CASE HISTORY

Enhancing Asset Value Through Corrosion Management

Ali Morshed, Production Services Network (PSN), Aberdeen, U.K.

Corrosion management can be used as a means of enhancing an aging asset’s value through helping to maintain (or improve) its production rate and continuity and also through reducing its overall integrity management (IM) costs. Data were collated over a five-year period pertaining to an offshore platform permit comparison of five parameters before and after the introduction and implementation of a new asset corrosion management system (CMS). This article also shows how a risk-based inspection (RBI) system could help identify high corrosion rate areas early on, so remedial action can be planned before corrosion failures occur and force a total or partial shutdown. Using an RBI system, the extent of ultrasonic test (UT) inspections can be optimized, more critical areas can be identified, and the relative inspection costs can be significantly reduced.

What is Corrosion Management?

Corrosion management (CM) for any asset is defined as the process of reviewing the applied corrosion engineering (CE) considerations, the regular monitoring of their performance, and the assessment of their effectiveness post-commissioning. Therefore, CM and its applications are very closely associated with an asset’s operations phase. Despite the distinctions, many still regard CM as a synonym for CE with an identical set of applications. For more detailed information on CM, its structure, principles, and applications, please refer elsewhere.

Corrosion Management and Enhancing Asset Value

As an asset ages, it becomes more susceptible to more frequent unplanned operation shutdowns from corrosion issues, caused mainly by either or both of the following:

The relative value of an aging asset depends on many parameters, among which are production rate/continuity and integrity management (IM) costs. Reducing unplanned shutdowns and IM costs can maintain or even improve the relative asset value. This article describes—using data collected over a five-year period—how having asset corrosion management and risk-based inspection systems in place may achieve the above.
• The continuous thinning and the eventual exhaustion of the corrosion allowance layer
• Corrosion issues such as microbiologically influenced corrosion (MIC) becoming more acute and causing higher corrosion rates

On the other hand, using a simple financial model, the relative value of an aging asset may be regarded as a function of its revenue and costs. While the revenue is dependent on the production rate and production continuity, cost is split into many different categories, including the IM costs. Such IM costs for a mature asset are often relatively substantial and can comprise the following:

• Chemical treatment costs
• Inspection costs
• Corrosion and fluid monitoring costs
• Repair and replacement costs
• Deferred production (from corrosion)
• Wasted or leaked product (from corrosion)

Consequently, one may be able to enhance the relative value of a mature asset at any time through either or both of the following:

• Increasing or maintaining production rate and production continuity by decreasing the number and extent of unplanned shutdowns caused by integrity or corrosion
• Decreasing the IM costs as much as possible without compromising the asset integrity

The implementation of a CMS can

<table>
<thead>
<tr>
<th>Table 1</th>
<th>List of deterioration mechanisms observed between 2001 and 2005 on a system basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Threat 1</td>
</tr>
<tr>
<td>Production flowlines</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Production headers</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Produced oil</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Export oil</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Recovered oil</td>
<td>—</td>
</tr>
<tr>
<td>Produced gas</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Export gas</td>
<td>—</td>
</tr>
<tr>
<td>Gas lift</td>
<td>—</td>
</tr>
<tr>
<td>Flare gas</td>
<td>—</td>
</tr>
<tr>
<td>Fuel gas</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Condensate</td>
<td>—</td>
</tr>
<tr>
<td>Produced water</td>
<td>—</td>
</tr>
<tr>
<td>PROWD</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Sandwash</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Drilling</td>
<td>Erosion corr.</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>—</td>
</tr>
</tbody>
</table>

Note that the order of threats in the table does not signify any severity/priority in regard to any specific threat—microbiologically influenced corrosion (MIC), external (Ext.), corrosion under insulation (CUI), produced oily water drains (PROWD)
enhance the value of an aging asset by possibly achieving both goals as illustrated by the following case history.

A Corrosion Management Case History

The case history covers an aging offshore platform (referred to as Platform M) located in the North Sea. It is an oil and gas producer commissioned in the early 1980s. The process pipework was mainly carbon steel; visual inspection and UT wall thickness measurements were the main inspection methods used.

The historical study covers the period between 2001 to 2005 inclusive. Its main objective is to compare the performances of five parameters, and their subsequent effect on the relative asset value, before and after the introduction of a new asset CMS in late 2003.

Therefore, 2004 was the first year within the five-year period where it was expected to observe possible changes in the trend and magnitude of those parameters. Prior to 2004, the asset lacked an RBI system as the incumbent inspection was semi-risk based. In early 2003, a thorough integrity review process (IRP) for the topside pressure pipework was started, and was completed in late 2003. The main output of this IRP was a new asset CMS and a real RBI system. Finding a solution to preempt corrosion failures was also a major aim of the IRP conducted in 2003.

Table 1 lists the main corrosion threats to the integrity of the topside pressure systems. Table 2 describes each of the chosen parameters in detail and Table 3 illustrates their magnitudes between 2001 and 2005. Of particular interest is the significant change in their magnitudes and trends after the implementation of the new asset CMS in years 2004 and 2005.

Case History Results

For the first three years (2001, 2002, and 2003), no asset CMS existed and 2004 and 2005 were the years during which a new asset CMS was being implemented.

Figure 1 illustrates the variations of these parameters during the above time period as follows:

- Hydrocarbon (HC) releases from corrosion: HC releases constantly declined between 2001 and 2003, from eight to two cases, respectively. There were no such releases in 2004 and 2005.
- Deferred production from corro-
2004 and 2005 were the only years where there was no deferred production from corrosion.

- Number of corrosion repair orders (ROs) raised: The number of ROs ranged between 80 to 74 from 2001 to 2003. In 2004 and 2005, 89 and 79 ROs were raised, respectively. Simultaneously, it should also be remembered that:
  - ROs were often raised during pipework UT inspections when low wall thickness areas (for example, areas with a remaining life of <2.0 years) were identified.
  - In 2004 and 2005, the number of pipework features inspected were <50% of those inspected in 2003 or before.

- Number of features inspected: A total of 12,000, 12,100, and 13,500 pipework features were inspected in years 2001, 2002, and 2003, respectively. Thereafter, in 2004 (when the conducted UT wall thickness inspections were risk-based), the number dropped to 5,500 features; a decrease of roughly 60%. For year 2005, around 6,200 features were inspected.

- Relative inspection cost: The overall annual UT inspection cost figure was not available for any of those five years. Therefore, the UT inspection cost for 2003, when 13,500 features were inspected, was assumed to be equal to 100 cost units and used as a benchmark for comparison with other years before and after it. Thereafter, relative UT inspection costs for other years were determined using the number of features inspected per year. Accordingly, the UT inspection cost dropped by ~60% in 2004 in comparison with 2003, following the implementation of the new asset CMS and a risk-based approach. The relative UT inspection cost for year 2005 was ~46 cost units.

### Discussion

**Hydrocarbon Releases from Corrosion**

In 2004 and 2005, there were no instances of HC releases onboard Platform M. This could not be fully attributed to the new asset CMS, however, since HC releases were already gradually and continuously declining between 2001 and 2003. Nevertheless, it is believed that the new asset CMS implementation significantly contributed to maintaining that trend, as explained in more detail later in this section.

**Deferred Production from Corrosion**

There was no deferred production in years 2004 and 2005, mainly because no major unplanned operation shutdowns from corrosion occurred during this period. An efficient RBI system was in place, which helped identify the existing, but as yet unidentified, low wall-thickness areas and planned repairs or replacement.

---

**Variation of different parameters including the inspection costs between 2001 and 2005.**

![Graph showing variation of different parameters including inspection costs between 2001 and 2005.](image)
well in advance, before such areas could develop into a HC leak and cause an unplanned shutdown.

After each UT inspection and using the latest wall-thickness data, the short-term corrosion rate and then the remaining life value for each pipework feature were determined. Thereafter, all features with a remaining life of <2.0 years were noted and marked for further and more detailed inspection. From 2004 onward, the number of pipework features to be inspected had reduced significantly, therefore it was possible to have a greater focus on the incumbent UT inspections.

This focus on a smaller number of features led to more accurate UT inspections and results. Accordingly, more accurate short-term corrosion rates and remaining life values were determined. This approach further facilitated the pre-emption of corrosion failures since low wall-thickness areas were identified before they could develop into leaks and cause operation shutdowns. The result was that the production continuity and rate were maintained and even improved. This was manifested by the fact that there were no HC releases or deferred production in years 2004 and 2005 when an RBI system was in place.

**Corrosion Repair Orders**

The number of ROs increased in 2004 by 20% compared to the previous year; in the same year, however, roughly 60% fewer pipework features were inspected (5,500 in 2004 compared to 13,500 in 2003). This meant that in spite of the significantly fewer features inspected in 2004, more right areas (in terms of higher corrosion rates) were covered in the inspection scopes. Such areas normally suffered from higher corrosion rates or lower wall-thickness values, rendering them unfit for use by a particular time in the near future (often less than two years). Hence, an RO would be raised for such features, and their repair and/or replacement would be arranged for the next planned shutdown.

**Relative Inspection Cost**

There was a 60% drop in the relative UT inspection cost in 2004 compared to 2003. A similar trend continued throughout 2005 when UT inspection costs were 54% lower than those in 2003. This was mainly because a new RBI system had replaced an inefficient and semi-RBI system. The huge savings related to inspection costs in 2004 and 2005 were an important indication that real RBI systems could optimize the overall inspection costs.

**Conclusions and Recommendations**

Table 4 summarizes the results and how they affected the relative asset value. The increase in relative asset value in 2004 and 2005 compared to 2001 to 2003 is attributed to:

- No HC releases or deferred production
- Overall improvement in production rate and production continuity
- Significant UT inspection cost savings

Implementation of an asset CMS maintains and improves production uptime and reduces IM costs. It increases personnel safety and environmental protection by reducing the number of HC releases. An asset CMS also aids advance repair/replacement planning for forecasted failures by including such repairs in the next planned shutdown.

### Table 4

This table illustrates the link between the five parameters, how they changed post implementation of the new asset CMS, the main associated effect on the relative asset value, and how that effect changed the asset value.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>How Parameter Changed from 2004 Onward</th>
<th>The Main Effect on the Relative Asset Value was Through</th>
<th>Increasing or Decreasing Asset Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC releases due to corrosion</td>
<td>No HC releases</td>
<td>Reducing the number of unplanned operation shutdowns due to corrosion</td>
<td>Increasing</td>
</tr>
<tr>
<td>Deferred production due to corrosion</td>
<td>No deferred production</td>
<td>Reducing the number of unplanned operation shutdowns due to corrosion</td>
<td>Increasing</td>
</tr>
<tr>
<td>ROs raised due to corrosion</td>
<td>89 followed by 70</td>
<td>Pre-empting the areas which could have developed into leaks due to corrosion</td>
<td>Increasing</td>
</tr>
<tr>
<td>Pipework features inspected</td>
<td>5,500 followed by 6,200</td>
<td>Reduced the use of various resources involved in UT inspection significantly</td>
<td>Increasing</td>
</tr>
<tr>
<td>Inspection cost</td>
<td>40.7 followed by 45.9 cost units</td>
<td>Reduced costs associated with inspection</td>
<td>Increasing</td>
</tr>
</tbody>
</table>
Therefore, it is recommended to have an up-to-date asset CMS and fully RBI system in place.

This approach will optimize inspection activities, yield a smaller number of feature inspections, improve inspection accuracy, and enhance the understanding of the integrity or fitness-for-service condition of different parts of the asset.

References


**Ali Morshed** is the principal corrosion engineer at Production Services Network (PSN), Wellheads Place, Dyce, Aberdeen, AB21 7GB, U.K. He has years of experience protecting oil and gas assets, specializing in producing asset-specific corrosion management systems. He received a Ph.D. grant from BP to conduct research on corrosion of carbon steel sweet oil transfer pipelines (1997-2001), has an M.S. degree in corrosion of engineering materials from Imperial College (London, 1997), and has authored several publications. *MP*