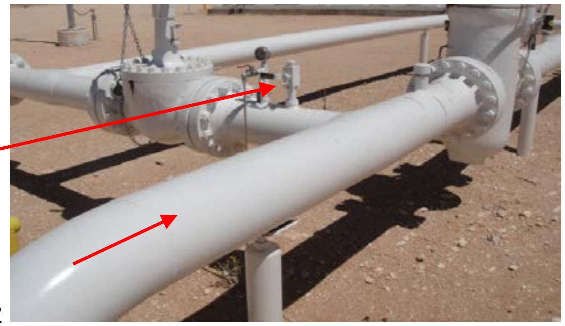
Excalibur Shield MIC Case Study

Microbiological influenced corrosion (MIC) refers to corrosion caused by the presence and activity of microorganisms such as microalgae, bacteria, and fungi. Microorganisms do not produce unique types of corrosion, however, accelerate and shift the corrosion mechanism.

Microbial action contributes to the rapid corrosion of metals and alloys exposed to soils, seawater, distilled water, freshwater, crude oil, hydrocarbon fuels, processed chemicals, and sewage. Many industries and infrastructure are affected by MIC, including oil production, power generation, transportation, and water and waste water.

In this case study, the Excalibur Shield was employed to monitor MIC and weight loss at a worst case scenario on a 20-mile long, 10” carbon steel condensate pipeline operating at 700 PSI.

Techniques to identify MIC are nonstandard and subject to interpretation. The areas we suspect MIC to occur are usually at interfaces where scale, wax, and other solids can settle or precipitate. Areas downstream of welds, where cleaning pigs have difficulty removing deposits, dead legs, low-velocity areas, and tank bottoms where solids, bacteria and biofilms can accumulate, are particularly susceptible to attack. Often this pitting is very isolated, with one hole surrounded by a number of shallower pits.

Fig 1  Fig 2 

The Excalibur Shield was employed to monitor MIC including sessile bacteria, planktonic bacteria, liquid sampling, chemical residual and weight lost coupon at a worst case scenario. The subject pipeline was a carbon steel 10" in diameter, 20-miles long operating at 700 PSI with flow less than turbulent (Figure 2). The pipeline shut down rate was 50% of the time, and the conditions inside of the pipeline were ideal for bacteria growth and induced corrosion. The weight lost coupon was previously being monitored by a retriever style coupon (Figure 1). The pipeline segment was suffering from a lack of internal monitoring; corrosion rate monitoring at the most severe locations, insufficient solid sampling, and water analysis.

The pipeline operator was injecting biocide and corrosion inhibitors with minimal opportunity to monitor the effectiveness of the chemical treatment because sample gathering was only available while operating a solid urethane cleaning pig. The cleaning pig cycles were also not consistent with best practice for monitor scheduling, and there was no coordination between the field technician and corrosion technician during the pig run. For example, the corrosion technician was notified weeks after sample collection. The corrosion control program lacked proper corrosion identification, mechanisms and optimization of chemical treatment programs.

Table 1: Qualitative Categorization of Carbon Steel Corrosion Rates for Oil Production Systems

	Average Corrosion Rate		Maximum Pitting Rate	
Category	mm/y	mpy	mm/y	mpy
Low	<0.025	<1.0	<0.13	<5.0
Moderate	0.025-0.12	1.0-4.9	0.13-0.20	5.0-7.9
High	0.13-0.25	5.0-10	0.21-0.38	8.0-15
Severe	>0.25	>10	>0.38	>15

The only effective analysis was the retriever style coupon (Figure 3). Depicted on Figure 3, the pre-weighted coupon with 2” x ¼” diameter was installed and exposed to the internal environment for period of 117-days, and resulted in a 0.17 MPY. The corrosion rate of a coupon is expressed in mils per year (MPY), or millimeters per year, or number of one-thousandths of an inch of metal lost from a coupon surface over a 1-year period. Average corrosion and pitting (localized corrosion) rates obtained from a coupon are categorized as low, moderate, high, and severe in accordance with classifications in NACE SP0775-2013, shown in Table 1. Ideally this style of coupon is inserted from 12 o’clock and lowered to near the 6 o’clock position in a horizontal pipeline. The placement of the coupon is often the most critical decision in obtaining meaningful internal corrosion information. Upon closer inspection, only the very end of the coupon was being exposed to the worst area inside the horizontal pipeline.

Fig 3

The pipeline operator agreed with our finding. As general rule, coupons should first be placed in a representative location, and second, the most severe location with respect to corrosion. Many operational and environmental conditions influence the optimal selection of location for coupon installation. We suggested installing the Excalibur Shield at the worst case scenario, or low lying area of the carbon steel condensate 10” pipeline, and again at the end of the 20-mile segment where the pig receiver is at the six o’clock position. The operator agreed to both of the installation locations of the Excalibur Shield (Figures 4 and 5).

Fig 4

Fig 5

The Excalibur Shield was easily installed using the existing infrastructure, and no welding was required. The existing sump tank drainage piping system (Figure 4) was also used to install additional fittings to accommodate for the Excalibur Shield (Figure 5). The Excalibur Shield can be installed with a minimum clearance of 13”. After installation, the owner operator had the capability of acquiring solids, liquids, and weight lost coupon at the worst case scenario.

The Excalibur Shield has a primary filtering system at the mouth of the 100 ml cavity. A coupon was installed inside the cavity with a secondary filter system surrounding the coupon. The outer portion has and octagon shape for easy removal including drain and ventilation valves for easy collection of fluids inside the cavity. The base adapter is outfitted with an O-ring seal for easy removal and secure sealing capability using a 316-L stainless steel body, mop 2000 PSI (Figure 5).

Fig 6

Fig 7

After 30-days exposure to the internal environment, the Excalibur Shield registered a 1.28 (MPY) at six o’clock, compared to the 0.17 (MPY) on the previous 117-day exposure using the retriever coupon (Figure 3), mincing a low lying area of worst case scenario. Now the operator can acquire fresh samples of corrosion to establish the presence and concentration of bacteria colonies, in mm or grams, within the corrosion sampling site.

Acid producing bacteria (APB) and sulfate reducing bacteria (SRB) tests measured very low. In addition, we now the capability of acquiring fresh solids (fig. 6) and liquid samples, (fig. 8).

Fig 8

After a second 30-day exposure and optimizing the inhibitor treatment with the Excalibur Shield resulted in a 0.08 MPY (Figure 9).

The case study shows the retriever style coupon and irregular sampling prior to the Excalibur Shield was insufficient. Fundamental awareness and involvement were lacking and highlighted the need for education on all levels of the internal corrosion program.

After acquiring samples at regular intervals, corrosion rate monitoring with a coupon in a worst case scenario, fluid sampling, and solid sampling, the operator and chemical provider had a wealth of data analysis to use going forward. Now, the pipeline operator and chemical provider are much more confident in the internal pipeline integrity and internal corrosion program and optimization.

Figure 9.

You can find the Excalibur Shield in both onshore and offshore pipelines.

See more on Youtube; https://www.youtube.com/watch?v=TiX2hcMPOvw

Thank you,

Joe Gallo
Cathodic Protection Solutions, LLC
P.O. Box 11192
Odessa, TX 79763
masgalex@sbcglobal.net
jgallo@cathodic-protection-solutions.com
http://cathodic-protection-solutions.com/
(432) 230-6955