Regulator Selection and Performance

Evaluating Regulators for Reliability and Performance

The following criteria are used:

- **Pressure regulation as a function of flow.** All regulators have some delivery pressure drop with increased flow rate. The smaller the drop as flow is increased, the better the performance.
- **Pressure regulation as a function of inlet pressure.** As the inlet pressure source is reduced, regulator delivery pressure may either rise or fall depending upon the regulator design. In both cases this is known as regulator "droop." Two stage regulators generally provide better regulation under these circumstances.
- **"Lockup" of a regulator.** This is the difference in pressure between a flowing and non-flowing condition. If a regulator has its delivery pressure set while gas is flowing, and flow is suddenly stopped, a small rise in delivery pressure (lockup) will occur before the regulator's valve closes fully. The lower the lockup, the better the performance.
- **Seat leakage of the regulator.** This is the tendency of the regulator to leak across the seat, with the regulator valve knob closed fully (counter-clockwise) and high pressure on the inlet side. A low leakage value is preferred.
- **Leakage rate across the diaphragm or fittings on the regulator.** This value is normally measured using helium gas and a mass spectrometer or other type of helium detector. Regulators for specialty gas service may have published values of typical leakage rates either inboard (from the atmosphere into the regulator) or outboard (from inside the regulator to the atmosphere). For safety, it is important that this leak rate value be as low as possible in order to prevent possible contamination by ambient air and moisture or escape of hazardous gases.

Choosing a Regulator for a Particular Gas or System

Several important factors must be considered when choosing a regulator for a particular application:

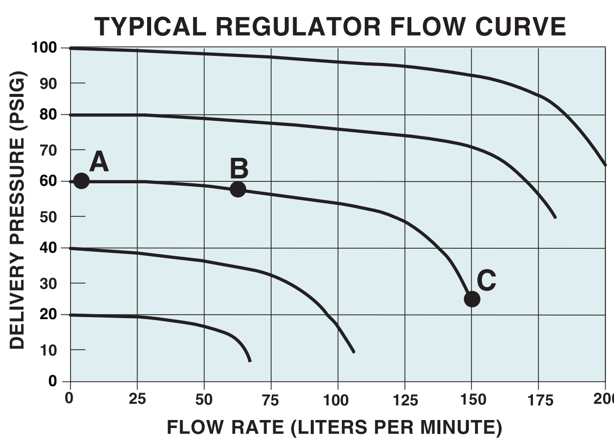
- **Gas pressure.** Some regulators are designed for lower pressures and should not be connected to sources of pressure greater than they are rated for. The inlet pressure gauge should be inspected for suitable range of inlet source pressure.
- **Regulator materials of construction.** Consideration should be given to the gas being used and the requirements of the system. Brass regulators are typically used with inert gases since brass is attacked by corrosive gases. Many regulators designed for controlling gases used in semiconductor processes are constructed of low tensile strength stainless steel (usually type 316 or 316L). This material displays good corrosion resistance and is not prone to hydrogen embrittlement problems. However, stainless steel can be corroded when exposed to some of the corrosive gases with small amounts of water present. For severe corrosive conditions, Monel or Hastelloy material should be used. Regulators may also be plated with corrosion resistant coatings when controlling some gases. Another important factor to consider is soft plastic material, or elastomers, used in regulators for seat and sealing surfaces. For example, some regulators use an elastomer called Viton which is a fluorocarbon. Viton is compatible with many gases, but gases such as ammonia will cause it to dissolve. When choosing a regulator for a particular gas, all internal regulator parts should be compatible with that gas under normal operating conditions.
- **Regulator cleaning prior to use.** Most regulators used in specialty gas applications are cleaned to very tight specifications to match the purity needs of the process. If oil or other combustible residue is left inside the regulator, spontaneous combustion may result when certain gases, such as oxygen, are introduced into the regulator.
- **Regulators should be used in a specific gas service, for maximum safety.** Once a regulator is used for a specific gas, it should not be used for any other gas unless it has been thoroughly cleaned, or the operator is absolutely sure that using the regulator in this condition presents no hazard. For example, an explosion could result if a regulator was used on an oxidizer and then placed in flammable gas service.

Always follow the manufacturer's instructions and warnings when installing, operating, purging, or shutting down a pressure regulator.

Reading Flow Curves

Flow Performance:

The flow properties of a pressure regulator are illustrated by the flow curve. The vertical axis indicates the delivery pressure at which the regulator is set and the horizontal axis indicates the gas flow that the regulator passes. The curves are made by setting the delivery pressure while there is no gas flow and then slowly opening the outlet valve downstream while measuring both the flow and the delivery pressure. Typically, as flow increases, delivery pressure drops. The portion of the curve to the far left is fairly flat and it is in this range that the regulator demonstrates a stable pressure regulation even though the flow is changing. For example, increasing the flow from point "A" to point "B" shows only a slight decrease in pressure. The portion of the curve to the right shows a rapid drop in pressure with increasing flow rate, indicating that the regulator valve seat is almost wide open. If flow is increased from point "B" to point "C", there is a large drop in pressure that is typical for all regulators.



For more information on regulators and Matheson's regulator product line, please order brochure BR-71, Matheson's Guide to Regulators.