CASE STUDY | AI for Predictive Maintenance
Refinery

Identifying the cause of erratic equipment performance

AI finds a choked impulse line on the main fractionator at a refinery

Shell is comprised of a global group of energy and petrochemical companies with more than 80,000 employees in over 70 countries.

The Shell Predictive Maintenance application for Control Valves on the BHC3 AI Suite offers a scalable solution that has been deployed at seven Shell assets. In this case, operators at one of Shell's largest refineries wanted a proactive way to discover and mitigate failures before they occurred. Using the Shell Predictive Maintenance application for Control Valves, enabled the team to be able to predict the expected behaviour of control valves within this downstream manufacturing asset. The software flags any anomalous behaviour for review to remote or onsite engineers who can pre-emptively address potential failures.

Project Objectives

An AI diagnostic approach was applied to control valves in order to improve reliability. Minimising unplanned downtime is a key objective in refinery operations and a crucial factor in maximising operational efficiency.

In this case, the operators used the Shell Predictive Maintenance application for Control Valves to detect and investigate erratic behaviour in the plant's main fractionator unit. Predictive maintenance methods based on advanced data analytics and machine learning techniques for monitoring can help prevent unscheduled deferment and enable smarter maintenance scheduling.

Results Summary

- Prevented margin loss due to shutdown of the downstream water stripper unit and production loss
- Avoided the risk of flaring and associated emissions
- Protected customer reputation by ensuring that erratic performance in the main fractionator did not result in poor quality product

Challenge

A world scale refinery requires thousands of control valves. Each of these can fail in a number of different ways. Having experts monitor all these control valves is not feasible. Therefore, the team implemented an automated approach leveraging artificial intelligence, which had previously been deployed in several other refineries.

The Shell Predictive Maintenance application detected deviations in the predicted movement of a globe control valve that is used to control the boot level of the main fractionator reflux vessel upstream of the sour water stripper. These deviations were identified when the predictive maintenance model was created and reviewed, but the anomalous behaviour had started months earlier (Figure 1a).

Time series data analysis showed that the valve had been hunting and that the impulse line of the differential pressure level transmitter might be choking. Instrument engineers at the refinery verified the observations and recommended a site investigation to validate the finding and correct any potential choking.

The control valve in question regulates the level of a vessel upstream of the sour water stripper and the impulse line, a small-gauge pipe that transmits the process pressure to the differential pressure transmitter, was clogging up. This clogging effect in the line was causing the control valve to hunt and the resulting observed disturbances in the valve movement. A failure caused by this problem could have caused a hydrocarbon breakthrough downstream. This would have resulted in lost production margin due to the need for shutting down the sour water stripper for cleaning, and the need for flaring at the plant. It could also have resulted in a period of lower quality product because of poor controllability of the control valve in the fractionator unit.

Approach

The unit's maintenance focal point made an on-site inspection and performed a pump through on the transmitter's impulse line to clear the potential choke. The time series data was then monitored for two weeks and this verified that control valve hunting had been significantly reduced (Figure 1b).

Results

- Intervention prevented the risk of unplanned shutdown of the Sour Water Stripping unit.
- Identification of the impulse line issue removed the potential risk of having to flare sour gas.
- Early and effective intervention helped to ensure that the plant's isobutane product remained on-specification and safeguarded the plant's reputation with customers.

Application Highlights

- Successfully deployed in assets ranging from upstream to petrochemicals
- Works on control valves of any type and age without additional hardware
- Monitoring more than 5000 control valves every day in Shell
- High level of automation makes it possible to deploy 100+ models in a day
- Designed for remote monitoring

With Shell Predictive Maintenance for Control Valves, operators can:

- Monitor the health of control valves and associated instrumentation, identify assets at risk in advance, and mitigate risks through AI-driven alerts.
- Embed specialist knowledge using instrument engineers' expert knowledge about the equipment to tune model training and alerting.
- Compare multiple automatically trained models to select the best performing models to use for monitoring.
- Understand control valve health at enterprise scale with simple and extensible valve onboarding process and monitoring tools.
- Enable engineers to intervene early and take preventative action.
- Improve turnaround efficiency and focus areas by using a data-driven approach to prioritize equipment and maintenance tasks.
- Seamlessly embed insights on control valve performance into BHC3.ai Reliability and asset exception based surveillance workflows.

With Shell Predictive Maintenance for Control Valves, energy companies can:

- Enable early detection of anomalies to reduce unscheduled deferment and unplanned downtime, ultimately increasing availability.
- Reduce maintenance costs through timely intervention.
- Provide assurance on the state of the equipment to support proactive equipment care strategies and reduce maintenance costs.
- Improve productivity, availability and performance of control valves.

FIGURE 1:
A predictive model created in September 2020 indicated that erratic valve movement had started several months earlier (a). Cleaning of the choked impulse line eliminated the valve's hunting behaviour (b).

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