Corrosion Monitoring of Non-Common Carrier North Slope Pipelines

Technical Analysis

Of

ConocoPhillips Alaska Inc. – Commitment to Corrosion Monitoring Year 2003 for Greater Kuparuk Area & Alpine

Submitted by

COFFMAN ENGINEERS
800 F Street
Anchorage, Alaska 99501
907/276-6664
907/276-5042 Fax
www.coffman.com

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Table of Contents

EXECUTIVE SUMMARY 2

CORROSION PROGRAM STATUS – GREATER KUPARUK AREA 3

INTERNAL CORROSION MANAGEMENT 3
PRODUCTION SYSTEM (WELL LINES AND FLOW LINES) 3
SEAWATER AND MIXED WATER INJECTION 4
EXTERNAL CORROSION MANAGEMENT 4
ABOVE GRADE PIPING 4
BELOW GRADE PIPING 4

RECOMMENDATIONS 5

CONCLUSIONS 5

EXECUTIVE SUMMARY

Coffman Engineers, Inc. is responsible for the technical review of the 2003 corrosion program report submitted by ConocoPhillips to the Alaska Department of Environmental Conservation (ADEC). The report outlines the measures undertaken to mitigate corrosion of ConocoPhillips non-common carrier North Slope pipelines. In addition, Coffman reviewed the presentation materials from the April and August 2004 Meet & Confer sessions.

From a global perspective of oil and gas production, Greater Kuparuk Area (GKA) has a conservatively managed corrosion control program. This suggests a long-term commitment to preserving facilities for future production and sensitivity to environmental consequences.

Monitoring, mitigation, and inspection data support the conclusion that the GKA assets are being preserved, but isolated locations of accelerated internal corrosion exist and have been found by inspections. The isolated locations of corrosion are where leaks may occur. ConocoPhillips appears to have responded to this threat by conducting wide-ranging inspections. Additional inspections are focused on known damage locations, but it does not appear presently possible to predict the onset of all new locations of accelerated corrosion.

Monitoring data, presented by ConocoPhillips, is in conformance to metrics agreed to by ADEC. However, the significance of isolated areas of aggressive internal corrosion is not intuitively reflected by monitoring data because 1) extreme values cannot be readily determined, and 2) monitoring tools are generally not located where the isolated corrosion occurs. In the future, it would be beneficial for the distribution of coupon corrosion rate data be presented for an improved representation of the extreme corrosion rates. Presentation of in-line inspection data would also be useful.

Inspection data supports the conclusion that seawater and mixed water systems are being adequately managed for internal corrosion and program improvements are continuously being made. A problem in the Central Processing Facility #2 (CPF2), resulting in corrosion in the mixed water system, was identified and addressed.

External corrosion of above-ground piping is largely confined to weld packs and ConocoPhillips has made a notable commitment to removing this threat through inspection and repair (where necessary) of all weld pack locations.

Long range inspection tools are used to detect external corrosion of cased and buried pipe. Although this is a proactive risk based approach, it should be recognized that industry experience with these inspection methods are mixed and there may be technical issues to be resolved as is the case with many state-of-the-art technologies. It is recommended that ConocoPhillips provide a comparison of inspection results versus direct examination so that the accuracy and reliability of this inspection method can be evaluated by ADEC.

CORROSION PROGRAM STATUS – GREATER KUPARUK AREA

Internal Corrosion Management

Production System (Well Lines and Flow Lines)

The data provided by ConocoPhillips supports the conclusion that the internal corrosion control/inspection program is well managed and effectively preserving the facilities for the future. It is notable that ConocoPhillips presents data in a transparent way and answers questions with candor. However, the data presented does not fully reflect the existence of isolated locations of accelerated corrosion that could potentially result in leaks. Although isolated locations of corrosion are repairable, they could have an environmental consequence if not detected. The ConocoPhillips approach to controlling these leaks appear to consist of a wide-sweeping and aggressive inspection program.

From a global perspective of oil and gas production, GKA has one of the most conservatively managed internal corrosion control programs. Corrosion inhibition appears to be controlling general corrosion and isolated locations of accelerated corrosion are identified by an expansive inspection program. This suggests a long-term commitment to preserving facilities for future production and sensitivity to environmental consequences.

Monitoring, mitigation, and inspection data support the conclusion that the GKA assets are being adequately maintained and preserved. Corrosion control efforts meet or exceed standard oilfield industry practice. The average corrosion rates of coupons and probes are near zero and the average pitting rate is <5 mpy. A 5 mpy corrosion rate is put into context by considering that a 0.375-inch wall thickness pipe would have over 70% of its wall thickness after 20 years. Inspection data supports the conclusion that most of the asset has low corrosion rates, but isolated locations of accelerated corrosion rates do exist. It would be beneficial to identify in future reports (in one location, if possible) what fraction of the piping experiences accelerated corrosion rates, what the pipeline services are, what the accelerated corrosion rates are (i.e., >10 mpy) and the remedial action that was taken to reduce the corrosion rates (Note: This information is currently not required by the reporting metrics agreed to by ADEC and some of the information is currently identified in various sections of the report).

The inspection intervals and methods at GKA are set by a risk based program approach, identified in the 2000 report, for all pipelines. The program methodology is based on the consequence and likelihood of corrosion related failures. Isolated locations of accelerated corrosion exist and have been found by inspections. The significance of isolated areas of accelerated corrosion within GKA is not intuitively reflected in the monitoring data presented by ConocoPhillips because many of the coupons and probes are not located where accelerated corrosion occurs (an effort has been made since 1997 to improve this). Rather, they are installed at locations that are convenient for installation and retrieval (as is common practice in the industry). Future coupons should be placed at locations that represent the highest susceptibility to corrosion. Additionally, presenting in-line inspection data would aid in understanding the distribution of accelerated corrosion within a pipeline system.

Seawater and Mixed Water Injection

The seawater and produced water systems have relatively low corrosion rates and appear to be well managed. The presence of only one phase (i.e., water) makes corrosion management less complicated than the multiphase production system. Corrosion of the seawater system is mitigated by removing oxygen and injecting biocides. Corrosion of the mixed produced/sea-water injection system is mitigated by carryover inhibition from the production system and the upstream treatment of the seawater.

Significant corrosion caused by the mixed water from CPF2 was identified by inspections and by monitoring results that indicated high coupon corrosion rates. Since the outcome of a CPF2 biocide program review was to revise the treatment procedures, it is assumed that the root cause of corrosion was determined to be bacteria. It is not clear if the bacteria originated from the seawater system (which should have already been treated with biocide) or from the commingled produced water. Biocide treatments are generally most effective when applied furthest upstream.

External Corrosion Management

Above Grade Piping

ConocoPhillips plans to complete inspection and repair (as necessary) of all weld packs in 2004. This is a commendable commitment to address and remove the pipeline integrity problems associated with corrosion under insulation. Additionally, the priority for inspection is based on the consequence of failure (e.g., weld packs over tundra are a higher priority than over the pad), ensuring that the highest consequence locations are repaired first. A new weld pack design is in use and is intended to prevent future water ingress and corrosion at these field-applied insulation locations.

Below Grade Piping

In 2003 ConocoPhillips inspected 82 cased crossings (chosen by risk prioritization) using long range inspection methods (i.e., electromagnetic pulse and guided wave technologies). Although this is a proactive risk based approach, there may be issues to be resolved with these technologies, as is the case with many state-of-the art technologies. ConocoPhillips should provide data that quantifies the ability of long range inspection to detect defects that could lead to failure (i.e., compare inspection results with subsequent direct examination of the cased pipe). Where it is not practical to perform a direct exam, determining the ability to characterize defects on a pipe where a defect has been detected by long range inspection would provide added confidence to the method.

RECOMMENDATIONS

Recommendations for areas that warrant further review or information that should be included in future reports are as follows:

1. Future coupons should be placed at locations that represent the highest susceptibility to corrosion.
2. Identify criteria to be used for locating future coupons.
3. Based on the inspection methodology and guidelines in the GKA corrosion inspection program, define matrix or priority indices used for selecting inspection locations that may be prone to accelerated corrosion.
4. Provide data that quantifies the ability of long range inspection to detect defects that could lead to failure (i.e., compare inspection results with subsequent direct examination of the cased pipe).
5. Continue the commitment to external corrosion inspection and mitigation of the weld packs.

CONCLUSIONS

ConocoPhillips has presented sufficient information to demonstrate that its corrosion control program meets the spirit of the Charter Agreement. This suggests a long-term commitment to preserving facilities for future production and sensitivity to environmental consequences. Recommendations and observations contained in this document should be viewed as opportunities for incremental improvement.

Although the vast majority of internal pipeline corrosion is being mitigated, isolated areas of accelerated corrosion have been detected through comprehensive inspections and by way of leaks that have occurred on isolated occasions. Priority should be given to those locations that represent the highest susceptibility to corrosion for future inspections.

Two significant external corrosion threats are below-ground cased crossings and weld-packs on above-ground pipe. ConocoPhillips has made a notable commitment to inspect and repair (when necessary) all of the weld-packs. ConocoPhillips inspects cased crossings by using visual inspections and state-of-the-art long-range inspection tools; however, it should be recognized that long-range inspection tools may have technical issues that need to be resolved.