Locating a Lost/Stuck PIG in a Pipeline Using XLI PWA Technology

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Abstract

Although a lost or stuck pig is rare, when it does occur, the costs can be extremely high, raising the locating efforts to the highest priority.

A lost or stuck pig in a pipeline can have a serious impact on an operator's ability to transport product. While uncommon these days, this does still occur, and when it does it can be detrimental to the safe and efficient operation of an Oil and Gas pipeline. Therefore, the ability to identify the location of the obstruction quickly is of utmost importance and can become a singular highest priority for the pipeline operator. Recent advancements in technology have facilitated such locating efforts, and saved operators time, expense, and aggravation.

Oil and Gas pipelines are comprised of ferromagnetic materials, such as iron, nickel, steel, and other materials. Large Standoff Magnetometry (LSM) technology is known be used to identify and locate elevated levels of stress through the measurement of the magnetic field surrounding steel pipelines. LSM detects inverse magnetostriction (also known as the Villari effect) which is the change of the magnetic susceptibility of a material when subjected to mechanical stress. LSM technology has been used to detect defects as they appear as changes in the magnetic field around the pipeline which can indicate the presence of stress on the pipe. Thus, LSM can identify stress concentration caused by full pipeline blockages.

This paper will discuss how the XLI PWA technology works to locate lost or stuck PIGs, and review 3 successful case studies.

Introduction

Oil and Gas pipelines operators have been utilizing Pipeline Inspection Gauges, more commonly referred to as PIGs, for a number of pipeline operations activities since the 1960s. These activities range from simple cleaning of the pipelines to gauging tools used to identify deformities in the line. Furthermore, Inline Inspection (ILI) Tools are used to assess the condition of these pipelines by attaching electronic instrumentation to these PIGs to perform various types of measurements such as wall loss or cracking identification.

All of these operations are designed to be completed with little to no disruption on pipeline operations and without stopping flow. When any of these PIGs or ILI tools do stop and prevent flow of the pipeline product, it can have a serious impact on the safe and efficient operation of that pipeline.

Now while this type of occurrence is fairly rare in day-to-day operations of oil and gas pipelines, it does still occur at various scales. When any tool, regardless of its purpose, gets stuck in a pipeline it can start to have severe consequences for the operation of that pipeline. Therefore, the ability to

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identify the location of the obstruction quickly is of utmost importance and can become a singular highest priority for the pipeline operator.

By combining two different technologies, Spectrum XLI and SmartBall, PureHM has been able to develop a technology that can be used to find stuck pig or ILI tools when they fully obstruct the pipelines or to locate tools that include large magnetic signatures (MFL).

Technology Overview – Spectrum XLI

Spectrum XLI is a direct assessment technology platform for proactive above ground inspection of buried pipelines. Unlike conventional above ground inspection tools – which often collect only a single data source in each pass – the XLI platform collects multiple sources of data in a single pass. Simultaneously, the system can collect: GPS/GIS, depth of cover, depth of water, gas leak detection, cathodic protection survey (CP CIPS/CIS), direct current voltage gradient (DCVG), alternating current voltage gradient (ACVG), alternating current-current attenuation (ACCA), and soil corrosivity measurements. It can be used for the following inspections: External Corrosion Direct Assessment (ECDA), Internal Corrosion Direct Assessment (ICDA), Stress Corrosion Cracking Direct Assessment (SCCDA), Cathodic Protection (CP) and Close Internal Surveys (CIS).

Inspections are completed by field teams that walk the pipeline ROW recording the desired pipeline data with the Spectrum XLI equipment. All measurements are logged into secured encrypted raw logs, which ensures that data cannot be compromised. The complete raw data log can be audited upon the pipeline owner's request. Post-analysis and reporting of inspection results is completed by NACE or AMPP certified CP and Corrosion Specialists, ensuring that reliable pipeline integrity recommendations are made. All project deliverables are completed and delivered quickly after the inspection, unlike traditional, single-technology platforms, which provide deliverables at different times in different vendor formats.

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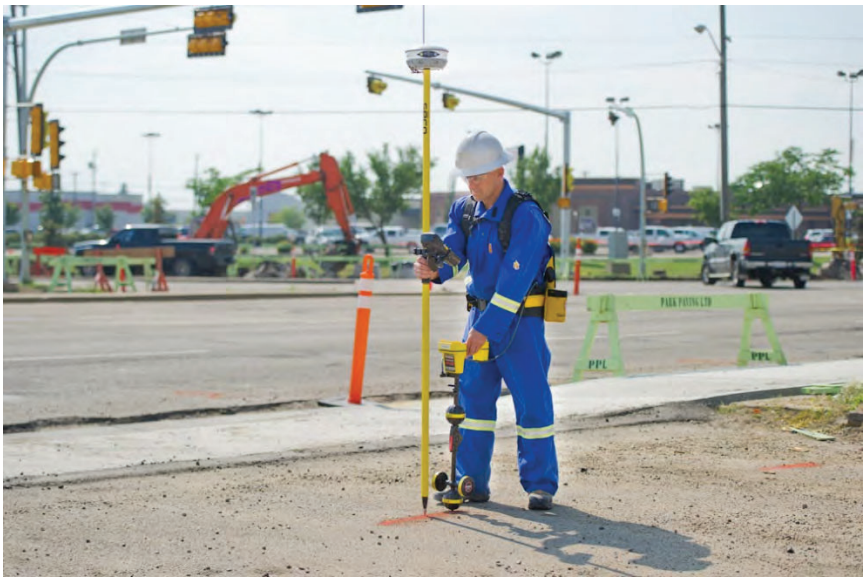

Figure 1. Spectrum XLI inspection

Technology Overview – XLI PWA

Looking to further advance the deliverables of the SmartBall magnetometer data, studies were performed using the magnetometer to identify locations that were under stress. The term for this deliverable was coined as Pipe Wall Assessment (PWA) While this did prove somewhat successful the rolling motion of the SmartBall introducing significant noise into the data set making accurate analysis and reporting difficult.

After working with both technologies for several years PureHM looked to combine the magnetometer inside the SmartBall with the above ground data collection method afforded by Spectrum XLI. The idea was that the rolling noise introduced by the SmartBall could be isolated when the sensors were deployed and help above the pipeline. Thus, XLI Pipe Wall Assessment was created.

PWA is a method of screening a pipeline for elevated levels of stress through the measurement of passive magnetic field changes in ferromagnetic pipelines. Identifying the presence of stress concentration zones is an important part of a pipeline integrity program and can provide owners with condition information that other integrity tools do not provide. For pipeline operators, a magnetic field change caused by stress can be produced by several pipeline condition factors such as: geotechnical issues, excessive loading, or poor bedding.

PureHM's PWA sensor can be deployed on the Spectrum XLI aboveground inspection platform to identify magnetic field changes in the pipe wall. A magnetic field change can indicate the presence of stress in the pipe wall. The Villari effect states that when a magnetic object is stressed, it creates a corresponding magnetic field. During PWA inspections, a technician walks the sensor along the

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ROW to identify magnetic field changes. The data is reviewed and reported to the pipeline operator with stress concentration zones ranked based on priority.

To locate a blockage, a magnetic sensor is placed close to the pipe at strategic points. Since the magnetic signals that are being observed are quite minute, the sensor must be quite close to the pipe if not on top of it.

Once in place, the pressure is cycled. The sensors are monitored for a few minutes with no pressure, then the pressure is increased. If the point monitored is upstream of the blockage, pressure will increase, and a magnetic disturbance will be detected. If the point monitored is downstream of the blockage, no pressure will build, and no magnetic disturbance will be detected.

This process is repeated until the area of the blockage in known to an acceptable level of accuracy.

Case Study 1- Pembina Stuck PIG

Challenge

Pembina Pipeline Corporation (Pembina) had launched a 4-inch pipeline cleaning PIG in a 100km long condensate pipeline. This tool became stuck in a 14-km section of the line and blocked flow of the pipeline to the extent that less than 2% of flow was able to pass the blockage. As the tool did not have a 22Hz transmitter or any other form of tracking, the operator was unable to identify the location of the stuck pig. Multiple attempts were then made to move the blockage by reversing flow on the line, however these attempts were not successful. Creating further issues for the operator was a contractual agreement requiring them to truck product over 30 miles during spring break up for as long as the line remained down. This required a $1,000,000 bond for the road and estimated trucking costs of over $200,000 per day until the blockage was cleared.

Solution

Following the unsuccessful attempts to move the blockage through flow reversal, the operator engaged PureHM's emergency response group to launch a second pig with a 22Hz transmitter to locate the blockage. This proved ineffective as the pressure differential with such slow flow restricted the rescue pig to a flow rate of under 0.1 kilometres per hour, which meant it was unable to locate the blockage. Once evident that the rescue pig was ineffective under the circumstances, the PureHM team began to collaborate with the operator on an exploratory method of locating the pig, using existing PureHM technologies. After learning that the operator was able to apply pressure from either end of the blockage, the PureHM team worked on a theoretical approach to locating the pig using non-intrusive technology to measure pressure indications on the pipe wall. PureHM's Pipe Wall Assessment (PWA) technology, which uses Large Stand-Off Magnetometry (LSM), was deployed as a mobile non-intrusive pressure sensor, able to confirm if the pipe was experiencing magnetic response to repeated pressure cycles while incrementally moving down the right of way. The open collaboration between the operator and PureHM to find a creative resolution unearthed a new and exciting

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application for Large Stand-Off Magnetometry, which until now, has primarily been used to locate and assess stress associated with geotechnical, corrosion or cracking anomalies on buried pipelines.

Outcome

Within 2 days on site PureHM was able to narrow down the blockage to a 6-foot long area on the pipeline using the PWA sensor. The client was then able to install a stopple and hot tap the pipe downstream of the blockage. The tap was then used to inject hot oil at high pressure to clear the blockage, freeing the stuck pig and resuming the normal operation of the pipeline. The non-intrusive nature of PWA allowed the operator to limit costs relating to digs and deployment of heavy machinery that would have otherwise been used to locate and free the stuck tool. By locating the tool quickly and returning the line to normal operation, the operator was also able to end the financial burden of $200,000/day spent on transporting product by truck, sooner than could have otherwise been achieved.

Following the success of this project, the client re-engaged PureHM to locate a number of stuck tools over the past 5 years.

Case Study 2- Pembina Stuck PIG

Challenge

TC Energy had a project that involved an MFL that had become immobile on a 42-inch gas pipeline. In this case the tool was not fulling blocking or obstructing flow, which left some time for TC to formulate a plan to retrieve the MFL tool. In an effort to reduce the costs and environmental impact of digging, TC Energy reached out to PureHM to have them confirm the exact location of the tool before digging.

Solution

Prior to mobilization PureHM personnel where able to provide a theoretical signal response that should be observed.

PureHM was able to mobilize withing 24 hours of the call to be onsite. There were 3 locations that had been staked to have potential to be where the MFL was lodged. Therefor the technician would focus their efforts on these 3 locations.

Outcome

Once onsite the technician was able to scan the areas in question and give confirmation of where to dig. The signal response observed with the XLI PWA unit matched that of which was expected as depicted below.

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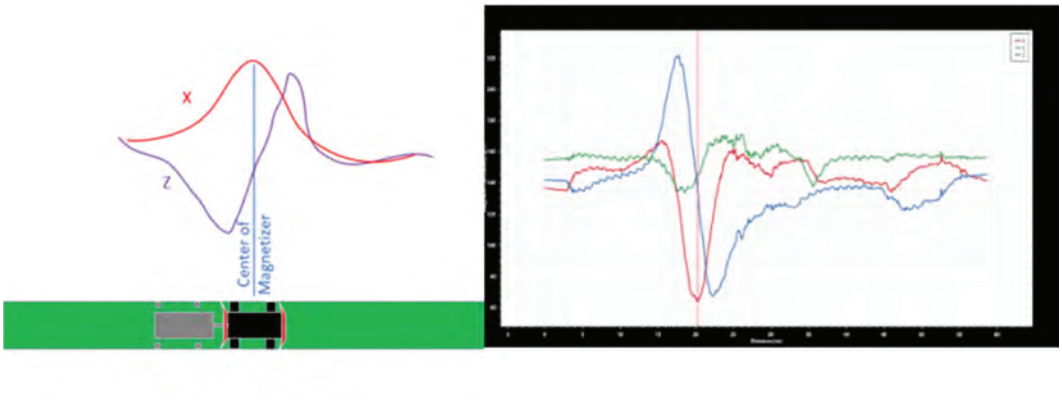

Figure 2. Theoretical signal response (left) actual response (right)

Case Study 3 – Keyera 2x Stuck PIG and Wax

Challenge

Keyera Corp (Keyera) contacted PureHM during the summer of 2023 stating that they had a number of PIGs that were stuck in a 4-inch line. The PIGs that were stuck were either right next to each other and touching, or close to each other and separated by some volume of wax. The PIGs, in this case, were not fully blocking the pipeline flow. It was estimated to be bleeding through about 2-5%.

Solution

PureHM mobilized to site and worked with Keyera Crews to identify 8 Pothole locations as a starting point to begin testing. Keyera had easy access and land permission for holes 1-6. Crews started to work from hole 1 up to hole 6 but all data showed that the blockage was still downstream. The crew then needed to demobilize due to land access for holes 7 and 8.

A new crew was able to mobilize a few days later and continue the work. At holes 7 and 8. The response at these locations was showed that the blockage was between these two points which allowed Keyera to start taking steps to address the blockage at that location.

Outcome

With the blockage identified Keyera was able to fully excavate the target area and wrap the line with heat tracing wire to melt the wax blockage. When pressure was then applied, the wax blockage along with the 2 PIGs, began to move and were able to be recovered from the Receive Trap.

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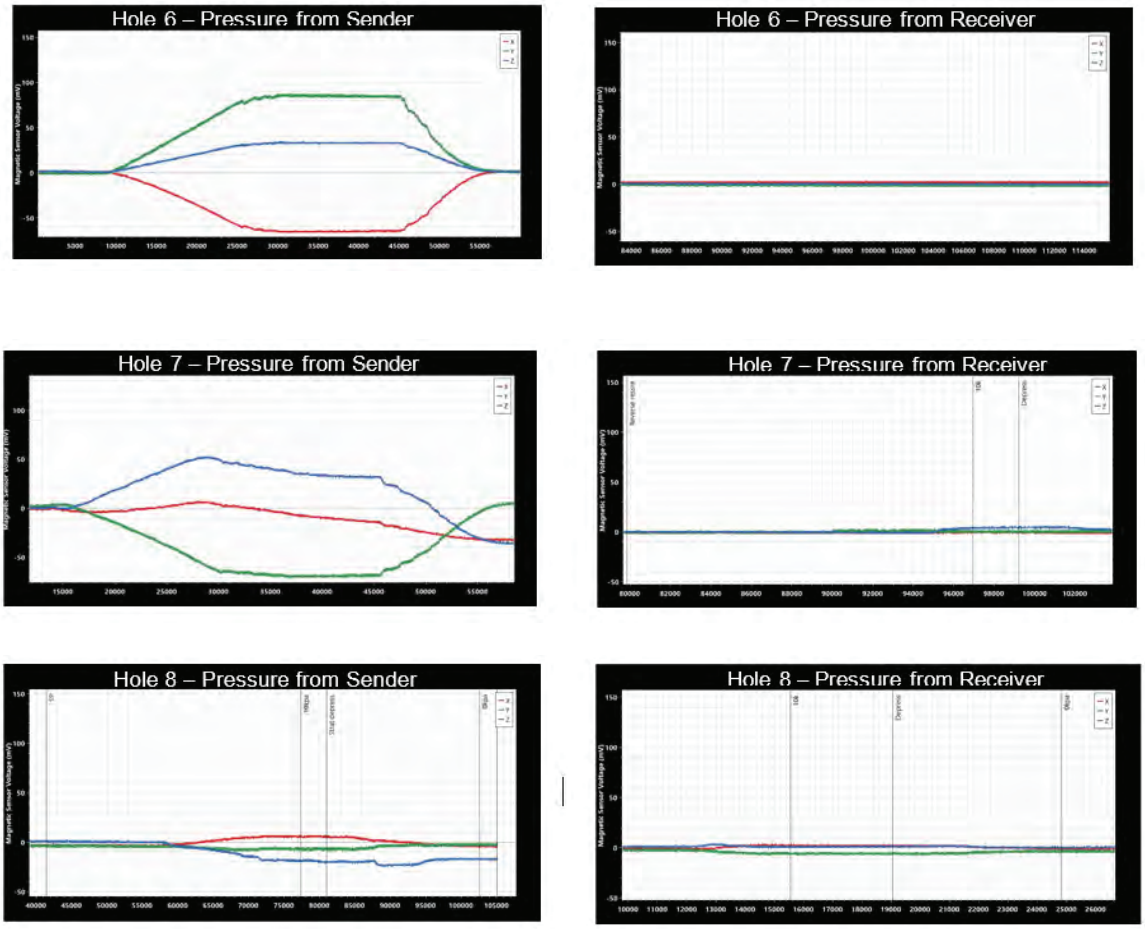

Figure 3. PWA response Holes 6-8

Conclusion

XLI PWA has proven to be a valuable tool for pipeline operators when they find themselves with the challenging situation of a stuck pig or ILI tool.

PureHM is currently working to further increase sensitivity of the XLI PWA units so that signal indications from smaller magnetic ILI tools and smaller pressure changes that be reliably detected. Additionally, development work will also see a focus on mesh deployments where you could deploy multiple XLI PWA units at one time to be able to collect data from multiple locations during a single pressure cycle.

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