

Refinery Reduces Overhead Corrosion Through Continuous Analysis And Online Control



INTRODUCTION

Corrosion of crude unit overhead exchangers continues to be a significant integrity and reliability concern within the refining industry. For many crude units, good desalting and caustic injection practices are the first lines of defense in managing overhead corrosion issues, while the injection of organic amine neutralizers and corrosion inhibitors are also applied in order to keep corrosion rates to a minimum.

Whilst these mitigation strategies are very effective in mitigating corrosion, traditional corrosion monitoring and control relies on periodic sampling and analysis of overhead sour waters to determine the corrosive nature of the process (i.e. pH and chloride levels) and an indication of the magnitude of corrosion activity by the measurement of iron in the sour water. However, the high degree of fluctuations in the acids present in the overhead system sometimes make it difficult to optimize the neutralizer and filming amine demand, which can result in elevated levels of corrosion being observed.

The 3D TRASAR™ Technology for Crude Overhead Systems (3DTCOS) enables real time measurements of key parameters that promote corrosion in the overhead system, and is a unique tool for identifying mechanical, operational, and chemical root causes of corrosion.

BACKGROUND

A European Refinery processes a wide variety of opportunity crudes and as a consequence of this, controlling corrosion in their crude unit overhead system remains one of the biggest challenges. The feed to this crude unit is particularly challenging, and the refinery is aggressive in the crude selection, which poses a high degree of difficulty in controlling the overhead corrosion. These challenges demanded constant attention from both the refiner and the Nalco Water team to monitor the operation and overhead conditions. However, due to the high degree of variability, the control of the overhead pH was difficult and there were frequent low pH excursions (pH

VALUE DELIVERED

ASSETS

MANAGE RISK

with online control

COSTS

IMPROVED RELIABILITY

Eliminating need for costly upgrade



IMAGE 1: 3D TRASAR TECHNOLOGY FOR CRUDE OVERHEAD SYSTEMS EQUIPMENT

<5). Consequently, controlling corrosion remained a constant challenge and the refinery was considering upgrading the metallurgy of the overhead system to address the corrosion concerns.

SOLUTION

Historically, the overhead sour water from the crude unit had been sampled on a daily basis and analysed in the laboratory for pH, chlorides and iron. Based on this spot analysis, the neutralizer injection rate would be adjusted based on the laboratory pH result. Trials of sampling the boot water on a shift-by-shift basis have also been conducted, but this increased analysis frequency did not deliver any significant improvements in overhead corrosion control.

The refinery was interested in the 3DTCOS technology initially as a means of improving the pH control of the overhead sour water, thus reducing the rates of overhead corrosion in the crude unit. If the 3DTCOS system could deliver significant improvements, it would negate the need for the refinery to commit to a capital project required to upgrade the system to a more corrosion resistant metallurgy. The cost of this upgrade was estimated to be in the region of \$3 to 5 million.

The 3DTCOS analyser was commissioned and connected to the refinery DCS with the unit initially being set up in monitoring mode only. With this link the refinery was able to track the pH, chlorides and iron levels of the sour water in real-time. This allowed for alarms to be set that would alert both the refinery and Nalco Water personnel to changes in the sour water quality that increase the corrosion risk. However, the greatest benefit to this particular refinery was the ability to improve the pH control.

Immediately after commissioning the 3DTCOS analyser, it was clear that the sour water conditions on this particular crude unit were extremely challenging compared to other 3DTCOS analysers

installed on other crude units. The water quality was far more severe than anything encountered from other installations with warmer boot water temperatures and higher hydrocarbon content being observed. In order to deal with these challenges, several modifications had to be made to the analyser during the months following the initial commissioning. The modification of the sample conditioning system to include hydrocarbon filters, a cooler and a planned and proactive maintenance regime addressed these issues and improved the reliability of the unit.

The other key challenge was the selection of a pH probe that could operate reliably with such a challenging environment. Operating in elevated temperatures with highly reactive contaminants, traditional pH-reference electrodes can in some cases last only several days. After initial success with the original pH probes, a change to a more aggressive crude slate resulted in reliability issues and required the need for Nalco Water to investigate an alternative approach and find a probe that could tolerate this aggressive environment. A new probe was found providing a considerably longer life and improved reliability.

As a result of this trouble shooting and field modifications, the 3DTCOS unit can operate reliably as designed with only weekly routine maintenance. These improvements have allowed the refiner to gain confidence in the unit. Following commissioning these modifications to the sample conditioning system and the 3DTCOS analyser, the pH control

and crude unit overhead corrosion has significantly improved, as can be seen in figures 1 and 2 on the following page.

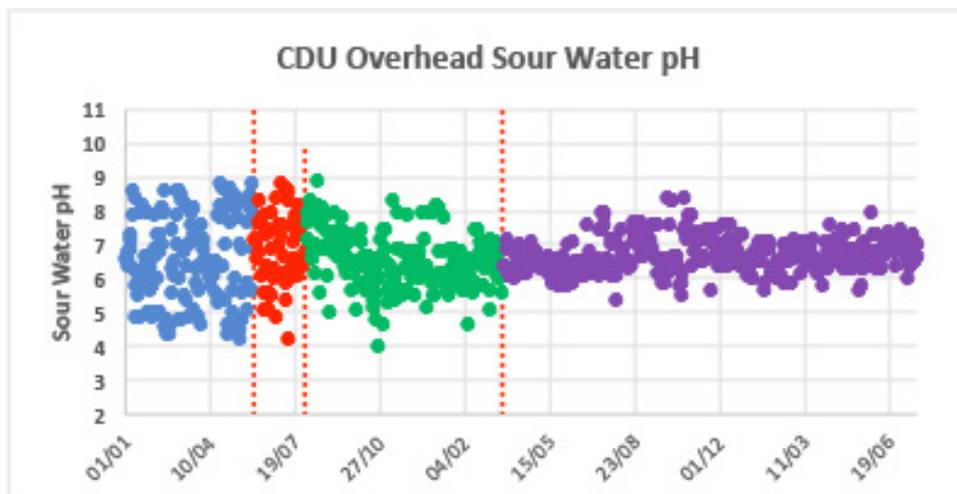
RESULTS

The main objective of installing the 3DTCOS analyser was to significantly improve the pH control of the overhead sour water, and consequently reduce the corrosion rates in the crude unit overhead exchangers. Figure 1 shows the daily laboratory boot water pH result before and after commissioning the 3DTCOS analyser and placing it in control mode. It is clear from this graph that since the 3DTCOS analyser was placed in control and the neutralizer dosing was automated, the variability of the overhead sour water pH significantly reduced.

Figure 2 shows the daily laboratory sour water iron result over the same time period, and from this, it is clear that the control of the corrosion rates significantly improved as a result of the improved pH control.

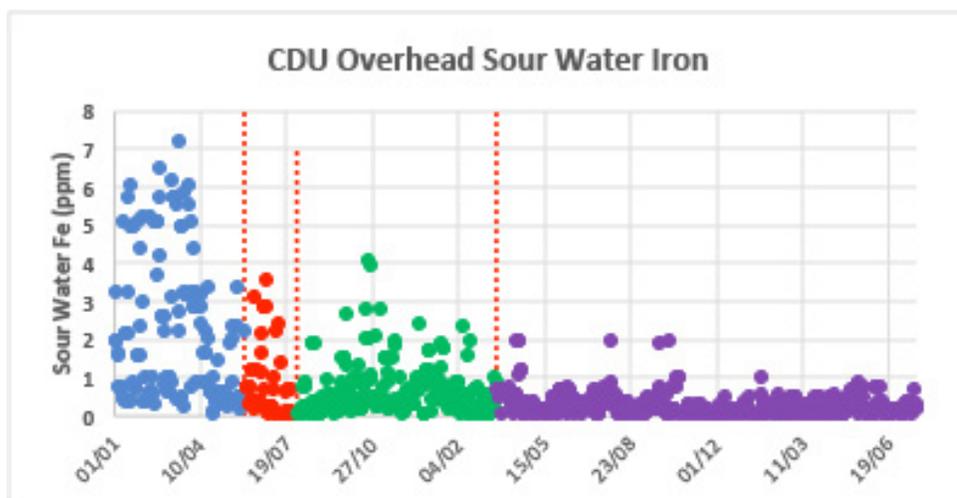
One of the most significant benefits of installing the 3DTCOS analyser was that it gave the refiner and Nalco Water insight into the events that take place between the daily sampling and analysis, which can significantly reduce the rates of overhead corrosion. It is often noted that corrosion is an event driven process and the continuous monitoring by the 3DTCOS analyser highlighted events that would otherwise go unnoticed.

In one incident, the crude tank that was about to be brought online had been reported as containing a higher level of BS&W than the one currently feeding the crude unit. As this tank was brought online, desalter amps and interface levels rose sharply indicating a water slug had hit the desalter. To mitigate this event,



| | std dev | AVERAGE | UCL | LCL |
|------------------------|---------|---------|------|------|
| Pre-3DTCOS | 0.83 | 6.57 | 7.40 | 5.74 |
| 3DTCOS Monitoring Only | 1.03 | 6.92 | 7.95 | 5.88 |
| 3DTCOS Control (1) | 0.81 | 6.56 | 7.37 | 5.74 |
| 3DTCOS Control (2) | 0.51 | 6.68 | 7.19 | 6.17 |

FIGURE 1: CDU OVERHEAD SOUR WATER pH



| | std dev | AVERAGE |
|------------------------|---------|---------|
| Pre-3DTCOS | 1.11 | 0.85 |
| 3DTCOS Monitoring Only | 0.90 | 0.76 |
| 3DTCOS Control (1) | 0.66 | 0.66 |
| 3DTCOS Control (2) | 0.30 | 0.30 |

FIGURE 2: CDU OVERHEAD SOUR WATER IRON LEVELS

operators increased demulsifier dosing and reduced desalter wash water rates. Shortly after, the overhead sour water pH dropped quickly from pH 6.5 to 4.5. In response to this reduction in pH, the 3DTCOS analyser significantly increased the neutralizer dose rate.

In this scenario, the real-time monitoring immediately highlighted the low pH of the sour water and the potential for high rates of corrosion in the crude unit overheads. Without the presence of the 3DTCOS analyser, it is highly likely that this process upset would have gone undetected leading low pH conditions for a prolonged period, as any corrective action would only have taken place after the daily boot water sample was taken. This real-time analysis from the 3DTCOS analyser allowed corrective action to be initiated quickly, thus minimizing the duration of the corrosion event. Furthermore, once the unit had stabilized and the target pH was achieved, the unit optimized the neutralizer dose rate accordingly.

CONCLUSION

The installation of the 3DTCOS analyser allows for the real-time analysis of the overhead sour water, thus providing the refiner with the ability to make a significant step change improvement in the control pH and corrosion in a very challenging overhead system. Furthermore, the increased amount of data provided by the unit allowed the refiner and Nalco Water to quickly spot and respond to corrosion events as they are taking place, thus allowing for much more effective overhead corrosion control.

With this increased data, it provides greater understanding on what events are driving overhead corrosion, allowing the refiner and Nalco Water to optimize process conditions and further improve the management of the corrosion control program.

Ultimately, as a result of the improved system assurance and asset integrity management that comes with the 3DTCOS analyser, the refinery chose to stay with carbon steel overhead metallurgy, postponing a project that would cost an estimated \$3-5 million indefinitely.

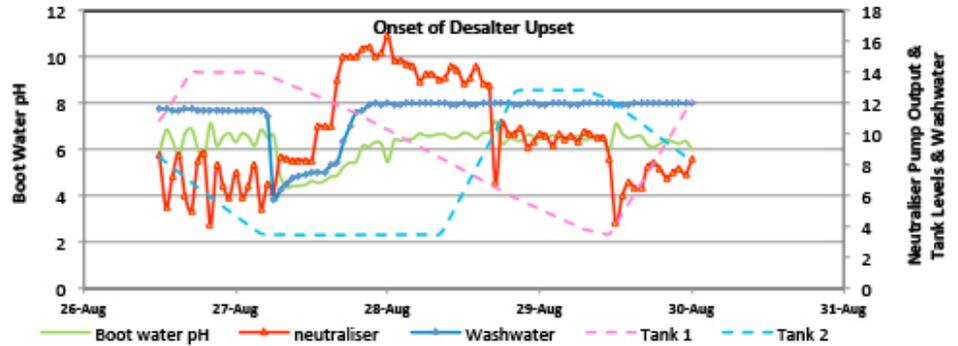


FIGURE 3: IMPACT OF WET CRUDE TANK

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