Case Study: CH-1969

REFINERY OVERHEAD AUTOMATION DELIVERS SIGNIFICANT KPI COMPLIANCE IMPROVEMENT

Case Study: Refining Process Treatment

INTRODUCTION

As part of a project to improve the heat transfer capacity in their crude unit overhead system, a Gulf Coast refiner installed carbon steel twisted tube bundles in their 1st stage heat exchangers. However, because of small tube clearances, this design of heat exchanger bundle was susceptible to fouling due to salt formation caused by tramp amine ingress and highly variable levels of overhead chlorides.

Furthermore, this salt related fouling resulted in under deposit corrosion leading to premature failures, with exchanger bundles lasting only 1–2 years. These premature failures incurred costs and lost opportunities of ~$2.5Million.

To mitigate the threats of salt formation and under deposit corrosion, mechanical changes such as installing a continuous water wash, were considered, however, this would have a negative effect on heat transfer efficiency. Therefore, the refiner, with the support of Nalco Champion, looked at other means to improve the situation.

BACKGROUND

To effectively manage highly variable levels of overhead chlorides, good desalting and caustic injection practices are critical. Nalco Champion worked closely with the refiner to minimize chlorides in the overhead system, but even with good management, it can be difficult to effectively control the chlorides within a narrow range, especially when processing challenging feedstocks.

The crude slate to many crude units change every 2-3 days, sometimes even more frequently. When combining operational variability with varying feed slates and significant batch-to-batch variation in salts and tramp amines ingress, the result is highly variable contaminant levels in the overheads. The difficulties with the variability of the process are exacerbated by the low frequency of measurement of key corrosion control indicators like pH, chlorides and iron levels. Under the current service provision, pH was measured twice daily and chlorides daily by the refiner, while Nalco Champion technicians conducted twice weekly service visits.

With a highly variable process, trying to control the corrosion in the system with such infrequent measurements is very difficult. The result is a unit that swings between high and low chlorides and total ignorance about what is happening in the intervening periods between measurements. To improve the situation, Nalco Champion was contacted for a solution to minimize chlorides in the overhead system without caustic over-injection.

SOLUTION

The refinery implemented the Nalco Champion 3D TRASAR Technology for Crude Overhead Systems (3DTCOS) as a means of improving the chloride control of the overhead sour water. The 3DTCOS analyzer takes a stream of the crude unit overhead sour water and determines the pH continuously along with the chloride and iron levels hourly. The goal is to link chemical addition directly to the demands of the overhead system.

After the initial start-up, the unit was used in monitoring mode only to continuously observe the system and establish direct linkage between fluctuations in chloride levels and operational variables such as feed quality, desalter performance, and caustic dosing.

From the initial monitoring period, the increased sampling frequency showed the chloride KPI performance, thought to be 90% within the specification limit of 20ppm, was in fact only 80% compliant with a high degree of variation in the chloride numbers. The average chloride concentration was 14.7ppm with a standard deviation of 10ppm.

Another challenge was the neutralizer dose rates, since the varying levels of tramp amines make it very difficult, if not impossible, to control. The pH levels were frequently more than 6.5, which may suggest a lower risk of corrosion; however, it is incorrect to assume the dew point is being protected. This was borne out by the iron analysis from the 3DTCOS in monitoring mode with average levels of 1ppm being observed and KPI compliance to the specification of <1ppm at only 79%.

The overall conclusion from the increased set of data was that there was significant room for improvement for both the caustic and neutralizer control.

RESULTS

Whilst still in monitoring mode, there were feed quality issues with decreased dewatering capabilities causing higher crude water content. This resulted in average chloride levels increasing from an average of 14.7ppm to 18.1ppm with a similar standard deviation of approximately 10ppm. Due to the deterioration in chloride control, moves were made to improve the situation through optimization of the desalter mix valve and caustic injection. Still in monitoring mode, the 3DTCOS unit showed that comparable levels of chloride control could be attained while at the same time reducing the amount of caustic being used. The results are summarized in Table 1.

	Average	Std Dev	Chloride <20ppm	Avg NaOH (PTB)
Monitoring 1	14.7	10.0	80.7%	1.35
Monitoring 2	18.1	10.5	81.8%	1.05
Monitoring 3	16.5	10.4	79.4%	0.80

Table 1: Chloride Levels in Monitoring Mode

Now that the reliability of the unit and the data had been proven in monitoring mode, the decision was made to place the 3DTCOS in control mode where the addition of caustic, neutralizing amine and filming inhibitor were injected based on the demands of the system. There were a number of phases required to establish the optimum control logic for the chemical dosing pumps and over a period of a couple of months this was refined in order to optimize control. These optimization steps involved various degrees of adjustment to the caustic control logic and the actual chemical injection pumps to tighten the control of the overhead chlorides.

It was clearly evident that when control mode commenced, the overhead chloride control improved significantly reducing both the average and standard deviation, while compliance to the KPI of <20ppm increased significantly without the need for increased caustic consumption (shown in Table 2).

	Average	Std Dev	Chloride <20ppm	Avg NaOH (PTB)
Control Mode 1	12.1	6.0	95,2%	0.67
Control Mode 2	17.7	9.3	72.6%	1.00
Control Mode 3	13.4	6.9	93.3%	0.80
Control Mode 4	13.0	4.8	97.0%	0.83

Table 2: Chloride Levels in Control Mode

Comparing Monitoring Mode 3 (table 1) to Control Mode 4 (table 2) shows the control of overhead chlorides improved massively for the same caustic dose rate. The improvements were even more compelling in the histogram of the chloride results in optimized control mode (see Figure 1), which clearly shows the improvement in control and the tight span of chloride levels observed, eliminating most of the high and low numbers previously observed under manual control.

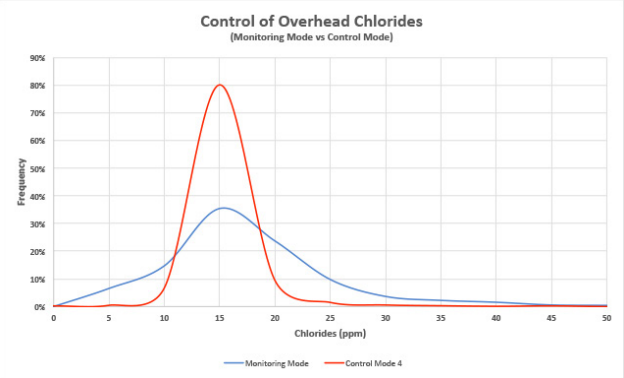

Figure 1: Distribution of Chloride Numbers in Monitoring Mode vs Optimized Control Mode

The improved chloride control had an impact on the relative risks of salt formation. Modeling with the Nalco Champion PATHFINDER™ software demonstrated that the calculated mass of salt generated decreased by 40% after the switch to control mode.

Another observed benefit of operating the 3DTCOS in control mode was the improved overhead iron levels. The control logic for the neutralizer was optimized over a period of months, resulting in a significant improvement in the iron levels; average iron levels decreased to 0.4ppm with KPI compliance increasing from 71.5% in monitoring mode to 97% in optimized control mode.

Additionally, this reduction of iron levels and increased KPI compliance was achieved with a 10% reduction in neutralizer consumption, demonstrating the ability of the 3DTCOS unit to optimize dose rates at the moment of demand.

CONCLUSION

Before the implementation of the 3DTCOS, there was a large degree of variation in the key control parameters of the crude unit overhead corrosion control program.

With the installation of the analyzer, the refiner and the Nalco Champion team were able to utilize the increased volume of data to deliver a step change in performance. The greater understanding on what events are driving overhead corrosion allowed for optimization of process conditions and further improvements in the management of the corrosion control program.

The placement of the 3DTCOS in control mode delivered the largest improvement, allowing for the injection of the correct amount chemistry at the exact moment of demand. This allowed the refiner to make a significant step change in KPI compliance for both overhead chloride and iron levels, increasing from ~70% to 97.0% for both parameters.

The improvement in chlorides was achieved with a 40% reduction in the amount of caustic added, while the improvement in the overhead iron levels was achieved with an average 10% reduction in the monthly neutralizer consumption.

The improved control of overhead chlorides resulted in a reduced risk of salt formation helping resolve the fouling concern in the overhead heat exchangers, which is limiting throughput of the crude unit and costing the refiner approximately $2.5Million per year.

By implementing this innovative technology, Nalco Champion and the refiner have successfully worked together to drive significant improvements in asset reliability and integrity while reducing the frequency of failure and the costs associated with unplanned shutdowns.

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