THE CORROSION CHALLENGE

Kjell Wold, Emerson Process Management, Norway, addresses the issue of corrosion in refineries and explains how this process can be more closely monitored and improved.

With an ever-rising focus on the safety, reliability, throughput and operational integrity of plant facilities, corrosion management is in the spotlight like never before. From naphthenic acid corrosion to sour water corrosion, hydrogen induced cracking (HIC) and sulfide stress cracking (SSC), corrosion can take many forms in refineries and can have a highly negative impact on both the plant's operational integrity and running costs.

Corrosion, for example, can lead to pipeline leaks, threats to asset integrity, and unplanned interruptions and shutdowns. Typical examples of corrosion include the underground corrosion of buried parts of vessels and pipelines, general and localised internal corrosion in processing piping and vessels, corrosion under insulation, and high temperature naphthenic corrosion in distillation units and high temperature process piping.

Such unscheduled occurrences can impact refinery capacity significantly. It also leads to poor risk-based planning processes and the inability to plan and bring in spare equipment properly. Extended operating window programmes and design envelopes, common in many refineries, can also overload critical equipment capacity, such as desalters and heat exchangers, and lead to severe corrosion.

Crude oil desalting and distillation, for example, generates considerable wastewater that contains corrosive components, such as H_2S, CO_2, chlorides and high levels of dissolved solids. Similarly, solid deposits on heat exchangers can affect heat transfer efficiency and lead to plugging. According to the Abnormal Situation Management (ASM) Consortium, 76% of equipment failure is related to managing operations outside operating boundaries (range or design envelopes).

Corrosion also results in rising maintenance costs. NACE, the professional body for the corrosion control industry, predicts that the total annual cost of corrosion in the oil and gas production industry is US$1.372 billion. The Saudi Aramco Journal of Technology also estimates that as much as 36% of all maintenance costs in refineries can be linked to corrosion remediation and repairs and, according to Honeywell, up to 50% of all pipeline leaks are down to corrosion.

Aside from maintenance costs, corrosion can also have a major impact on the optimal blending of crudes. Crude oil purchasing today represents over 90% of the cost structure of a refinery and is subsequently a major area for achieving profitability and reducing costs.

Many high total acid number (TAN) and opportunity crudes, synthetic or sour crudes or diluted bitumen, for example, all characterised by a relatively high metal and sulfur content, can

Figure 1. Parts of a refinery where corrosion monitoring is carried out.

Figure 2. The Roxar Corrosion Monitoring system consists of wireless-based probes.

be purchased at a substantial discount of up to 20% compared to conventional crude oils.

While the extra cost of processing high TAN crude might be higher, there are still significant savings. An increase in opportunity crudes from 1.5 to 3.5% in a refinery with a capacity of 300 000 bpd, for example, could result in savings of US$7 - 10 million/y based on a US$4 price difference.

The downside, however, is that such opportunity crudes, which tend to have a TAN of 1.0 or higher, are more corrosive by nature. The localised nature of naphthenic acid corrosion, for example, makes it difficult to monitor through traditional methods.

The corrosivity of opportunity crudes must, therefore, be monitored in realtime to ensure the optimal blending of high TAN and low TAN crudes and also determine when, which and how much corrosion inhibitors are required.

From both an operational and financial standpoint, an integrated corrosion monitoring strategy is therefore essential to modern refineries. Corrosion monitoring can verify assets and integrity, optimise corrosion mitigation and control, provide vital input to inspection planning and asset maintenance, and ensure the optimal blending of opportunity crudes. Yet, are today's technologies and refineries rising to the challenge?

Rising to the challenge

Despite the undoubted technology developments in corrosion monitoring over the past few years, the fact remains that many older refineries have outdated monitoring solutions with little integrated data management capabilities. Wiring costs also make upgrades to online corrosion monitoring cost-prohibitive.

In addition, too often the focus has been on process monitoring rather than asset health and integrity. The result is limited data quality and access, and the missing of early warnings of asset health degradation.

There is also a danger of costly, environmentally unfriendly corrosion inhibitor programmes being initiated without accurate corrosion information. Expensive trips are also sometime made to hazardous areas within refineries, due to the lack of realtime corrosion information and an inability to access information remotely.

An integrated, wireless-based model corrosion monitoring system

It is with these challenges in mind that Emerson has introduced a new online corrosion monitoring system. Combined with the Field Signature Method (FSM) technology, a non-intrusive system for monitoring internal corrosion at the pipewall, refinery operators will be able to use the new system to access more comprehensive corrosion information and corrosion rates, leading to improved operator insight and control over assets. The system consists of electrical resistance (ER) and linear polarisation resistance (LPR) probes and weight loss coupons, all coming with high temperature ratings. ER probes also come with high resolution (10 - 100 nm) and fast response times.

The ER and LPR monitoring functions are also available on the same instrument and a 20 m cable provides added flexibility with respect to positioning, optimised signal routing, easier maintenance and probe replacement.

The system can be installed in a number of refinery applications, including side streams, cooling systems and in addressing naphthenic acid corrosion in high temperature distillation processes. It can also tackle increased corrosion triggered by high velocity and temperatures, malfunctioning desalting units and high sulfur content. The system is also compatible with the WirelessHART protocol and works alongside other Emerson solutions.

The system provides a number of benefits to refinery operators. Firstly, it will ensure optimal production processes and reduced refinery downtime via its fast, integrated, high resolution and accurate corrosion monitoring.

Only the necessary amount of corrosion inhibitors will be injected to meet environmental requirements. The system will also provide operators with the ability to understand the process conditions that may be influencing faulty equipment or integrity risks as well as determine the root causes of certain failures.

The fact that the system is wireless-based will also enable access to the plant's most critical and often inaccessible areas as well as coming with reduced installation costs and improved data management. Asset monitoring can also take place remotely, eliminating unnecessary trips to the refinery and hazardous areas, and improved HSE.

Operators will also be able to access highly accurate measurements of uniform and localised wall thickness changes through Emerson's FSM technology, thereby fully understanding

corrosion's impact on pipeline conditions. This will be particularly important in estimating naphthenic acid corrosion's impact on pipeline integrity.

Finally, at a time of high crude volatility, operators will have maximum crude selection flexibility and can blend the maximum amount of opportunity/high TAN crudes into the crude mix. A baseline can be defined before introducing high TAN crudes and the effects of changing inhibitor programmes can be monitored.

Refinery applications

One such installation of the new system was on an Eastern European refinery where the goal was to monitor corrosion rates in a 330 tph main crude oil stream when processing 6 tph heavy slops of oil.

In this case, the wireless corrosion probe, detecting fluid corrosion measurements, provided early warnings of significant corrosion rate changes. Within hours, corrosion rate changes were established, allowing the user to manage their processing strategy and keep within material performance limits.

Another application of the FSM can be found in the Jamnagar Refinery in India. The refinery is owned by Reliance Industries and is the world's largest.

In this case, the need was for permanent wall thickness monitoring as input to a pipe replacement plan. There was a need to detect small changes in the actual pipe wall, see the effect of opportunity crudes, and identify any changes due to naphthenic corrosion.

Emerson generated full pipeline wall loss measurements at high temperature locations with 58 online FSM systems installed. For the operator, benefits included optimal chemical injection dosages and optimal crude blending leading to significant cost savings.

The integrity of the plant was also confirmed and maintained even when processing high TAN crudes and the corrosion rates of the piping were assessed, providing input to future pipe replacements and upgrades.

Conclusion

An integrated corrosion management system today is essential for operators to take full control of their refinery assets, secure the ideal blend of crudes without increasing corrosion threats, and ensure that their production processes are operating at peak potential. It is also an investment in improved economics, extended asset life and safer operations. It is therefore encouraging to see that corrosion monitoring technologies are starting to rise to the challenge.

Bibliography

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