Corrosion Management and Cost Optimization

Ali Morshed, *London, United Kingdom*

A better appreciation of the various components of typical corrosion costs in the oil and gas industry could further facilitate their optimization. For example, preventing corrosion failures would eliminate post-failure corrosion costs, thus significantly reducing the overall corrosion costs. Simultaneously, due to the congruity between the corrosion management and the corrosion cost optimization concepts, the former could be utilized to positively affect the latter. This article explains in detail how this could be done.

Optimizing corrosion costs can markedly affect the overall integrity management costs for many oil and gas assets. Corrosion costs can be divided into pre-failure and post-failure categories. Preventing corrosion failures to the extent possible will eliminate or minimize post-failure corrosion costs. On the other hand, pre-failure corrosion costs may be further divided into corrosion engineering (CE)-based and non-CE-based costs.

The definition offered herein for the concept of corrosion cost optimization renders it almost fully congruous with the corrosion management concept. That means proper and timely corrosion management applications can facilitate corrosion failure preemption, while simultaneously optimizing both CE-based and non-CE-based corrosion costs.

Corrosion Cost Categorization

There are many different types of corrosion-related costs and different ways of simultaneously classifying or categorizing them. In this approach, the time to failure during an asset's operating phase is used as a chronological reference point for corrosion cost categorization, as illustrated in Figure 1. Based on this methodology, there are two main types of corrosion costs: pre-failure and post-failure.

The pre-failure corrosion costs are further divided into CE-based and non-CE-based costs, which pertain to the corresponding integrity management measures. CE-based costs are divided into three smaller subcategories, as illustrated in Figure 2. Some CE-based costs in these subcategories are closely associated with an asset's design stage (e.g., corrosion allowance and materials selection costs), while others are largely determined during the design stage and materialize during the asset's operation stage (e.g., corrosion inhibitor and biocide injection costs).

Non-CE based corrosion costs are divided into the following four subcategories:

- Inspection costs
- Corrosion monitoring and fluid-sampling costs
- Management costs (e.g., producing or updating strategies, procedures, databases, various documentation, communication, and the corrosion management strategy document)
- Failure risk assessment (FRA) activities costs

المنارة للاستشارات
www.manaraa.com

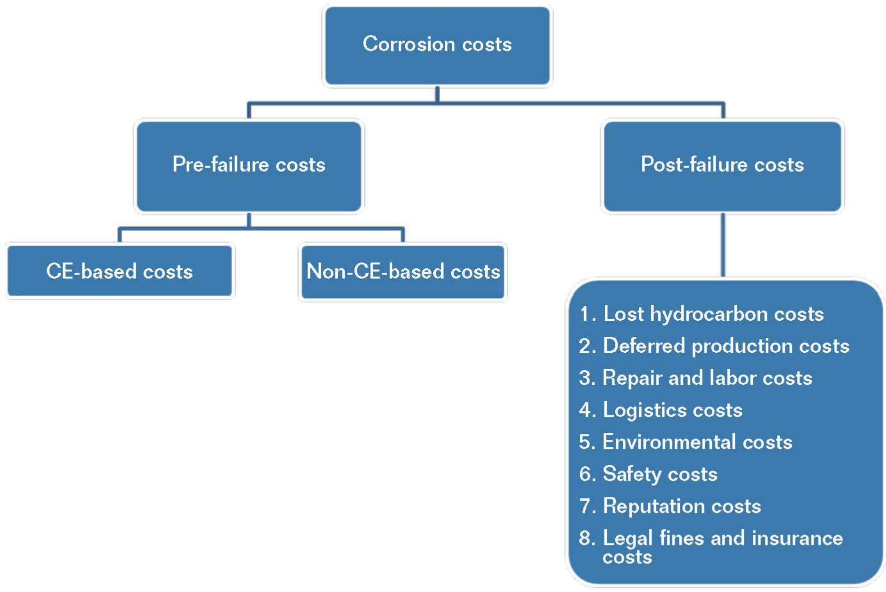

FIGURE 1 Corrosion cost categorization, using the failure time as a chronological reference point for classifying different corrosion cost types.

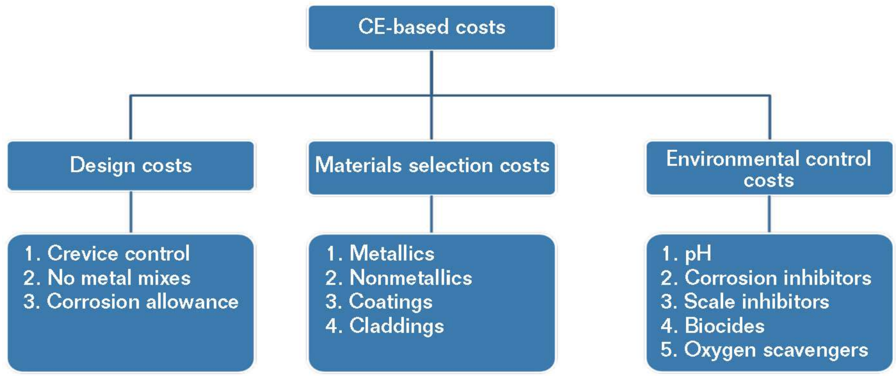

FIGURE 2 Corrosion cost subcategorization for CE-based integrity management measures.

Figure 3 lists the parameters or variables that influence these non-CE-based costs.

Post-failure corrosion costs include, but are not limited to:

- Lost hydrocarbon and deferred production costs
- Repair and labor costs
- Reputation costs

Once the different types of corrosion costs are fully identified—their origins together with the variables that determine and influence their magnitude, extent, and duration—planning can begin for optimizing these costs. Such corrosion cost optimization must be accomplished without sacrificing the performance and efficiency of any of the asset's incumbent or future CE-based or non-CE-based integrity management measures.

Cost Optimization Definition

After clearly defining and understanding the various components of the corrosion-related costs, corrosion cost optimization can be defined as managing the cost of both CE-based and non-CE-based integrity management measures in such a way that corrosion failures are kept to a minimum (ideally zero) while the efficiency and performance of these measures are not sacrificed, compromised, or adversely affected.

The following points can be further highlighted with regard to the above definition:

- By preventing corrosion failures or minimizing the number of their occurrences as much as possible, a significant portion of corrosion costs (Figure 1) can be avoided, thereby markedly reducing the overall corrosion cost figure.
- Not all corrosion costs pertain to an asset's operating phase; a significant portion is associated with the design phase. Hence, a proper design process could play a major positive role in optimizing the overall corrosion costs.
- By definition,[1] corrosion management incorporates both CE-based and non-CE-based integrity management measures exactly as corrosion cost optimization does. Therefore, thorough implementation of corrosion management applications can significantly affect and optimize overall corrosion costs.

Corrosion Management and Cost Optimization

A comparison of the corrosion management concept[1] and corrosion cost optimization reveals marked congruity between the two. Both concepts incorporate components such as CE-based and non-CE-based integrity management measures. Thus, such similarity means that adequate and proper corrosion management implementation can influence both CE-based and non-CE-based measures in such a way that the extent and effectiveness of these measures are not compromised, yet potential corrosion failures are preempted as much as possible (i.e., the near total elimination of the post-failure corrosion costs) and pre-failure corrosion costs also are optimized.

Eliminating the post-failure corrosion costs (via preempting potential corrosion failures) is achieved through proper application of CE-based and non-CE-based integrity management measures, which themselves are best optimized through proper corrosion management implementation. The following two sections describe in more detail how corrosion management implementation can enhance both CE-

المنارة للاستشارات
www.manaraa.com

based and non-CE-based integrity management measures and simultaneously optimize their pertinent costs, thereby optimizing the overall corrosion costs.

Optimizing Corrosion Engineering-Based Costs

CE-based costs are divided into the following three subcategories:

- Design costs (e.g., corrosion allowance)
- Materials selection costs (e.g., metallic and non-metallic options)
- Environmental control costs (e.g., corrosion inhibitor injection)

The variables listed under each subcategory (Figure 2) determine the total cost associated with that subcategory and contribute to the overall CE-based cost.

A very important point is highlighted here regarding the upstream hydrocarbon assets and their associated pipelines. The costs associated with these three CE-based subcategories are very much dependent on conducting proper well sampling and the accuracy of sample analyses during an asset's design stage. Any erroneous conclusions regarding the corrosivity level of the produced fluids can have huge adverse repercussions. Conclusions that fluid corrosivity is greater than is actually the case can increase design-stage costs when implementing the following:

- Specifying thicker corrosion allowances
- Selecting corrosion-resistant alloys (CRAs), which are typically more expensive than carbon steel
- Including inner coatings or claddings instead of, or in addition to, corrosion inhibitor injection for internal protection of equipment
- Injecting higher-than-necessary concentrations of various chemicals (e.g., corrosion inhibitors)

Thus, opting for such overdesign options, due to erroneous fluid sampling and/or compositional analysis, could have a huge adverse effect on the overall CE-based costs at the design stage. Some components of such overdesign options at the design stage (e.g., overdosed chemical treatment) could also continue well into an asset's operation stage before (if at all) they are rectified.

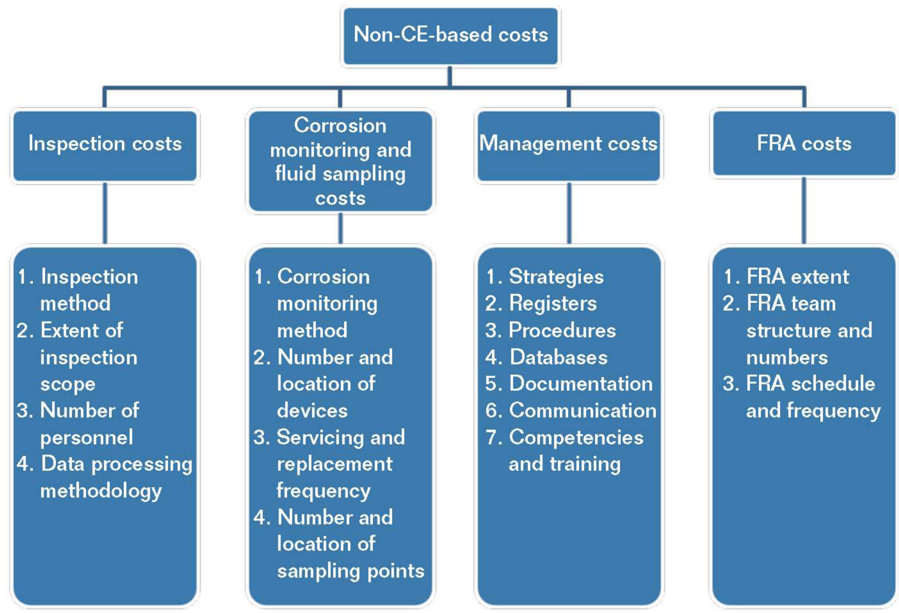

FIGURE 3 Corrosion cost subcategorization for non-CE-based integrity management measures.

Furthermore, asset underdesign based on sampling/analyses errors may appear to have optimized corrosion costs at the design stage; however, such assets can suffer from the following corrosion costs post-commissioning:

- Increased CE-based costs such as material replacements or corrosion allowance upgrades along with injection of higher doses of chemicals to control or reduce an increasing number of corrosion failures due to an underdesign
- Increased post-failure corrosion costs due to inadequate corrosion control measures that result in earlier and more frequent failures than expected in an asset's life

The best way to optimize CE-based corrosion costs is to avoid both overdesigned and underdesigned corrosion control measures, while requiring that fluid sampling and analyses are carried out in an accurate and meticulous manner.

It is of paramount importance to remember that CE-based cost optimization commences at the design stage and continues throughout the operating stage. Any revisions, alterations, or variations in the incumbent corrosion measures during the operating stage will directly influence the overall CE-based corrosion costs.

Optimizing Non-Corrosion Engineering-Based Costs

As illustrated in Figure 3, non-CE-based corrosion costs are divided into four subcategories that are associated with different integrity management measures. The cost optimization pertaining to each measure is discussed individually.

Inspection-Related Costs

Inspection-related costs are best optimized if the inspection scope is fully risk-based. A conservative inspection scope can mean unnecessary inspection costs. Conversely, a scope that is not risk-based and has fewer selected points (compared to a risk-based scope) may not detect high-risk or high-corrosion-rate areas. That means there is a greater likelihood of failure and the occurrence of post-failure corrosion costs.

Corrosion Monitoring and Fluid Sampling Costs

This situation is exactly the same as inspection-related costs. A conservative approach to corrosion monitoring and fluid sampling creates unnecessary costs. On the other hand, a less conservative approach increases the chance that higher corrosion rates are not detected, which can possibly lead to failures and their associated post-failure corrosion costs.

المنارة للاستشارات
www.manaraa.com

Management Costs

Many costly corrosion failures are related to inadequate or totally absent management items such as registers, databases, communication, and competency (Figure 3). Furthermore, their creation (if they do not already exist) or updating can be done often at little or no cost. Producing and updating such items can significantly improve corrosion management of an asset and preempt corrosion failures. Simultaneously, pertinent corrosion costs can be significantly optimized.

Failure Risk Assessment Costs

The only costs associated with FRA activities is the cost of carrying them out. Therefore, proper planning and ensuring that the FRA process is carried out using reliable input will optimize such activities and thus their pertinent costs.

Cost Optimization Misconceptions and Their Repercussions

The greatest misconception when optimizing corrosion costs is to reduce a CE-based and/or non-CE-based integrity management measure without assessing the possible adverse effects it may have on the overall corrosion control program. That is, the integrity situation in the long term can actually deteriorate when downsizing or reducing the inspection scope, chemical injection rate, training budget, communication, etc., without carrying out any prior assessment to determine the effect of such reductions in size, number, rate, or budget. The fact is, in many observed cases, an instant decision is made to reduce a particular CE-based or non-CE-based integrity measure to make a cost saving. However, such improper and superficial acts often lead to much greater corrosion costs in the long term.

Conclusions and Recommendations

Conclusions

Preempting corrosion failures would eliminate post-failure corrosion costs, thus significantly reducing the overall corrosion costs.

Due to the congruity between the concepts of corrosion management and corrosion cost optimization, proper implementation of the former can have a marked positive influence on the latter.

Recommendations

Beginning at the design stage, avoid both overdesign and underdesign in corrosion engineering as much as possible. Basing engineering decisions on accurately collected information is critical to achieving this objective.

Pay close attention to the management requirements (within the non-CE-based category). Proper and timely creation of such requirements, including their regular updating and maintenance, can significantly improve corrosion management implementation, and significantly optimize non-CE-based costs.

Reference

1 A. Morshed, "The Evolution of the Corrosion Management Concept," *MP* 52, 8 (2013): p. 66.

ALI MORSHED is a consulting corrosion engineer based in London, United Kingdom, email: allok_morshed@hotmail.com. He is a corrosion engineer by education, training, and experience, and is also interested in the concept of applications of corrosion management and its influence over the overall integrity management of an asset. He is the author of the NACE International best-selling book, *An Introduction of Asset Corrosion Management in the Oil and Gas Industry,* with the second edition published in Fall 2016. A member of NACE, he is a regular contributor to *MP* on the subject of corrosion management. *MP*

www.manaraa.com

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

www.manaraa.com