REGULATOR BEST PRACTICES

EMERSON™

Regulator Best Practices

SIZING AND SELECTION

Spring Selection

- If two or more available springs have published pressure ranges that include the desired pressure setting, use the spring with the lower range for better accuracy.
- The full advertised range of a spring can be used without sacrificing performance or spring life.

Sizing Guidelines

- Do not oversize regulators. Pick the smallest regulator and orifice that will handle the maximum flow requirement.
- Regulator body size should not be larger than the pipe size. The regulator body is often smaller than the pipe size.
- Regulating C_g (coefficient of flow) can only be used for calculating flow capacities on pilot-operated regulators. Use capacity tables or flow charts for determining a direct-operated regulator's capacity.
- When sizing direct-operated regulators, use interpolation for application pressures differing from the values in the capacity tables. For best results, use data from within the same spring range.
- Parallel runs can improve the turndown at stations with large differences between the maxim
- Restricted trims do not improve low flow control unless they reduce the flow area size when the valve plug is at low travel.

Pilot-operated Regulators

- Pilot-operated regulators require a pressure differential to operate the main valve. The published minimum differential requirement is the pressure needed to overcome the force from the main spring and fully open the main valve.
- A pilot-supply regulator can be an invaluable tool for achieving optimum performance with a pilot-operated regulator. It improves accuracy by eliminating inlet sensitivity, increases stability by reducing gain and improves closing speed-of-response.

Monitors and Slamshuts

- The intermediate piping in monitor and slamshut applications can reach full inlet pressure so the equipment must have sufficient pressure ratings
- Wide-open monitors and stand-alone slamshuts create a pressure drop, reducing the available pressure drop for sizing the working regulator. To determine the flowrate of the station, calculate the maximum pressure drop of the wide-open monitor or slamshut using the Non-critical Pressure Drop Sizing Equation. Use the remaining pressure differential to size the worker regulator.
- To maximize flow with working monitors, take roughly 35% of the pressure drop of the station in the first cut.

Reliefs

- The relief valve will not see the maximum regulator inlet pressure if properly sized; therefore, its pressure rating is often lower. The inlet pressure to the regulator is only relevant when determining the maximum flow through the regulator.
- Reliefs valves require a buildup over set pressure to fully open the valve. This build up should be considered when determining the correct relief valve for the application.

Speed of Response

- Speed of response, in order:
    - Direct-operated (a.k.a. self-operated)
    - Two-path pilot-operated
    - Unloading pilot-operated
    - Control valve

Note: Although direct-operated regulators give the fastest response, all types provide quick response.

- Fuel gas applications requiring pilot-operated regulators sometimes necessitate special regulator constructions to quicken opening and/or closing.

Liquid Service

- Due to differences in viscosity, regulators used in liquid service typically have larger pilot orifices and larger restrictors to improve speed-of-response.
- Cavitation is a function of pressure drop. Selecting a different regulator size will not affect cavitation.
- To avoid cavitation in pressure regulators, take large pressure drops in stages.

Noise

- Regulators with high flows and large pressure drops generate high aerodynamic noise. Regulator types with the most tortuous paths generate the greatest turbulence and therefore the highest noise. Noise attenuating trims are utilized to prevent initial noise attenuation by reducing turbulence, staging the pressure drop and lowering fluid velocities to subsonic levels.
- If noise attenuating trim is found insufficient, consider additional noise reduction methods such as working monitor setups to split the pressure drop, parallel runs to split the flow and reduce outlet velocity, increasing the outlet pipe thickness and/or swaging up the outlet piping to reduce outlet velocity. If these solutions are insufficient, path treatments such as acoustic insulation, enclosures, and noise barriers should be considered.

STATION DESIGN

Conditioning

- For every 15 psig / 1.0 bar d pressure differential across the regulator in gas service, expect approximately 1°F / 0.55 °C temperature decrease due to the natural refrigeration effect. Preheating is sometimes necessary to ensure the regulator's elastomers retain flexibility and to prevent freezing problems both inside and outside the pipe.

- To prevent plugging or damaging regulator components, ensure the process fluid is free of pipeline debris and contaminants using the appropriate equipment (filter, separator, strainer, etc.).

Overpressure Protection

- Adequate overpressure protection should be installed to protect employees, the public, the regulators, piping and downstream equipment.

- Frequently recommended 2-layer Overpressure protection configurations include:

    - 1st Stage: Monitor, 2nd Stage: Slamshut
    - 1st Stage: Monitor, 2nd Stage: Relief Valve
    - 1st Stage: Relief Valve, 2nd Stage: Slamshut

- Ensure that vent stacks for relief devices carry the relieving fluid away from maintenance activities and ignition sources.

Underpressure Protection

- To prevent a malfunctioning regulator from shutting down the gas feed, use a duplicate regulator run on standby. By setting the standby run at a slightly lower pressure than the primary run, the standby run will stay closed but prepared to open if the downstream pressure decreases for any reason.

Piping Setup

- Design downstream piping to accommodate proper control line placement. At least 6 pipe diameters of straight pipe are required, free of any turbulence generating equipment, such as elbows, pipe swages, regulators or block valves.

- When installing a working monitor station, include at least 10 pipe diameters between the upstream and downstream regulators. The upstream regulator requires adequate piping volume for stable control of intermediate pressure.

- Pipe bypasses or redundant regulator runs allow continued operation during maintenance.

- Piping supports prevent strain on equipment.

- Ensure the number of pressure taps is sufficient both for connecting regulator supply/control lines and for pressure gauges connections. Additional pressure taps are useful for troubleshooting, testing and future expansion or upgrades.

- A vent valve is required in the downstream piping to allow depressurization prior to maintenance.

- In liquid service, ensure that you have proper piping and regulator orientation to avoid trapping air in the actuator

Maintenance Considerations

- Allow sufficient clearance for maintenance and lifting. If the weight of the regulator requires lifting assistance, ensure accommodations are included for lifting equipment

Regulator Best Practices

INSTALLATION

Regulator Body

- Install the regulator so that the flow arrow on the regulator matches the flow direction of the process fluid.
- Regulators are not designed to align piping that is out-of-alignment. Using Cast Iron regulator bodies to force pipelines into alignment can result in damage.

Vents

- Diaphragms leak a small amount due to the migration of gas through elastomer diaphragms. To allow escape of this gas, be sure casing vents (where provided) remain open.
- Keep vents open. Do not use small diameter, long vent lines. As a rule of thumb, increase one nominal pipe size every 10 ft. / 3.1 m of vent line for units with internal relief and every 50 ft. / 15.2 m for units without internal relief (in both cases, an elbow is equivalent to 3 ft / 0.9 m of vent line).
- Vents should be pointed down to help avoid the accumulation of water condensation or other materials in the spring case.
- Burying regulators is not recommended. However, if you must, the vent should be protected from moisture and plugging.

Control Lines

- Make control line connections in a straight run of pipe at least 6 pipe diameters downstream of any area of turbulence, such as elbows, pipe swages, meters or block valves.
- Use control lines of equal or greater size than the control tap on the regulator. For every 10 feet of control line, increase the entire control line by one nominal pipe size. Small control lines cause a delayed response of the regulator, leading to an increased chance of instability. 3/8 in. / 9.5 mm OD tubing is the minimum recommended control line size.
- Valves used in the control line, should be full port valves. Needle valves or other restrictions may adversely affect speed-of-response.

STARTUP

- Pressurize the inlet to the regulator prior to outlet or regulator damage can occur. On pilot-operated regulators, avoid damage by first applying pressure to the piloting system through the inlet supply line. This method protects the regulator from reverse pressurization and slowly fills the pipe between the regulator and the outlet block valve.

Setpoints

- When adjusting setpoint, a direct-operated regulator should be flowing approximately 5% of the published capacity. Setting the regulator at other flow conditions will shift lockup and droop correspondingly.
- Do not make the setpoints of the regulator/monitor too close together. The monitor may try to take over if the setpoints are too close causing instability and reduced capacity. Set them at least one proportional band apart.
- When using relief valves, remember that the reseat point is lower than the start-to-bubble point. To avoid unwanted leakage, ensure the lockup of the regulator and the reseat of the relief valve do not overlap.
- Relief valve setpoint is defined as first bubble which occurs at the pilot in pilot-operated relief valves.

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