



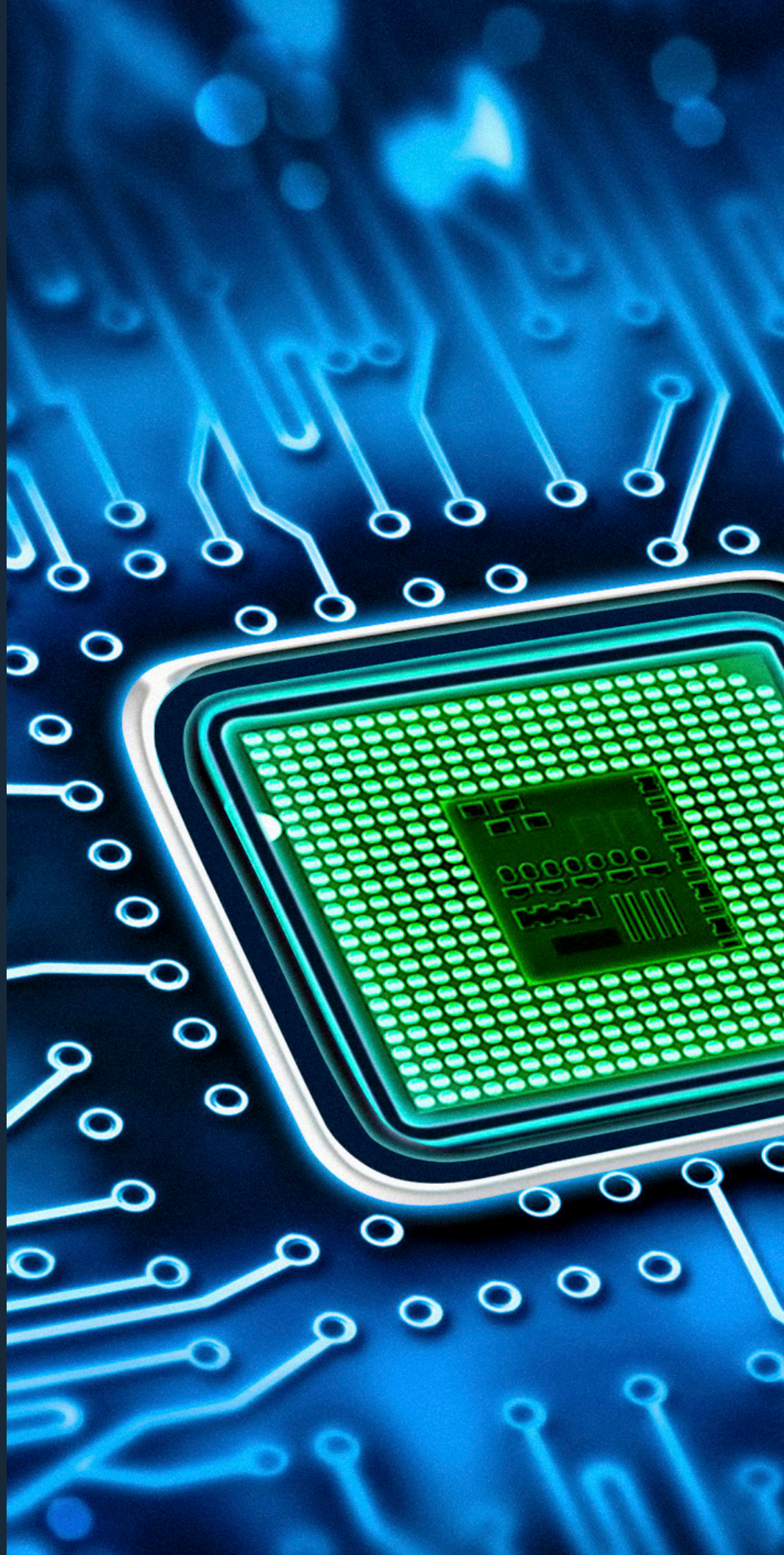
SEMICONDUCTOR REGULATOR INSIGHTS

Selecting the perfect regulator in
Semiconductor gas or fluid line systems



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HOW TO SELECT THE PERFECT REGULATOR

Understanding design parameters of pressure regulators in gas or fluid line systems

Pressure regulators are essential components in many industries, as they play an important role in the delivery of gases and fluids.

Device manufacturers tend to follow strict design standards and guidelines for safety, cleanliness, leak integrity and connection interface in order to cater specific products to different industries.

Therefore, it is crucial to find reliable brands that can meet the demands of the industry when searching for a pressure regulator. The next step is to find a regulator that fits the application - with manufacturers typically offering an extensive range of sizes, this process may take some time.

However, by following the aforementioned design standards and guidelines, you can ensure the integrity of your regulator and the overall system will remain intact.

Choosing the right regulator can have critical positive consequences.

In this whitepaper we will help simplify your selection process by covering what factors to consider for your application.

- A more efficient system
- Improved performance
- Reduced troubleshooting
- Reduced safety hazards

What factors should you consider when selecting a regulator?

Pressure regulators are devices designed to control gas or fluid pressure. The ideal regulator for your system depends on your process and system requirements. Here are the key factors to consider when selecting a regulator:



- Inlet and outlet pressure
- Flow requirements
- System temperature
- System media
- End connections
- Tied vs. non-tied diaphragm

Inlet and outlet pressure

Knowing the upstream and downstream pressure requirements of your line or system sets the pressure envelope, narrowing down the field of regulators to choose from. Ensure you know the application's operating pressure range and maximum pressure for both the inlet and outlet.

Is your inlet pressure stable, or does it fluctuate?

Gas systems typically have two types of regulators 1) source regulator 2) downstream regulator.

Source regulators are connected to a gas cylinder. It will see inlet pressure decrease as the gas in the cylinder depletes. Whereas the pressure signal of a downstream regulator will be stable as it is fed by a regulator upstream.

Decreasing inlet pressure has an inverse effect on outlet pressure causing it to rise due to supply pressure effect (SPE).



Outlet Pressure (psig)

Set Pressure: 88.0

P1: 54

P2: 110.1

P3: 94.8

Inlet Pressure (psig)

Set Pressure: 1200

P1: 1700

P2: 875

P3: 1100

Figure 1 – Example of supply pressure effect. How changes to inlet pressure affect outlet pressure.

What is Supply Pressure Effect (SPE)?

The regulator's outlet pressure has an inverse response to the inlet pressure as a function of the internal force balance occurring in the regulator.

It is measured as a rate of change in outlet pressure per every 100 psi change in inlet pressure. The change between inlet and outlet pressure are inverse.

For example, if the SPE of the regulator is rated at 6.8psi/100psi, the outlet pressure will increase by a rate of 6.8 psi per 100 psi decrease of inlet pressure and vice versa.

The manufacturer will publish the SPE value of a regulator which should be considered when managing outlet pressure on systems with dynamic inlet pressure.

Outlet pressure

When selecting an outlet pressure range option for an application, a good rule of thumb is to select a suitable pressure range that is nearest to the application pressure.

It is inadvisable to select an outlet pressure range that is too far above what is needed because regulator performance will suffer and may be difficult to adjust to desired outlet pressure.

Each outlet pressure range is designed with a unique range spring providing the exact load & rate needed to achieve optimal pressure adjustment and flow characteristics.

A lower outlet pressure range option would have a "lighter" range spring, while a higher would have a "heavier" range spring. A lighter spring minimizes pressure drop and provides finer adjustment capability.

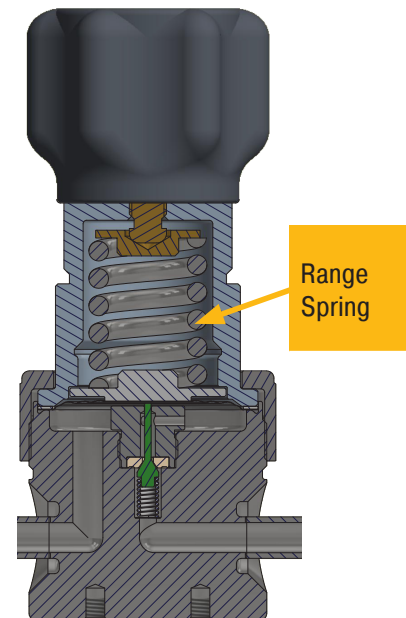


Figure 2 – The knob drives the range spring, controlling outlet pressure.

Flow requirements

The downstream flow demand determines the size regulator needed.

Key considerations:

1. Flow Demand - Knowing the downstream demand is important for selecting the size of regulator needed. If there are multiple downstream lines, it is good to know the operating flow range and the peak flow demand to ensure the regulator has the available flow capacity to support all conditions. An estimate of downstream flow demand can be made by summing the flow rates of all downstream devices.
2. With flow demands established, take the opportunity to reference a flow curve to ensure the flow demand is within the operating range of the regulator and that the outlet pressure drop is within an acceptable limit.
3. Flow options – Manufacturers often provide multiple flow options (i.e. high, medium, low flow) within a product series to accommodate a wide range of applications.
4. The published Cv of a regulator should be taken as a point of reference for selection and can work for a relative comparison. It is not indicative of a regulator's flow performance.

Unlike valves, regulators do not operate in a fully open state. Checking conditions against a flow curve is always recommended to verify if is correct for the application.

System temperature

Process gases can reach extremes in temperatures therefore it is vital to confirm the regulator can support the minimum and maximum operating temperatures of the application.

Materials of construction play a large role in a regulator's temperature ratings.

Although metals and alloys can make-up majority of components. Non-metallic materials such as plastic and rubber are used for critical components such as seats, seals and vibration dampening. Non-metallic materials have a more limited temperature rating than metals and alloys and exceeding the temperature ratings can cause serious safety hazards and costly downtime.

System media

Process gases are used based on specific characteristics in order to achieve an desired outcome. For example in semiconductor manufacturing, Fluorine-Based Gases and Chlorine-Based Gases are used to remove layers from the wafer.

These gases are highly corrosive and require specific materials of construction and surface treatments to ensure the safety, reliability and longevity of devices used to handle these gases. Surface treatments such as electropolish and passivation, in addition, to low surface finishes, enhances the corrosion resistance

of stainless steel. Seat materials are influenced by media as well. Regulator seats are typically constructed from a soft plastic or rubber material.

Knowing media compatibility will ensure the best seal material is chosen to avoid serious safety hazards and costly downtime.

Set Pressure / Set Flow: Initial regulator outlet conditions

Drop (Droop): Decrease in Outlet Pressure with increasing Flow

Cv: Flow capacity at wide open position

Operating Range: Optimal flow range, linear portion of the curve

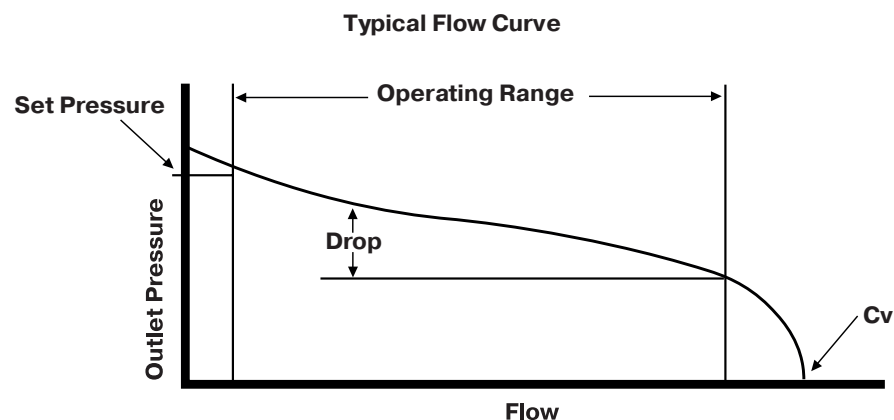


Figure 3 – Example of a typical pressure-reducing regulator flow curve.

End connections

End connection types are usually synonymous to industries and the means to provide the level of leak integrity needed.

For example, ultra-high purity regulators used for semiconductor processes commonly have welded face seal or tube-end connections due to more stringent leak requirements. Whereas regulators for general industries commonly use National Pipe Thread Tapered (NPT) connections.

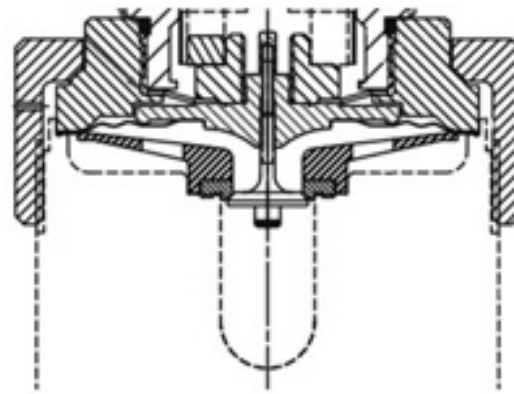
Tied vs. non-tied diaphragm

Tied diaphragm regulators physically connect the poppet to the diaphragm, resulting in a mechanically assisted positive shut-off in event of a seat leak. This is an added safety benefit to protect the downstream system especially for source regulators where the pressure difference between inlet and outlet can be great.

Parker Veriflo's SQ Series and SQ2Micro Series line of premium UHP regulators uses tied-diaphragm design to take cleanliness one step further by eliminating the poppet spring in the wetted flow path. With the absence of the poppet spring, the patented tied-diaphragm design eliminates entrapment points and surfaces where media can collect and dislodge potentially contaminating the system downstream.

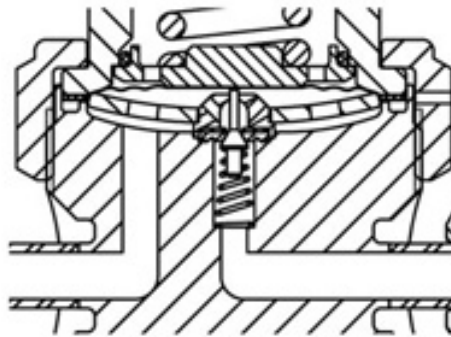
Other factors to consider:

- Material of construction
- Cleanliness
- Leak rate
- Sensitivity of regulator
- Flow curve



Tied

Figure 4 – Regulator cross-sections showing the absence of the poppet spring in tied diaphragm design, which minimizes components in the wetted flow path.



Non-tied

Figure 5 – Regulator cross-sections showing the non-tied diaphragm design

Conclusion

No matter what your application is, choosing the proper regulator is vital. Your regulator supplier can help with the selection process by providing pressure and flow requirements, sizing information, temperature ranges, and other essential information.

Sizing a regulator based on flow demand is critical in selecting the optimal regulator for your application.

Flow curves are a valuable resource

to ensure that your regulator will match your application for performance optimization and process optimization.

A regulator is not a shut-off device. Instead, a valve should be paired with the regulator for a proper shut off.

The better you understand your application's requirements, the more equipped you will be to make the right decision on a pressure-reducing regulator.



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