Tech Sheet #CVR 405

Valve Actuator Fail Action Using Air Supply Regulators

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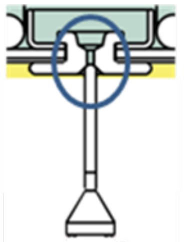
Introduction

There are many applications using what the industry calls an “airset”, a special type of filter and regulator combination. An airset can be defined as a small pressure regulator that supplies air pressure for pneumatically controlled valves, actuators, and instrumentation. The pressure regulators come with a variety of options including internal relief valves, gauges, high and low temp constructions, and even corrosion resistant constructions.

This paper focuses on two important characteristics of these airsets. First is the “air bleed”, which can impact operating cost, safety, and the environment. Second is the action of the airset when the air supply is removed. It is vital for the user to understand what the airset will do, and also, how and when it effects the position of the main valve. There are various designs available in the marketplace that offer different responses.

Internal Relief Valve Designs

Most of the airset regulators are equipped with internal relief valves (IRVs). These relief valves provide some overpressure protection against downstream leakage through the regulator’s main valve plug and orifice. If a leak occurs, the main diaphragm travels upward against the main spring and also against an IRV spring. When the pressure rises above the regulator’s setpoint, this opens the IRV seat to exhaust the higher downstream pressure past the diaphragm assembly and through the regulator vent to the atmosphere, protecting the downstream system to a safe but elevated outlet pressure. The IRV can protect instruments and actuators from experiencing pressures that could be higher than their maximum pressure ratings, preventing damage.


Leaking IRV seat

Early designs of many airsets allowed some leakage past the IRV seating area, so air was always being bled through the atmospheric vent. The actual seating area was made with a harder elastomeric seat that would not seal completely. In some designs, the stems could be out of alignment causing additional IRV shut off problems also. In many cases this did not matter, but as energy became more expensive, many operations figured out they were compressing a lot of air that was being wasted through leaks to atmosphere. When used in natural gas production applications, compressed air was not available and since natural gas was abundant, that became the source fluid for instruments and actuators. The problem is, now you have gas leaking all around a gas production facility and it would only be compounded by the amount of control devices in the system. With the advent of a green technology focus, IRVs that shut off tight became a necessity to reduce greenhouse gas emissions.

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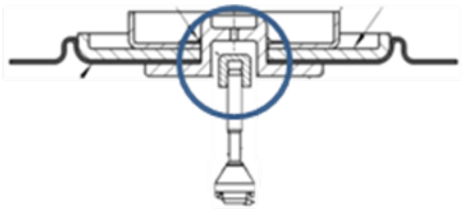

Bubble tight IRV seat

A call for a new improved IRV seat was required, which, in some products, has led to a redesign of the entire IRV. A softer elastomeric material was used and the stem design had to incorporate a feature so it would prevent misalignment. Most of the North American natural gas industry use IRVs on every residential and many commercial regulating meter sets, where zero leakage is an absolute requirement. This technology was used in the development of many of the newer styles of airsets. The industry fixed the leaking IRV problem but created an entire new problem for valve automation facilities.

Achieving Actuator Failure Modes

These leaking airsets were utilized, and expected, for many decades in the valve industry, where users depended on the leaking IRV seat for control and automated on-off valve failure mode. Loss of supply air or gas would cause the airset to relieve, thus venting air from a spring opposed actuator. The main valve would then move in a reasonable time to the spring fail position, either open or closed. When the new airsets with the improved IRV seating technology came about, these applications no longer worked correctly during an upset condition. In many cases, users were unaware of this consequence of the airset leakage improvements.

In the airset and valve actuator schematic below shows an example application, for discussion purposes only, of an airset supplying an actuator with air opposing a spring to keep it open or closed. When the shutdown controller opens the 3 way solenoid, it dumps the air pressure between the solenoid valve and the airset to atmosphere. Upon the loss of inlet air pressure, the older style airset would bleed the actuator pressure to atmosphere through the leaking IRV. The time would vary by the airset's design and its actual leakage rate. The main valve would fail to the intended spring position.

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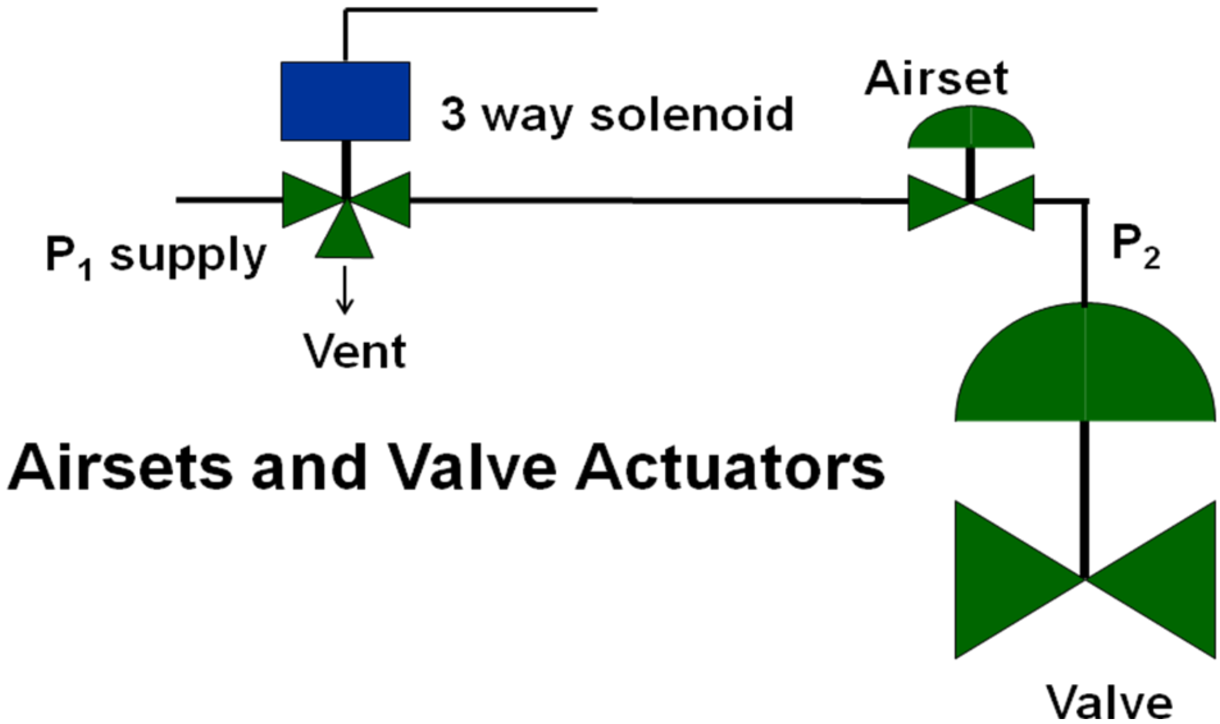

The new technology no longer worked in this application because its bubble tight IRV trapped the pressure in the actuator and prevented it from escaping to atmosphere. There were a couple of fixes to correct this problem. The first was to install a fixed bleed in the downstream side of the regulator. Many times this would be as easy as installing a pipe tee in a gauge port with a fixed bleed orifice in the spare NPT connection. The problem with this is, you are constantly bleeding pressure to atmosphere and losing the benefits of the bubble tight IRV technology.

A second possibility is using a differential relief valve or check valve across the inlet to outlet. In the event the outlet pressure exceeded the inlet pressure by a certain amount it would open and discharge the downstream system into the inlet side. This would give you the benefits of the leak free IRV technology and also the safety that the system would close upon a failure. Some manufacturers included this differential relief valve within the airset body eliminating extra tubing in the piping system.

The example in the airset and valve actuator schematic is for illustration and discussion purposes only. Normally the solenoid is downstream of the airset, and the venting capacity is through the solenoid. If this were a true ESD (Emergency Shutdown) application per IEC 61511, that should certainly be the case. And a no-bleed airset should definitely be used to prevent or delay spurious trips due to air loss. Trip of an ESD valve should only happen upon "true demand" from the Safety Controller.

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In more common cases, there may or may not be a solenoid, but users have grown to expect that the main air valve will fail to the spring position within a required time frame, on loss of air to the airset. With some new regulators, that may not happen. The purpose of the default spring action may be defeated without proper considerations.

These "lossless" types of airsets do have technology features that can save money in many applications, so when selecting a pressure regulator you may want to call up your local regulator expert as they are not all the same.