Solenoid valves with diaphragms

Safety in process automation

Pneumatic control valves are used to shut off or open pipelines in chemical and process plants. Solenoid valves are the interface between the electric control level and the pneumatic actuators for automated valves. Apart from explosion protection, functional safety is becoming more and more important.

Schematic drawing of a solenoid valve with a flapper/nozzle system and a diaphragm

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Solenoid valves with diaphragms provide high reliability in hazardous areas and safety instrumented systems
Plant safety has always played a major role in process automation. The European Directive 94/9/EC (Atex 100a) stipulates the fundamental safety specifications for the design of explosion-protected devices. A notified body must issue an EC type examination certificate to verify that the device meets the safety requirements.

The international IEC 61508 standard (functional safety) and the standards derived from it, namely IEC 61511 (functional safety for the process industry) and ISO 13849 (machinery safety), describe a procedure for quantifying the probability of failure by assessing the risk and allow the requirements for safety equipment to be determined. The safety integrity level (SIL) and the performance level (PL) for safety equipment are established by a test laboratory and verified in a certificate.

Safety-instrumented systems

Solenoid valves with diaphragms are the preferred option in safety-instrumented systems. Samsomatic solenoid valves with the “intrinsic safety” (Ex i) or “flameproof enclosure” (Ex d) type of protection ensure high reliability in hazardous areas and can be installed in safety-instrumented systems for requirements up to SIL3 (IEC 61511) or SIL4 (IEC 61508) as well as PL e (ISO 13849).

The proven-in-use combination of a flapper/nozzle system and diaphragm has decisive benefits: efficient switching even after remaining static for long periods of time, switching behaviour independent of the mounting position, low power consumption and a wide ambient temperature range. All solenoid valves are subjected to on-demand function and leak tests to minimise the probability of failure.

Functional description

The solenoid valves consist of an electropneumatic binary converter with a flapper/nozzle system and a booster valve with diaphragm. The air supply for the electropneumatic binary converter is routed internally using a reversible seal through supply air connection 1 or externally through connection 9. The pressure reducer reduces the supply air pressure to 1.4 bar. In the idle position, the flapper is lifted off the outlet nozzle by a spring. This causes a pressure lower than the activation pressure of the booster valve to build up in the pressure divider, which consists of a restrictor and an outlet nozzle. The supply air flows through the open outlet nozzle and purges the electronics compartment. The slight positive pressure prevents moisture from entering the device and thus inhibits corrosion.

When the solenoid coil is energised by a binary electrical signal, the outlet nozzle is closed by the flapper against the force of the spring. This causes the pressure in the pressure divider to rise above the activation pressure of the booster valve, switching it to the operating position. The supply air flows through connection 1 to the output port 2, activating the actuator. When the solenoid coil is de-energised, the booster valve is switched back to the idle position by the return spring and the output port 2 is closed.

Redundancy plate for fail-safe action

To achieve better reliability and possibly also a higher level of safety (SIL or PL) in safety-instrumented systems, the solenoid valves must be designed in a redundant configuration. In this way, if one solenoid valve fails, the fail-safe action of the actuator is still guaranteed by a second valve. The solenoid valves are hooked up either in series or in parallel depending on the required fail-safe action, namely to vent the actuator or to fill it with air. A redundancy plate allows series or parallel connections of two solenoid valves without any additional hook-up. The solenoid valves are mounted to the redundancy plate using Namur interfaces (VDI/VDE 3845). This plate can be directly attached to rotary actuators via a third Namur interface. An additional adapter plate also allows the valves to be hooked up with threaded connections or mounted to linear actuators with a Namur rib (IEC 60534-6).

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