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How innovation can avoid a shutdown

This article describes how a novel solution was successfully implemented and allowed the removal and repair of the damaged PCV valve without the need to shut down the main flare line system serving Saudi Aramco Abqaiq plant.

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A specific innovative solution was deployed by Saudi Aramco engineers to stop internally leaking (passing) valves and removing the damaged PCV. An estimated cost saving of approximately $43.5 MM was achieved by avoiding a definite plant shut down and valve replacement.
The Abqaiq Plant, which is located at the Eastern province of Saudi Arabia, plays a pivotal role in the day-to-day operation of Saudi Aramco. Abqaiq is the main oil processing center for Arabian Extra Light and Arabian Light crudes, with a capacity of more than 7 million barrels a day. Abqaiq Plant consists of three main processing areas, i.e., Oil, NGL, and Utilities.

Valve seat design

In isolation valves, the most common problem is a passing seat. As a result, valve manufacturers have conducted many studies and engineering designs to develop the valve seats design/ configuration. Lately, valve seats have been configured into four different categories in order to eliminate the seats passing chronic problem. These seats configurations are as follows:

- Self-Relieving Seats
- Double Piston Effect
- Dual Seat Design
- Retractable Seats

In addition to the above valve seat configurations, the seat is designed to have a pack up groove to be used for sealing injection in the event of o- rings wear or damage.
Despite the above seats configurations, the valve can still pass if the following conditions are not met:

1. Performing adequate periodic valve maintenance (PM)
2. Selecting proper material for valve service/application during project design and engineering
3. Appropriate handling, transporting, storing and installing during commissioning stage

Moreover, some of the existing old valve designs can't be sealed or drained. For instance, the 60" old design gate valve located at Abqaiq Plant flare line has experienced a major passing seats problem. The valve had continued passing and was not equipped with an emergency sealant nor with cavity drain to be used for cleaning or draining.
This 60" old design gate valve was too complicated to be repaired inline and

under pressure. In fact, it was a major repair challenging task for Saudi Aramco Abqaiq Plant.
This paper will explain how this huge challenge was overcome and the 60" valve passing problem was resolved.

The problem & solution

Saudi Aramco Abqaiq plant request to evaluate and resolve the 60" isolation passing valve of PCV-7A installed on the main flare header system. Abqaiq plant had two choices to resolve this critical problem, i.e., either to shutdown the header line that will cause an entire shutdown of Abqaiq plant or to perform a valve replacement by hot-tap and line stopping. However, shutdown was not cost effective (production loss of 7 million barrels per day) and stopping was not feasible since the pipe was not round.
Consequently, valve engineer specialist conducted a site visit and worked diligently with Abqaiq Plant by providing an Innovation Solution to resolve this issue thus avoiding a total plant shutdown.
Thorough visual inspection and troubleshooting were performed on site to assess the internal and external subject valve component conditions, such as seats, stem, actuator, gear box, traveling distance etc., to diagnose and specify the problem root cause.

Based on the assessment and findings it was found that these valves could not be repaired while they were in service. They were not equipped with emergency sealant grease fitting and hence no cleaner / sealant could be injected. Also, cavity drains were plugged with steel threaded plug and could not be opened to the atmosphere since the service contains toxic H2S.
In light of the above, and based on our historic valve trouble shooting experience, we came up with the creative idea of drilling two holes on the top and bottom of each valve in-line to be used as an access port to inject sealant.

Drilling method

After the preliminary investigation, the following data had to be gathered and evaluated at the initial stage.

- Contents of the piping system
- Isolation Valve wall thickness and material type
- System Design, Operating Pressure & Temperature
- UT scanning of subject valve

All gathered data was verified prior to starting the valve alteration. Afterwards, drilling hole locations and size were identified and marked accurately on the valve body. Then, the drilling procedure commenced as per the following steps:

1. Using Nitrogen to drive the drill for safety and start drilling the hole with a 5mm diameter pilot drill leaving 6 mm remaining thickness at the bottom of the hole
2. Enlarge the pilot hole diameter to the required tapping size i.e. 12mm
3. Tap the hole using full tap set to ensure the 12mm hole is threaded (leaving the 6 mm bottom thickness untouched)
4. Install a ball valve to the tapped hole and tighten in place
5. Commence drilling through the open ball valve using a long series 5mm drill bit. Running cold water to be sprayed on the drill bit throughout the drilling process to eliminate any heat or spark generation
6. Once break through was achieved; the drill bit was slowly retracted and the ball valve closed

On-line valve body sealant

Upon successfully creating a new access port, the subject main valve became ready to receive injected valve cleaner and sealant into the valve body to seal. In this situation, "Chameleon" sealant was recommended to be injected into the valve body. The required quantity was calculated as per the following formula.
Valve Body Capacity = L*W*H (cubic inch) – Gate volume/ 231 = total gallon.
Before commencing sealant injection,

the valve body cavity was drained and cleaned by using valve cleaner, and then the following steps were implemented for sealant injection:

1. Connect the sealant pump to the drilled cavity drain fitting
2. Start pumping the sealant to fill the cavity. By filling the body cavity with sealant, line pressure forces the sealant through the leak path or form a layer on the seating surfaces until a perfect seal is achieved

Experience has proven that the body cavity does not need to be completely filled. Filling to the top of the seat ring (assuming the valve is installed in the normal upright position) is adequate in most cases.

The valve was successfully sealed with ZERO leakage and the failed PCV replaced with a new one in a safe manner without the need of Saudi Aramco Abqaiq plants shutdown.

Conclusion

This exceptional practice was applied for the first time within Saudi Aramco and can be generalized for similar applicable isolation cases if safety measures are followed. This innovative solution has enhanced the safety and reliability of the header flare system operation at Saudi Aramco Abqaiq Plant. In doing so, old valve design can be modified and maintained while in line service. Taking the trouble to collect proper data and understand the valve maintenance techniques have contributed in resolving this problem. This successfully implemented solution avoided Saudi Aramco Abqaiq Plant Shutdown and safely replaced the damaged main header flare line PCV (pressure control valve).

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