Case Study: On-Plot Piping Corrosion Analysis for GOSPs

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Abstract

Corrosion is a serious challenge for piping systems in gas-oil separation plants (GOSPs) that causes piping failures. Two GOSPs, selected on this study (Plant-A and Plant-B) observed chronic corrosion issue with an on-plot piping system that led to having more pipe replacements over the past few years. Since it is almost impossible to avoid corrosion, it is becoming more obvious that managing the corrosion level may be the most economical resolution. Corrosion engineers are therefore increasingly involved in approximating the cost of their answers to corrosion prevention, and assessing the useful life of equipment. This case study covers the background of corrosion encountered in piping internally and externally in these two GOSPs. The collected piping replacement data from 2011 to 2014 was covered. The purpose and display trends and performance analysis to replicate corrosion levels in an on-plot piping system. In addition, in this case study, included is the total pipe replacement with a drain line system and other service lines in both plants.

Keywords: GOSP, On-Plot Piping, Drain Lines, Saudi Aramco

Introduction

A team was formed to review the pipe replacements owing to corrosion and the absence of drain lines in some facilities. The groups selected, examined and assessed various options for repairing the corroded lines and advised the best solution for the captioned issue. The reviewing of the pipe replacements was conducted in-house to underline major areas of worry, and advise the most suitable solution to put an end to the problem to improve plant reliability and safety, and reduce pipe replacements. The case study involved trends and statistical data that demonstrate the replacement performance over the prior four years, reflecting the seriousness of corrosion in the piping system. Two Saudi Aramco GOSP pipes were covered by the study; those are Plant-A and Plant-B.

Theory of the Case Study

Corrosion is the deterioration of a metal or its properties, and it attacks every part in every phase of the existence of every gas and oil field, due to the interaction with the surrounding environment. Oxygen plays a major part in the corrosion of the pipes. The on-plot piping refers to the piping system in the processing firm and production platform. Typical corrosion processes contain two electrochemical reactions, cathodic and anodic. A corroding platform can be taken to be a short circuited battery, whereby a short circuit is an electrical assembly made by a conductor in between two physical places, which are frequently separated by minute distances. The dissolution reaction at the anode gives electrons for the reduction reaction at the cathode. The case study of corrosion procedures includes usage of several of the same tools as electrochemists studying fuel cells, batteries and analytical and physical electrochemistry use.

There are different kinds of corrosion depending on the morphology of the attack and the kind of surroundings to which the metal is exposed. In the case study scenario, the common kind of corrosion is the general or uniform corrosion.

Application of Equipment and Procedures

Internal corrosion is a crucial parameter in a firm's asset integrity management program that should be methodically mitigated and evaluated. Early operational complicated issues can be detected by the use of the internal corrosion monitoring program, for example, black powder creation; fluid quality upsets and observing the service life of assets. The function of an internal corrosion-monitoring program is to record the corrosion and handle the data collected on a regular basis from the monitoring components. The program identifies the different monitoring procedures that may be used in an individual system, and gives guidance on where and when monitoring should be done.

Data and Results Presentation and Discussion

1) Plant-A Study Analysis (2011- 2014)

The history of replacement shows that the majority of the stated replacement in Plant-A facilities were evident in the gas service system with drain lines as shown in Fig. 1, 2 and 3. As anticipated for these kinds of systems, the majority of the stated corrosion was internally and at the six o'clock position. The reason for the high replacement is due to the fact that the drains are generally stationary and initially were not internally coated, and the gas lines experience even more corrosion than the other types of lines due to the higher degree of moisture. Beginning in 2013, a trend of increasing replacements was noticed, particularly in the relief gas lines of Plant-A. The reason for this is because in 2013 a test and inspection (T&I) was conducted, and a majority of the defective lines were substituted. Initially, the as the drain is immobile, it leads to aggravated corrosion increases in the system, and directly results in a raised number of leaks as the facilities age. In addition, cases of leaks and replacements are still conveyed in the internally coated systems, particularly in the drain lines and other service lines. Its very hard to attain good quality coating when it comes to small diameter piping cases.

Total Piping Replacement without Drain Lines

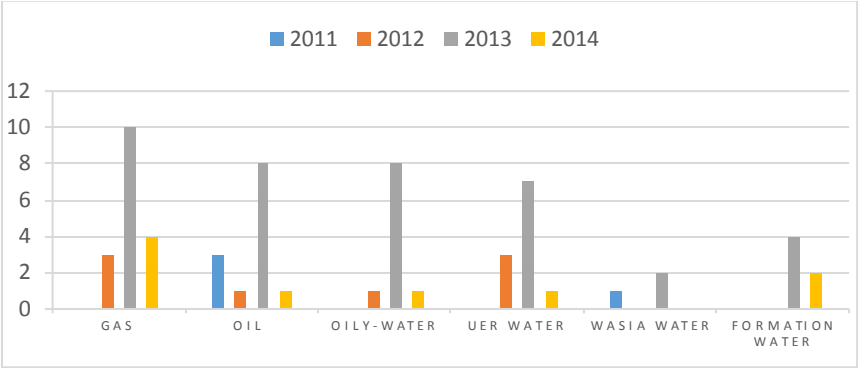

Figure 1: The gas service had the highest number of replacement pipes in Plant-A

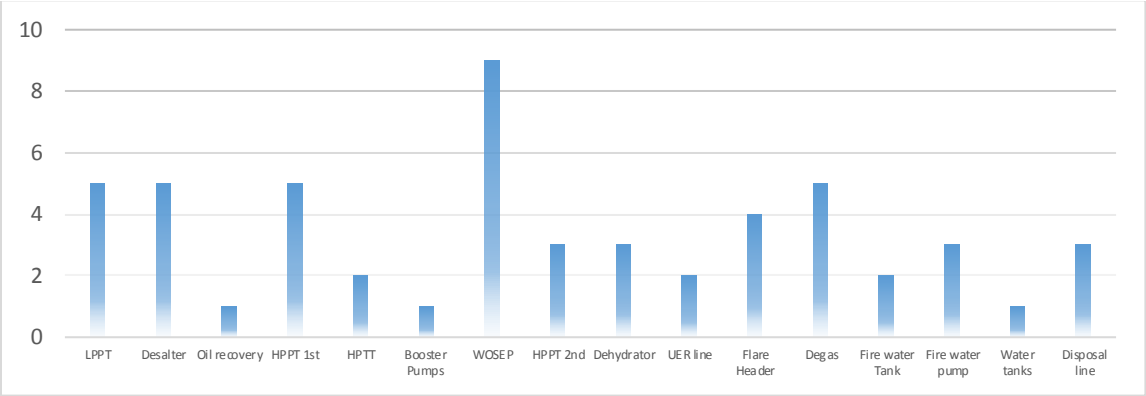

Figure 2: The WOSP has the highest piping replacement in Plant A.

Total Piping Replacement with Drain Lines

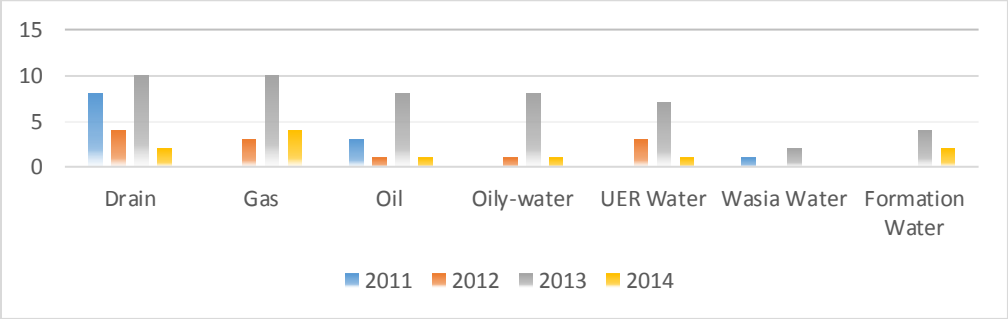

Figure 3: Drain and gas service are most of the replacements for Plant-A.

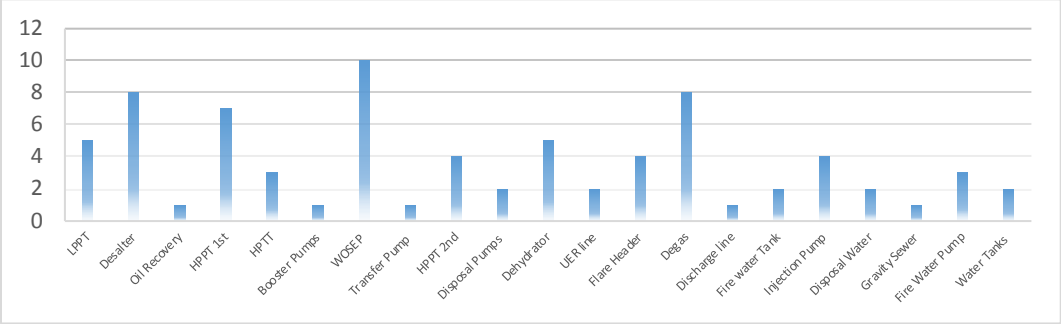

Figure 4: The WOSP and other equipment have more piping replacements.

2) Plant-B Study Analysis (2011-2014)

As per the replacement history of Plant-B, it is indicated that the majority of the stated replacements were in the Wasia water and drain lines (Fig. 7). The drains, being immobile in the majority of cases, led to the high corrosion level in these systems, and therefore, the number of leaks reported in the end as the facilities age. In this case, the Wasia water is more corrosive than the other service lines, due to its higher content of salt, which acts as a catalyst for corrosion.

Total Piping Replacement without Drain Lines

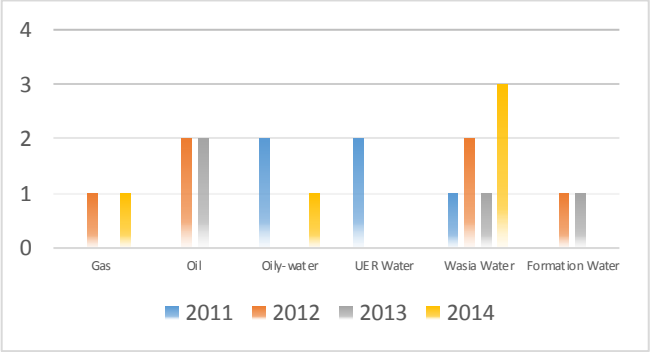

Figure 5: The number of replacements in Plant-B, showing the Wasia water pipes has the highest number of replacements.

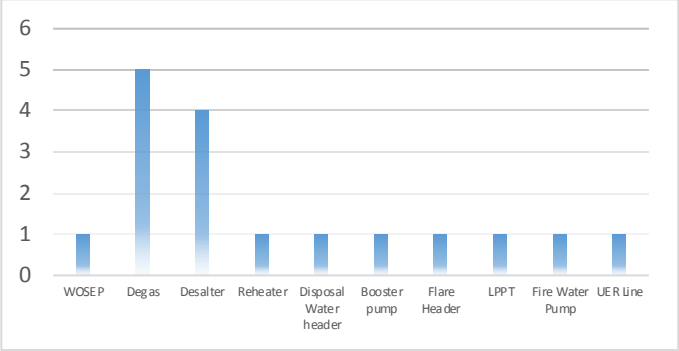

Figure 6: The de-gas equipment had the highest number.

Total Piping Replacement with Drain Lines

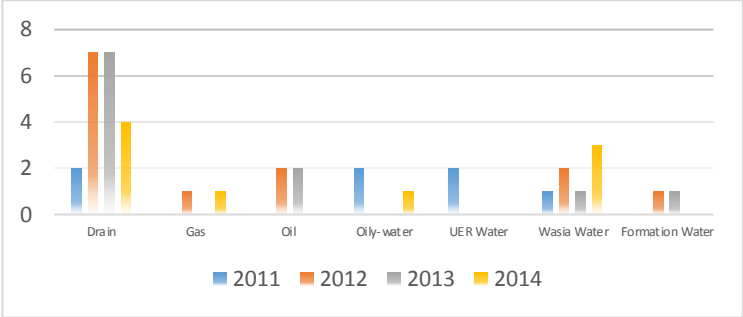

Figure 7: The highest number of replacements for Plant-B was for drain lines.

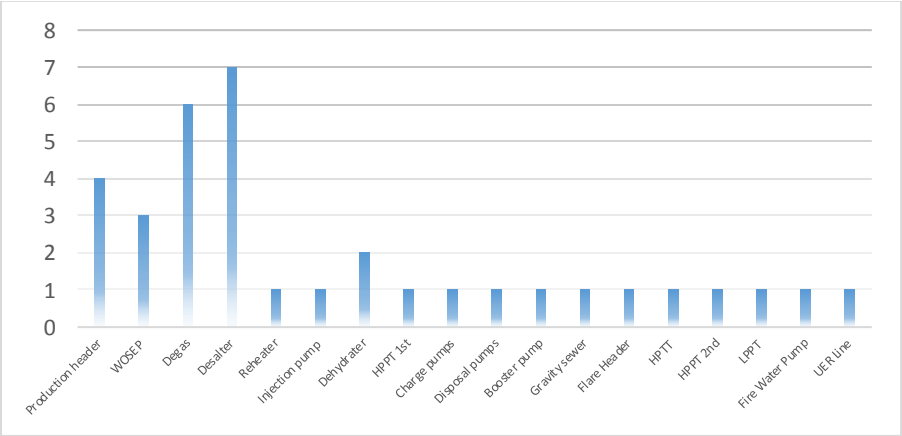

Figure 8: The highest piping replacements by equipment item.

Evaluation

Alternative solutions for line replacement, due to corrosion include:

1) Internally Coated Pipes

Internally coated carbon steel pipe is the most common choice for the replacement of drain lines (Revie and Uhlig, 2012). The internal coating application process cannot completely solve the issue of drain line corrosion, due to the difficulty faced when coating pipes, especially the small diameter pipes, and the difficulty in inspecting these pipes after coating.

2) Lined Carbon Steel Pipes

In this case, use of fluorocarbon lining as a linear material is recommended, since it will handle the sour kind of fluid, which contains higher levels of acid oil and salt water (ASM, 2015).

Conclusions

Corrosion is a challenge to the world of piping and much effort shell be taken to mitigate it. For Plant-A (2011 to 2014), the total piping replacement without drain lines was highest in gas, followed by oil. The number is higher in gas due to the exposure of the pipes. In the scenario of total piping replaced with a drain line in Plant-A, the drain category led the replacements, meaning that drain corrosion was the highest of all the categories. In the case of Plant-B, the total piping replacement without drain lines was higher in Wasia water, because of the high level of salt, which acts as a catalyst for corrosion. In the case of total piping replacements, the drain lines in Plant-B were the same as in Plant-A, with the drain category having the highest number of replacements. This study shows that inspections need to be consistent to avoid dangerous leaks, which can result in major losses for the concerned company.

Recommendations

After this case study analyzed the pipes in two plants, it is recommended the continued use of internally coated tubes, since this practice reduces the replacement rate of pipes. It was also recommended to optimize the stream inspection program. The chemical treatment program is recommended to be reviewed, to bring better solutions and reduce corrosion in all piping systems, and also extend the study to all company GOSPs, to ascertain any possible areas of concern. Finally, it is recommended that the replacement of drain piping be done with the use of fluorocarbon piping in the future.

References

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Biography

Sultan A. Al Shaqaq received his B.E. degree in Electrical Engineering and M.S. degree in Mechanical and Manufacturing Systems from Lawrence Technological University, Michigan, USA. He joined Saudi Aramco as a Senior Engineer. He has been exposed to different field work, such as operation, and construction projects in oil and gas industry. Sultan trained as a Lean Six Sigma Black Belt at Shiloh Industries, Inc. In 2016, Sultan certified as a lead auditor from International Register of Certificated Auditors (IRCA). He has taken courses in leadership, quality, and lean six sigma. Sultan's research interests include corrosion, industrial, material, reliability, and lean. He is member of ASQ, SCE, IRCA, and IEEE.