TechTalk

Lowering operational costs with pro-active fault-finding techniques

Outline

IIoT and VOM

Even though the methodological steps to disassemble, inspect, repair, assemble and test valves have not changed much in recent history, the last decade has revealed some significant advancements to better understand the exposure that lead to a valve's overall condition. Welcome to Industrial Internet of Things (IIoT) and Valve Operability Monitoring (VOM).

The Evolution of Valve Service Inputs

A few years ago, only the number of accumulated strokes and days in service were recorded during valve inspections. The interpretation and accuracy of feedback posed a challenge to the end user as to the actual contributors of wear associated with in-line exposure.

Today, MOGAS uses operational data already available to support its end users in actively managing their severe service isolation valve assets. These advantages include:

- lower repair costs due to a better understanding of valve exposure
- a more pro-active approach in scheduled maintenance from pro-active triggers that highlight priority or 'hot' valves to be removed before excessive wear occurs
- an elevated level of safety of the overall system containing isolation valves because of the above, but also due to additional systems that MOGAS implements to capture, monitor and track critical dimensions on valve components (following numerous repairs) to trigger replacement when compared to industry design standards
- increased production due to higher levels of performance brought about by the combination of the above factors.

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These benefits mean end users are more open to partnering with MOGAS and making their operational data available. Additionally, this partnership assists in the development of even better valves, which will allow the end user to further push the limits of both installed life and valve performance.

System Monitoring: Macro Factors in Addition to Micro Objectives

Pressure leaching is a niche hydrometallurgical application that liberates valuable metals or makes them more manageable to leaching downstream. This method is typically considered for ore bodies difficult to leach under conventional processing techniques, such as atmospheric leach, and uses cladded or brick-lined metal pressure vessels. Autoclave units typically operate in combination with other equipment, including vessels designed for pressure let down and staged heating for efficient use of energy. The entire system flows abrasive slurries at elevated temperatures and pressures, and with various degrees of acidity. Therefore, only selective exotic materials of construction are considered for withstanding these severe conditions. Operation of these systems is a more cost intensive investment compared to conventional leach projects for the same throughput.

Efficiently monitoring the entire system prevented production losses had the autoclave needed to be shut down.

During a recent valve trial at a commercial autoclave site, MOGAS requested for operational data that would assist in accurately quantifying its operational exposure for benchmarking purposes. The end user partnered with MOGAS and diligently provided operational data throughout the trial period, regardless of the trial outcome. This attitude and commitment by the end user to partner with MOGAS lead to more than just a successful trial of the specific valve under investigation. In fact, being able to efficiently monitor the entire system on the client's behalf resulted in preventing significant costs associated with another valve in the system. This potential valve failure, if not tracked, could have resulted in production losses had the autoclave needed to be shut down.

A systems approach is required when setting up VOM (Valve Operability Monitoring). The system typically consists of several primary elements monitored, such as isolation and control valve outputs or in-line temperature and / or pressure. However, in most cases the valves contain other secondary systems that have an impact on the primary element, such as an actuator—also referred to as an 'operator'. The actuator, whether pneumatic, hydraulic or electric, provides the rotational force to the valve stem to turn, or 'stroke' the valve ball. The valve's open / close positioning status is also typically provided by the feedback from the actuator rather than a mechanical device installed on the valve itself.

The system monitored during the trial was in an autoclave slurry discharge application consisting of two MOGAS isolation valves, a control valve, actuated choke fill and drain valves, and various pressure and temperature instruments scattered amongst the system internally and externally. Data for each of these components was provided on a 30-second data capture frequency and distributed to MOGAS on a monthly basis.

Upon interpreting and recording the exposure to the trial valve (primary discharge valve), it was noted that the valve just downstream (secondary discharge valve) showed infrequent, abnormal stroking during start up, hot park and shut down.

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The trend in Figure 1 shows that the output of the **secondary discharge valve** (red) did not reach the 0% limit over an extended period. The **primary discharge valve** (dark blue) then attempted to close, but also didn't reach the limit. The actuality of these malfunctions was supported by the **autoclave level control valve** (green) remaining in the open position and releasing media from the autoclave until it ultimately closed as a result of the primary discharge valve finally reaching the closed (0%) output.

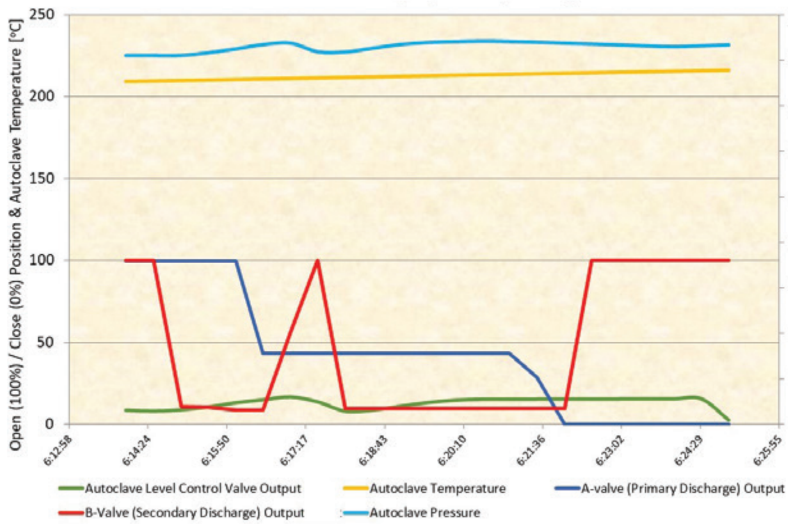

Figure 1: Autoclave discharge system operating detail (15 June) shows Initial indication of malfunction.

The tracking of these valves led to this event being observed, and triggered further attention in subsequent stroking events, which were closely monitored. The sequencing events a couple of weeks later provided further evidence of similar stroking malfunction.

In Figure 2, the secondary discharge valve also didn't stroke to the fully closed position. The primary discharge valve continued to close for successful isolation. Data shows that instead of taking approximately 16 seconds to close, the secondary valve took several minutes to close fully.

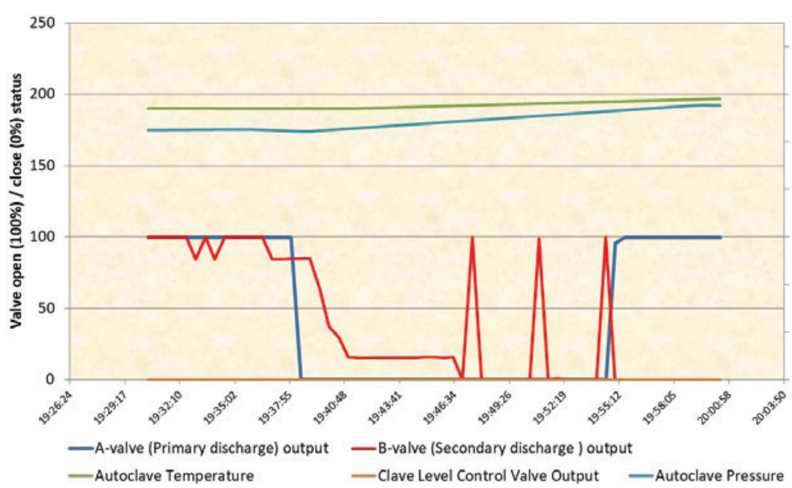

Figure 2. Autoclave discharge system operating detail (23 June) shows actuator stroking malfunction.

Maintaining the stroke duration per the design specification is critical. An isolation valve that is not in the fully open or closed positions is exposed to extremely high velocities of abrasive slurry and three phase flow patterns, all under significant pressure (Figure 3).

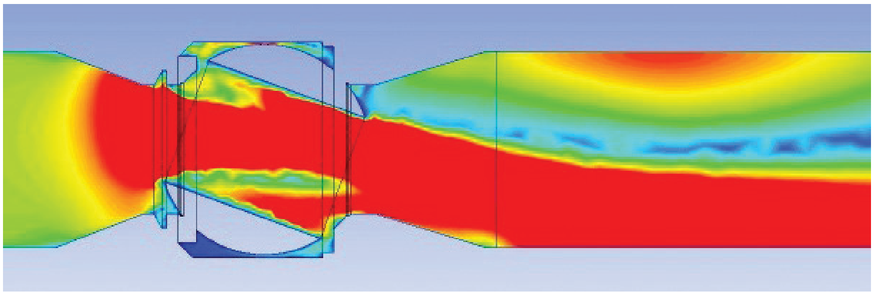

Figure 3: CFD analysis of partially open isolation valve. Exposed surfaces such as the nose of the ball, seat sealing surfaces, end connect and downstream piping are subject to accelerated erosion from high velocities (red), decreasing the performance and life of these components.

In the trial, the Distributed Control System (DCS) had triggering systems in place to alarm the operator, but these alarms and notifications can be easily missed. This is especially true when running a large operation with multiple autoclaves that require several operators and supervisors. Commonly, a malfunction like this will only be highlighted when other conditions are affected, such as low system pressure, sustained discharge line temperature, or a decreasing autoclave level. If events like these are recurrent, it can result in circuit downtime, elevated repair costs and unwanted production losses.

The Bigger Picture of Pro-active Asset Management

The control and feedback systems in autoclave isolation valves are not usually very involved or complicated. They are normally interlocked with various instrumentation and integrated into control loops. From a functional perspective, the instantaneous open / close limit switch feedback signal is the most important, and is visible to the control room operator on the DCS system.

The position feedback output from the hydraulic actuator was monitored in MOGAS' VOM to provide better insight into the duration and quality of the stroke. Upon investigation of the actuator's performance, it was found that the unit was leaking hydraulic oil past the actuator seals, preventing it from building adequate hydraulic pressure to complete a full stroke. The opportunity presented itself for the production train to shut down, and the actuator was replaced. Unfortunately, an in-line inspection of the valve could not be conducted because of the short duration of the shutdown. The isolation integrity of the valve was, however, still satisfactory prior to shutting down. This implied that the damage of the valve from previously being partially open and in the flow path was not significant. The actuator controller was reset, and it was clear after starting up successfully that the unit stroked satisfactory, per the design specification.

By proactively monitoring of the 'bigger' system, the end user was notified of several examples of problematic stroking. This, eliminated any further potential prolonged operational and equipment wear that could have impacted cost and production, and potential safety risk.

Small Efforts. Large Impacts.

Process circuits consist of numerous equipment pieces, each with its own integrity, performance and purpose. Large processing facilities make use of centralized control centers to operate their facilities. Their main objective is to ensure production is safe and responsible. Although monitoring functionality is available, it is often only looked at when a problem occurs. In most cases, after a sequence was initiated, such as closing of a valve on the autoclave via the DCS, there is an expectation that the equipment will perform as specified. Only 'condition monitoring' of the overall autoclave is performed (level percent, pressure, temperature, etc.) to ensure the unit is stable. Therefore, the status or actual duration of specific equipment to perform its function can be overlooked unless the functionality of alarms or interlocks alert the operator. Unfortunately, alarms are sometimes easily overlooked by the operator.

By sharing operational data with MOGAS, not only is better insight gained into the valve exposure, but it also adds value to the end user. For example, at this particular site if an actuation stroke malfunction was left unnoticed, it could:

- potentially damage more than just the typical replaceable valve parts. Valve repairs are approximately three times more expensive than parts replacement.
- increase safety risks because of a breached or 'holed' valve.
- create additional challenges to pressurize the autoclave and maintain temperature in the discharge line because a valve did not fully reach the end stops.
- shut down an autoclave well before the intended shut down date causing significant production losses. The hourly revenue potential from the extraction of valuable metals (predominantly gold and silver) roughly amount to $127,000 per hour per autoclave. Stopping production to shut down the autoclave can take approximately 10 to 16 hours before work on the unit can commence safely. The variable hours associated in performing the scope of work adds another 10 to 18 hours to start up. The cumulative hours and financial losses associated with production are self-explanatory.

Conclusion

Technology has provided a new platform for pro-active monitoring of various assets in the end user's process facility. MOGAS uses valve monitoring at various autoclave sites globally for performance tracking and development of the isolation valve product line.

Because MOGAS takes a systems approach to verifying valve exposure and performance (valve monitoring), the 'big data' can identify issues with other equipment in the system. As seen in the MOGAS trial, pro-active monitoring facilitated further faultfinding, and rectified problems before significant financial losses were sustained.

An end user / MOGAS partnership realized significant value for both parties, allowing the end user to focus on production, while MOGAS provided in-depth monitoring of the installed valves. As IIoT grows, the monthly data dump becomes real time monitoring with preventive maintenance and condition-based monitoring. All combined, it takes customer uptime to a new level of reliability.