Case study

Oxygen pipeline inspection during refinery shutdown

Challenge

Air Liquide Deutschland GmbH (ALD) wanted to carry out the first inline inspection of 8" and 12" oxygen pipeline sections on a refinery in Germany during a shutdown period of 21 days. The inspection scope was metal loss to detect pinhole & geometry/mapping defects specifically. ALD was willing to perform the inspection in either water or nitrogen.

Solution

PPS successfully ran the latest generation MagneScan™ ILI tool, delivering the highest level of detection and sizing propelled by gaseous nitrogen using PPS nitrogen vaporization equipment. An experienced senior data analyst was mobilized to site to inform ALD immediately of any potentially significant features.

Benefits

The avoidance of water as a propelling medium was a significant time saving aspect when drying the pipelines to the required dew point. As the shutdown periods of oxygen pipelines were dependent on shutdown periods of ALD's customers, the fact that a medium length pipeline can be put out of operation, prepared for inspections, cleaned, gauged, inspected and reinstated within one week on schedule, is a great example of pipeline integrity.

A unique integrated solution from Baker Hughes, Process & Pipeline Services (PPS) ensured that both pipelines were ready for oxygen operation on time and to schedule.

AIR LIQUIDE Deutschland GmbH (ALD) offers large chemical producers a connection to their extensive pipeline network for oxygen, nitrogen and hydrogen. ALD operate 08" and 12" pipelines to provide oxygen to a chemical park in the Ruhr region of Germany. Both lines are rated PN 63 and have been operational from the early 1970s.

Challenge

The chemical park had a planned shutdown period of 3 weeks, so the pipelines would be available for an integrity and maintenance program during this time. ALD was looking for in-line inspections (ILI) with the ability to detect metal loss and geometry flaws. Since the reporting would be georeferenced, a mapping survey for delivering GPS coordinates for both pipelines was also required. The inspection needed to deliver defect reporting in a timely manner in order to allow repair of any significant flaws before the pipeline returned to operation.

Oxygen is essential for life; however, it has a high-risk potential. Everything which comes into contact with an oxygen pipeline has to be free of grease or oil, as when combined with pure oxygen can lead to self-ignition1. It must be ensured that no remnants from an inline inspection are in the line once it is commissioned back to oxygen. These requirements are extremely challenging for inspection tools as they are designed to run in oil and gas pipelines and have moving items like arms, joints and wheels which may require lubrication for reliable functionality.

Another consideration for this inspection was country regulations for oil and gas pipelines. Oxygen pipelines fall under the regulation of the TRFL (Technische Regeln für Rohrfernleitungen) code which defines that: tools (e.g. magnetic or ultrasonic inspection tools) have to either be resistant to abrasion or equipped with material which abrasion is harmless to the further oxygen operation of the line.

In addition to this, legal requirements in Germany do not allow use of Polyurethane (PUR), for any oxygen inspection. PUR is commonly used as sealing material for many pipeline tools, and the Federal Institute for Materials Research and Testing (BAM) in Berlin must approve all non-metallic materials touching the pipe wall for the compatibility for oxygen service.

Solution

Reviewing the scope and the available timelines, PPS did not deem it possible to perform this project with water as a propelling medium. For safely operating the pipelines in oxygen, a drying to a dew point of -40°C is necessary which would require 1 – 1.5 weeks per pipeline section giving no contingency for any unforeseen operational challenges. PPS committed to an infield time of 15 days for the entire inspection program, giving 6 extra days for potential repair or other maintenance activities and contingencies.

PPS offers nitrogen pumping services and MagneScan™ intelligent inspections as a combined integrated service. With a vast fleet of nitrogen vaporization equipment and ILI tooling, experienced engineering capabilities and a highly trained and competent workforce, PPS designed a unique integrated solution for ALD which incorporated nitrogen as the propelling medium.

Both the MagneScan™ system and nitrogen supply equipment had been cleaned for the oxygen service. This required a full strip down of the entire system and all cleaning and de-greasing was documented. Furthermore, the pig traps and the mainline valves also had to be considered. PPS also reviewed the design of the 08" and 12" MagneScan™ inspection vehicle for options to reliably negotiate these lines with Viton as an alternative material for PUR.

To complete the entire operation within the 21-day timeframe, PPS recommended mobilization of self-sufficient units and teams for each of the pipeline operations to work fully in parallel and independently of each other. For a successful inspection in nitrogen, the control of the tool velocity is key. There must be direct communication lines between the crew at the pumper, the crew at the outlet as well as the pig tracking crew.

To monitor the behavior of the tools inside the pipeline in real time, the PPS ThreatScan™ system was mobilized. This enabled full control of the tool velocity saving valuable time. None of these pipeline sections had ever been passed by any tool, so the project team had to be prepared for unexpected findings.

During the project, ALD confirmed that in Germany conducting a 'blow-out' after the inspection is not necessary, however a detailed review of the tools after the individual runs would be sufficient and in parallel a post inspection cleaning run was carried out.

Benefits

As planned, both pipelines were ready for oxygen operation 15 days after the beginning of the operation.

Directly after the tool was received, the data was downloaded, checked for completeness and sufficient quality for metal loss pinhole analysis. Simultaneously, the tool was carefully checked for any lost or missing items. An experienced senior data analyst was on site to immediately inform ALD about potentially significant features which could require attention before the lines returned to normal operation. Within 24 hours of the tool being received a report had been submitted, containing all details of the features as well as clear advice on how to find the locations in field. PPS also supported ALD during the verification exercise. All reported sites from the infield analysis following immediate verification showed an excellent match between the predictions and the actual findings.

Despite a very detailed preparation and engineering program, any inspection program can bring surprises, and this was the case during the inspection of the pipe bridge. An incorporated T-piece had an undocumented configuration, which caused the inspection train to stall meaning that it had to be cut out. This challenge was resolved in a professional and efficient manner; 4 days later the pipeline bridge was inspected successfully with the MagneScan™ system. The other three sections were successfully negotiated with the intelligent system on the first attempt. The tools were received with the expected wear, but with no mechanical damage. All sensors and systems operated flawlessly, and the inspection vehicles remained within the optimum velocity range.

The success of such an operation depends entirely on detailed pre-engineering and planning. Having the nitrogen pumping controlled by the same supplier organization as the inspection technology provides the optimal scenario to run the inspection vehicle safely and within its operating limits. The right pumping hardware is provided and direct communication between the teams ensured quick and correct responses to individual running scenarios.

This operation proved that in one week a medium length pipeline can be put out of operation, inspected and reinstated while being completed on schedule - a solid result for the operator and a great example of pipeline integrity in action!

References
[1] Berufsgenossenschaft Rohstoffe und chemische Industrie, M034 Gefahrstoffe Sauerstoff, DGUV Information 213-073, Stand Juni 2010

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BHCS39030 (06/2021)

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