Pinhole leak discovered in process gas line

Incident date

19 June 2011

Summary

A pinhole leak at a weld in the process gas system was discovered. The system was shutdown and the line made safe. Close NDE examination of the weld showed that it had suffered preferential weld root/HAZ corrosion. A detailed program of weld inspection was then instigated to determine the condition of other welds on the system and welds on other systems considered to be of high risk of similar preferential corrosion attack.

Alert ID: 00xxx

Incident consequence

Hydrocarbon Release

Cause of accident or incident

Undetected corrosion of welds in discharge line

Location

Gas Compression Common Discharge Line

Activity

Production

Description

WHAT HAPPENED?

An operator was carrying out daily routines on the gas compression upper deck when a leak was observed from the six o'clock position of a circumferential butt weld in a 14” line in the process gas system. The CCR was contacted and the plant shutdown immediately. Initial external visual inspection found that the leak was a pin hole in the weld.

Inspection of fifty welds on the three major sections of pipework between the 1st Stage Export Gas Discharge Coolers and Glycol Dehydrator Knock-out Drum found similar preferential weld corrosion.

A metallurgical analysis of the welds and analysis of the corrosion deposits was conducted. The analysis concluded that cause of the weld failure was carbon dioxide corrosion, in the form of preferential weld attack. The analysis indicated that the weld metal contained ~0.7% nickel, and that the hardness values for the welds were normal. A review of welding

Lower part of the pipework
(six o' clock position- Localised Root Defect)

recommendations indicates that this weld consumable is satisfactory, i.e. the welding itself is not a root cause for the failure. Visual inspection of corroded welds indicates that weld corrosion initiated at the weld heat affected zones (HAZ) either side of the circumferential butt welds by a galvanic corrosion mechanism and progressed, at the most corrosive locations, into the weld metal itself, probably due to erosion corrosion once the circumferential grooves had formed at the HAZ.

Attachments:

Lessons Learnt

WHAT CAUSED IT?

1. The Material Selection Report specified Low Temperature Carbon Steel with a corrosion allowance of 6mm for the process gas system. Gas phase corrosion inhibition was not specified or installed and a design life of 20 years stated. The project made assumptions that sections of the process gas systems would be wet and hence susceptible to general CO_2 corrosion in the material selection process. The project team did not specifically consider preferential weld corrosion in the material selection report.
2. Corrosion Risk Assessment (CRA) identified the process gas system as 'high risk' but due to inspection data being incorrect issue was not detected. Corrosion probes & weight loss coupons installed at the start of the project with no significant corrosion trend to date.
3. Zero degree UT inspection techniques failed to identify the weld corrosion. In December 2010 the welds had been inspected using this method and were found to be at nominal or near nominal thickness. On the welds inspected, the morphology of weld corrosion that had occurred has concentrated metal loss in a narrow band of the HAZ either side of the welds, and the severe root corrosion was limited to small areas at the 6 o'clock position thereby making detection of the defects difficult. A UT angle probe would have highlighted the weld root/HAZ corrosion.

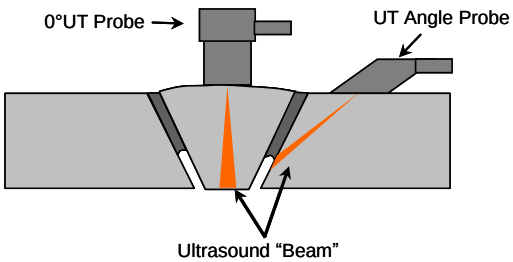

Fig. 5.- Compression (0°) and Angle probe UT Probe Weld Scans

4. ICP received HOIS Joint Industry Program issued a report which could have pre-empted the issue in Q1 2010. Had the conclusions of the report been acted on sooner a different inspection method could have been identified prior to the December 2010 inspection.

Recommendations

CORRECTIVE ACTIONS:

1. Conduct cost-benefit analysis of the cost of installing and operating a gas phase corrosion injection system against a medium term replacement of the line in a CRA (corrosion resistant alloy)
2. Line replaced prior to commencement of production
3. Future projects to have the appropriate level of “Maintenance and Operations” experience involved, at the design stage to ensure that operating experience, practical requirements, best practices and lessons learned are incorporated into the design. The findings of this investigation (with regard to material selection and corrosion) to be communicated to engineering design teams.
4. The use of the zero degree UT probe technique on its own to scan through the weld cap to detect weld root corrosion is no longer permitted and should be re-evaluated. Angle probe UT method now used to inspect weld corrosion. Corrosion management contractor will conduct an annual review of the appropriateness and effectiveness of inspection and NDT methods and techniques being employed taking into account industry lessons learned and advances in technologies
5. ICP procedures for NDE and inspection to been revised to take account of the HOIS report and feedback learning from this incident to the HOIS user group