracy, i.e. +/- 1.3mm.

The tools are also very flexible (up to 80% ID passage) and create less friction than the MFL tools with magnetic yokes. Due to the touchless measurement, a coupling to the wall is not necessary, allowing for accurate measurements regardless of the medium

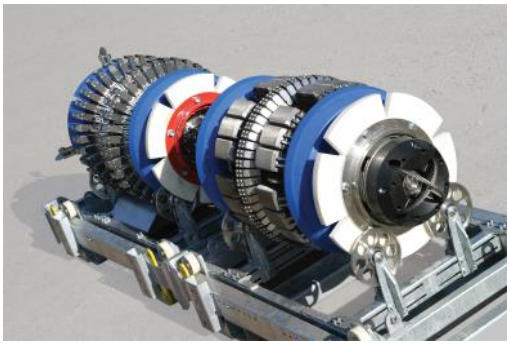

Figure 1: The combined-technology setup ensures that all internal and external corrosion, as well as geometry anomalies, can be accurately measured.

present in the pipeline. The RoCorr IEC Service is capable of coping with all pipeline diameters between 6" and 56", as well as multi-diameter pipelines.

Combination of IEC and standard MFL

Although the abilities of IEC depth sizing of shallow internal corrosion substantially exceed that of MFL, the combination of both technologies provides significant benefits, including:

- Absolute measurement and depth sizing of metal-loss defects
- Improved distinction of individual pits in dense clusters
- Determination of wall thickness / general thinning

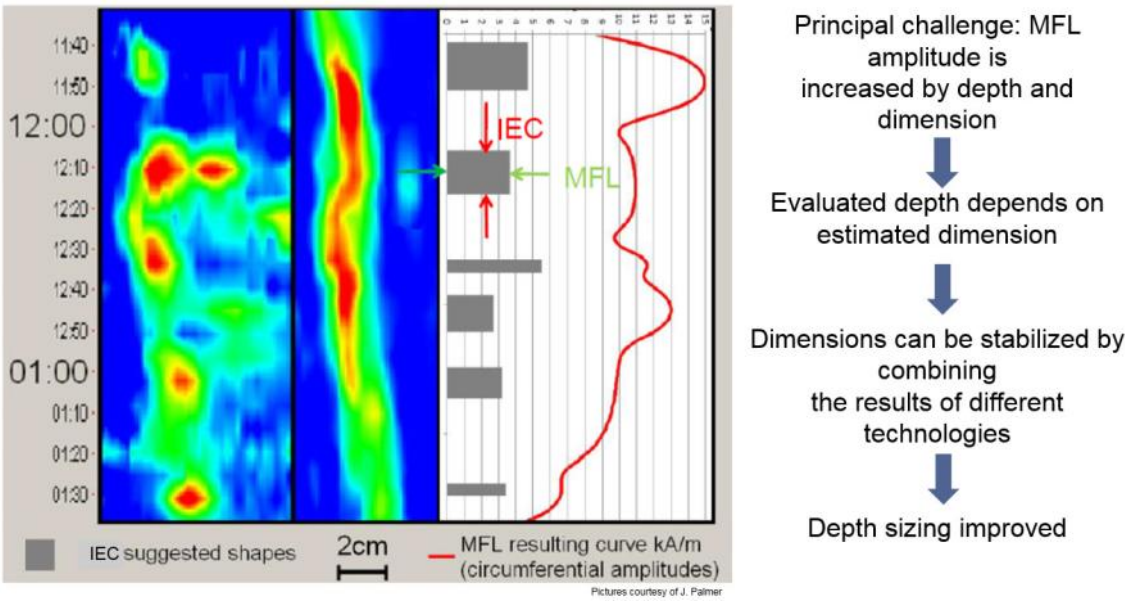

Figure 2: By combining IEC and standard MFL-A technology, the absolute measurement and depth sizing of metal-loss defects is possible.

IEC supplements the relative wall-loss measurements of the MFL technology by supporting defect identification and depth sizing thanks to its higher spatial resolution. Figure 2 provides an example of the advantages of combining IEC with standard MFL-A technology.

In addition, general pipeline thinning can be accurately measured by combining the caliper component of the IEC, which would reveal a general impression of the thinning, with the MFL component, which would measure the smaller indications within the general thinning area.

Recent improvements and customer benefits

Over the past eight years, ROSEN has been applying IEC technology in the inline inspections of more than 15,000 km (10,000 miles) of pipeline. The experience gained over the years has allowed for further optimization of the technology.

As a result of these IEC improvements, ROSEN's experts are now able to

- qualitatively discriminate between different materials within a pipeline, enabling operators to monitor the condition of internal coatings;
- clearly identify and discriminate ferromagnetic debris from corrosion; and
- assess pipelines with corrosion resistant alloys (CRA), i.e. identify defects within the stainless steel layer which is not possible when using stand-alone MFL technology.

In summary, the IEC technology offers several benefits:

- High accuracy in the absolute measurement of internal corrosion in both liquid and gas pipelines
- Applicable in pipelines with high wall thickness
- Suitable for pipelines with ID restrictions
- Dataset collected also includes pipe geometry information, allowing for dent strain/stress calculations
- Detection of general pipe wall thinning
- Inspection of pipelines with CRA cladding or internal flow coatings
- Combination of IEC with MFL-A allows for the assessment of internal/external corrosion and geometry features in a single ILI run.

1 In-Line Inspection of Dents and Corrosion using "High Quality" Multi-Purpose Smart-Pig Inspection Data. Beuker, T., Brown, B. and Paeper, S. 2006. International Pipeline Conference.
2 Shallow Internal Corrosion Sensor Technology for Heavy Pipe Wall Inspection. Stawicki, O., Ahlbrink, R., Schroeer. K. 2009. PPSA Conference.