Increasing safety

Combining partial stroke testing and solenoid valve testing

Many valves are used very rarely in practice, such as safety valves, which only have to open or close in an emergency. Their friction may increase in the course of time, especially the initial break-off force or torque of linear and rotary actuators respectively as a result of corrosion or increasing encrustation of the plug stem. The consequence is that the valves often block when they are required in an emergency situation. This article provides possible solutions to this problem.

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Automated Functional Safety

Wherever hazardous substances are used in the process industry or critical reactions occur, safety equipment ensures that risks are minimized. In safety chains, valves are those components with the highest risk of failing because, as simple shut-off devices, they remain, during normal operation, in the same position and are subjected to constant contact with the fluid that is flowing through them.

Many of these safety shutdown valves will never be operated during normal plant operation, so in the course of time the stiction will increase as a result of corrosion or a build-up of deposits on the shaft and the internal fittings. The breakaway torque for rotary valves and the breakaway force for linear valves can be multiplied. This increases the risk that the safety shutdown valve fails to operate, when it is actually required in an emergency. Until now, checking and verification of the functionality of these valves was costly: The safety valves had to be subjected to an annual inspection on site; this often meant that the valve had to be removed for inspection, usually in a workshop.

Fig. 1: Corrosion on a shaft of a valve

How can these inspection intervals be extended?

The solution to the problem is a valve test procedure that can be performed online during normal operation: The Partial Stroke Test (PST) supports functional testing of valves without the need to remove them from the plant. With the PST process, the respective valve is moved between 5 to 15 percent with the equipment running. The procedure supports online diagnosis of the actuators and reduces the probability of failure on demand (PFD). This allows the annual test intervals to be extended and the outlay and costs to be reduced due to the reduction in maintenance work and downtime. This procedure does not affect normal operation because the disturbance to the process is so small that it is negligible, but it does prove that the valve can move and there is another positive effect: Any deposit build-up is removed and the valve is then "free" again.

Partial stroke test with intelligent positioner

The intelligent positioner Sipart PS2 already provides comprehensive valve diagnostics. It reliably detects sluggishness, pneumatic leakages, wear of valve cones or seats, stick slip friction, etc. The "partial stroke test" function is also integrated into the positioner. It can be triggered locally, using a discrete signal, via a Simatic Process Device Manager (PDM) or also cyclically. The saved reference response time for the valve is compared to the current response time. A maintenance requirement is signalled in a 3-level alarm concept, in accordance with Namur recommendation NE107, clearly and understandably on the local display or in the process control system. Thanks to extended diagnostic possibilities, the positioner supplies a high-resolution PST response curve, which can be visualized using Simatic PDM and compared with a reference curve, stored earlier.

Testing of the solenoid valve is also necessary

Safety valves are usually controlled using solenoid valves in the same manner as many other Open/Close block valves. Since these

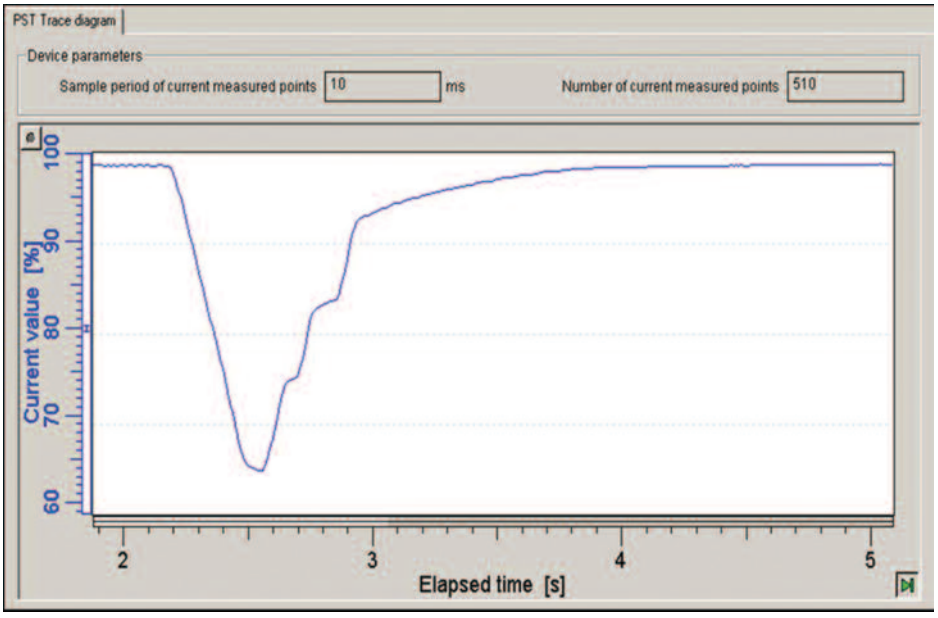


Fig. 2: High resolution PST response curve

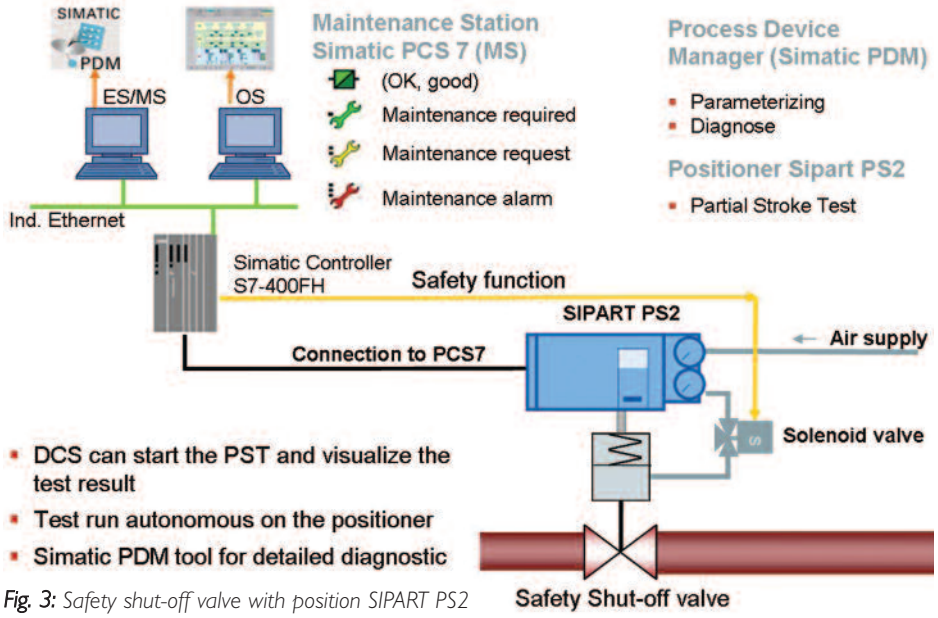


Fig. 3: Safety shut-off valve with position SIPART PS2

solenoid valves are only switched in an emergency, they also tend to "stick", i.e. their switching function can fail following a sufficient time in a static state. They must therefore also be subjected to a function test. This can, however, be problematic because the solenoid valves do not have read back functions. The response of the safety shutdown valve, whose function was verified beforehand by a partial stroke test, is therefore used and its movement is signalled to the control system via the feedback function of the positioner. Due to delays, such as the cycle times of the safety system, the re-opening command for the solenoid valve frequently arrives too late, that is when the safety valve has already closed too far so that a process upset is caused and a process shutdown occurs. To prevent this situation from occurring, Siemens offers several possible solutions with the SIPART PS2 positioner.

Stroke limiting with solenoid valve test by means of positioner and special solenoid valve (with switch device)

In this method, the partial stroke test is performed by the positioner as explained. The subsequent solenoid valve test is initiated by the control system via a discrete output when a switching device (e.g. relay) in the solenoid valve circuit interrupts the current flow. The actuator is depressurized and the safety shut-off valve moves in the direction required during a safety shutdown. It only travels until a contact in the positioner interrupts the activation circuit and then switches the relay, in the solenoid valve circuit, again without delay so that the solenoid valve opens again and the actuator re-pressurizes. Immediate interruption is possible due to the fact that the contact is mechanically directly linked to the position feedback shaft of the positioner. The value of the test stroke can be set using a simple rotating disk. When the switching position has been reached during travelling, the circuit is automatically closed again by the contact in the positioner, the relay opens the solenoid valve circuit and the procedure is repeated again. The safety shut-off valve permanently swings to and fro to the adjusted test stroke value. This ensures that the control system has sufficient time to detect this procedure. As soon as the movement to and fro is reliably detected by the control system, as verification of the solenoid valve function, the output signal for the test procedure is reset by the control system and the solenoid valve test is ended.

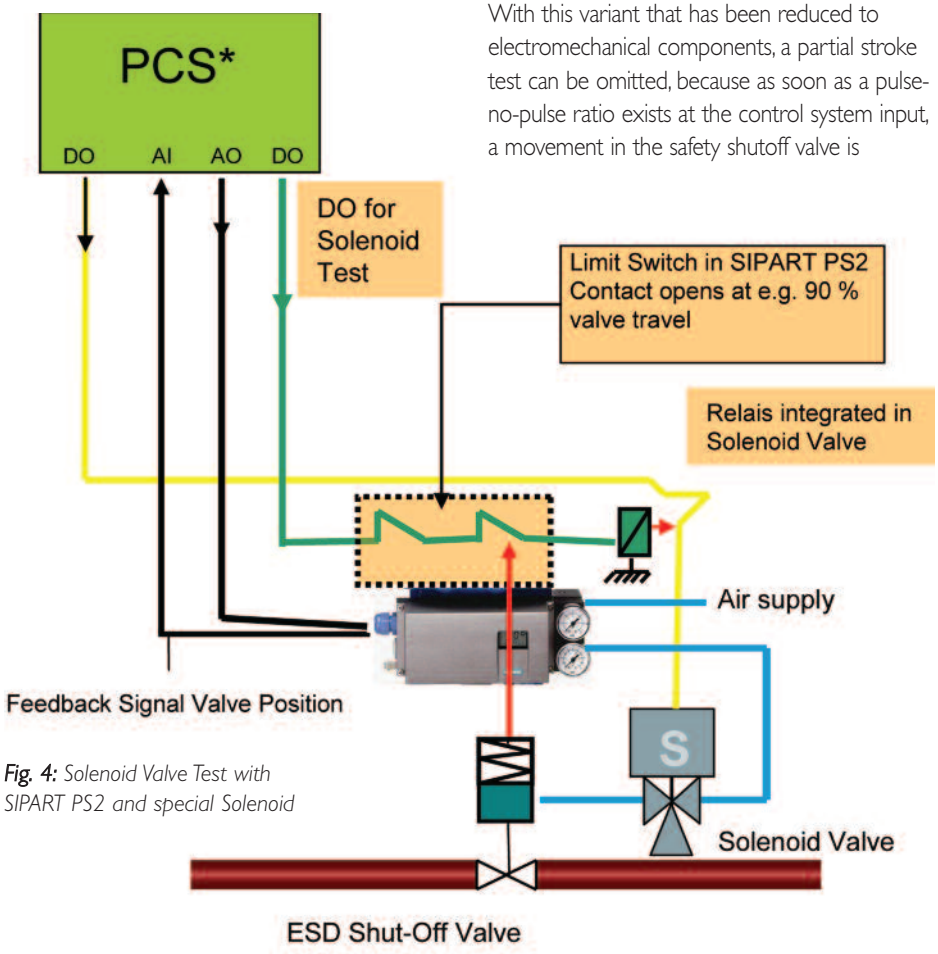


Fig. 4: Solenoid Valve Test with SIPART PS2 and special Solenoid

Switchbox' for solenoid valve test dispenses

In accordance with the same solenoid valve test principle as described above and with the same disconnection contact(s) as well as the contact arrangement in the solenoid valve, a solenoid valve test can be performed without the need to connect a positioner. Only the disconnector contacts that are connected to the check back shaft will be used in the positioner housing; the pneumatic function block as well as all the electronics can be omitted, because they are not required for a pure solenoid valve test. The control system is then solely responsible for evaluating the test to determine whether the solenoid valve is functional or not, which for example can evaluate the pulse-no-pulse ratio resulting from the movement to and fro.
With this variant that has been reduced to electromechanical components, a partial stroke test can be omitted, because as soon as a pulse-no-pulse ratio exists at the control system input, a movement in the safety shutoff valve is

detected with high probability, since only its actuator could have moved the disconnector contacts in the switchbox. The correct functioning of the control valve as well as that of the solenoid valve has then been successfully verified. If a pulse/no-pulse ratio does not establish itself, one of the two components is definitely defective. It cannot, however, be determined simply from the lack of a signal whether the control valve or the solenoid valve is defective. A defect in the solenoid valve, actuator and control valve assembly has definitely been detected, so this shutoff function will not be available in the event of a fault. A closer inspection on site can clarify the cause.

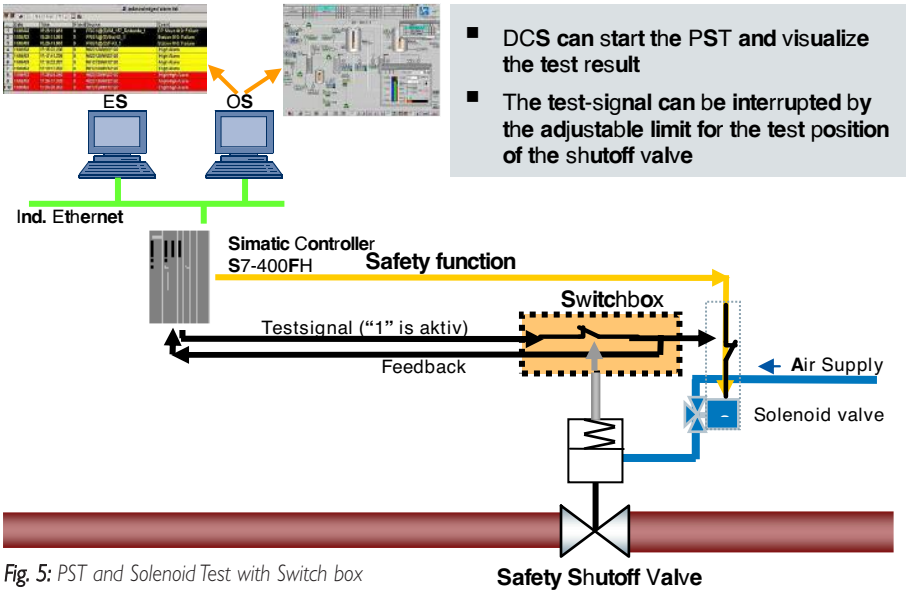
A compact solution

Using Sipart PS2 as an "intelligent solenoid valve" is a simple and compact solution with little overhead but considerable benefits for the plant operator.

Why is this?

The intelligent positioner Sipart PS2 is certified in accordance with SIL 2 for reliable depressurizing of the actuator chamber of the final control element. The intelligent positioner Sipart PS2 has been certified to IEC 61508/61511 to meet the functional safety requirements of SIL 2.It can therefore operate in place of a solenoid valve with a supply voltage of, for example, 24 V. Since it is equipped with all the available diagnostic functions, it can also perform a partial stroke test at regular intervals. An additional device does not have to be mounted on the actuator, because Sipart PS2 functions both as solenoid valve and PST execution device. The solenoid valve test can also be omitted because the positioner verifies the function of its pneumatic output block with every output step change at, for example, the 98 % position. This function combination only requires the 24 V signal line that is necessary for the solenoid valve. It also supplies the PST circuit with the necessary auxiliary power, so as is often the case today, only one two-wire cable runs into the field; this is a significant financial benefit particularly when solenoid valves in existing plants are replaced. The PSTs are started and evaluated by the positioner itself, cyclically and autonomously. The test cycle interval can be set to any integer value between 1 and 365 days according to the requirements of the application.

If the user can supply an additional two-wire cable, a user-friendly communication (e.g. by means of HART) can be set up for operator control and monitoring of the positioner. Then additional tests are also possible within or outside the cycle intervals. An 'intelligent solenoid valve' can also be easily implemented with Profibus PA or Foundation Fieldbus.



- DCS can start the PST and visualize the test result
- The test-signal can be interrupted by the adjustable limit for the test position of the shutoff valve

Fig. 5: PST and Solenoid Test with Switch box

Summary

Using a suitable combination of partial stroke tests and solenoid valve tests, the reliability of both the safety shutdown valve and the initiating solenoid valve can be significantly increased so that maintenance intervals can be decreased. With the Sipart PS2 positioners from Siemens, suitable solutions are offered that can be implemented with a special solenoid valve with an integrated switch device as well as by using the positioner as an 'intelligent solenoid valve'.

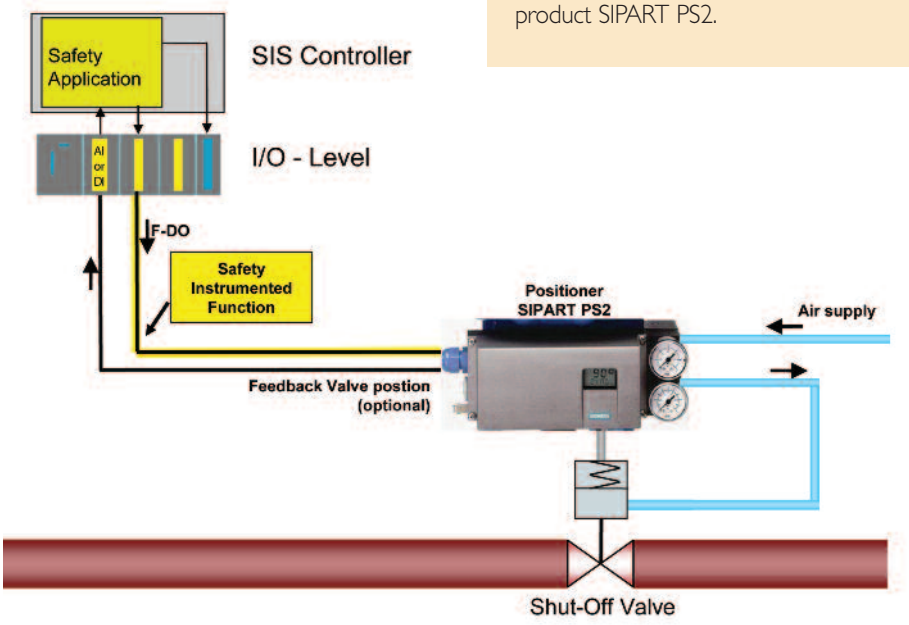


Fig. 6: The "Intelligent Solenoid Valve" performs both in one device: Partial Stroke Test and Safety Shut-Off function

About the author

Mr Klaus-Peter Heer works as Product Manager and is also responsible for the marketing of intelligent valve positioners within the Sensors & Communications section of SIEMENS Industry Sector, Division Industry Automation. He works for SIEMENS since 1977 after having studied Electrical Engineering in Aachen and Karlsruhe. Klaus-Peter Heer conceived the first generation smart positioner SIPART PS as well as the follower product SIPART PS2.