

Partial valve stroke testing enters new domain

By Bert Knegtering

Trends in the marketplace show an increasing demand for partial valve stroke testing (PVST) techniques. The underlying cause for this trend is due partly to their realization that they can save money by automated online PVST and partly to new safety standards pushing the industry to implement a minimum level of automated online fault diagnostic coverage. Safety PLC-based systems appear to play a central role concerning initiating, registering, and responding to PVST, where other solutions may use non-safety-related equipment.

PVST is an emerging concept to automatically increase the performance of Safety Instrumented Systems. PVST allows us to automatically test safety-related valves, like ESD valves and shut-off valves, with concern for failure modes related to valves sticking and slowing down operation.

A substantial amount of safety valves applied in process installation only see use in case of an out-of-control process. We usually only activate these dedicated safety valves once or a few times during their entire lifetime. Some safety valves will never need to come to action. Because of the importance of reliable operation of these valves in case of such an out-of-control process, periodic tests will reveal possible failures. Due to the rare moments when valve operates, one of the most likely failure mode occurrences is valve sticking. Physical influences may lead to erosion, corrosion, or pollution, which obstruct the valve to move and correctly close or open. During periodic off-line proof tests, these failure modes can reveal themselves, but because you can usually only do such off-line tests during a complete unit or plant shut-down, you only do them once per year or every couple of years.

Imagine the impact of valve sticking in combination with the low-test frequency on the reliable operation of the valve. At the moment the valve does not function anymore, the failure will reside in the valve until the next off-line test. The longer the time span until this test, the higher the probability of a demand on the valve due to an out-of-control process. As a result, the global reliability performance depends on two aspects. First, the mean time to failure due to corrosion and pollution, and second, the time it takes to detect and resolve this failure.

This testing partly concerns the test of the valve. It tests whether it is sticking at its

defined normal position or whether it is not sticking and still able to move.


PVST does not cover failures related to 100% operation, fully closing or fully opening, because testing against such failure modes normally results in an undesired process upset or shutdown. As in most cases, the most dominant failure mode appears to be sticking of a valve at its normal position. We consider PVST to contribute to detecting this type of failure and resolving it quickly. The reliability of the valve will therefore increase.

Based on a number of valve related reliability influencing parameters, we can calculate the Probability of Failure on Demand (PFD) value using IEC 61508 (part 6 annex B) equations. The PFD of the valve will increase over time in the absence of any tests or repairs. Therefore, we should make a distinction between the momentary PFD or PFD and the average PFD with regard to a predefined time period, such as the off-line proof test interval.

As valve end users are more interested in the reliability performance of a valve for a particular period of time, we consider the PFD average value to be the most important performance indicator. The diagnostic coverage (DC) is one of the parameters that strongly influence the PFD average value.

Technical solutions

After investigating the current marketplace of PVST solutions and products, we've observed about 12 different types of technical solutions or products various instrumentation vendors offer. Characteristics include features such as the application of limit switches, valve positioners, and jammers.

We select an available technical solution depending on the typical application and the most dominant failure modes PVST covers. Criteria, such as the inclusion of the solenoid, the actuator, valve leakage internally and externally, travel time requirements, and so on, will result in how we select one of those techniques. Measurement based on air pressure, valve stem position, and temperature will determine whether this technique is adequate. For each practical problem where PVST is considered to add value, you'll want to investigate the best technique. 

Behind the byline

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