Your Guide to Pressure Regulator Selection

Making the right choice for the needs of your industrial fluid system

Swagelok

The Right Regulator Is Critical

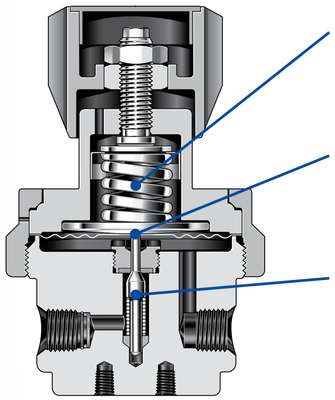
Pressure regulators play a crucial role in fluid handling and instrumentation systems, helping to maintain or control desired pressure and flow in response to system changes.

It is important to select the right regulator to keep your system operating as intended. The wrong choice can lead to inefficiency, poor performance, frequent troubleshooting, and potential safety hazards.

This guide will cover basics of regulator selection and function. Armed with the right information and knowing where to turn if you have additional questions, you will be prepared to make more informed choices for higher-performing systems.

How Regulators Work

Understanding a regulator’s functionality begins with familiarity of its component parts:



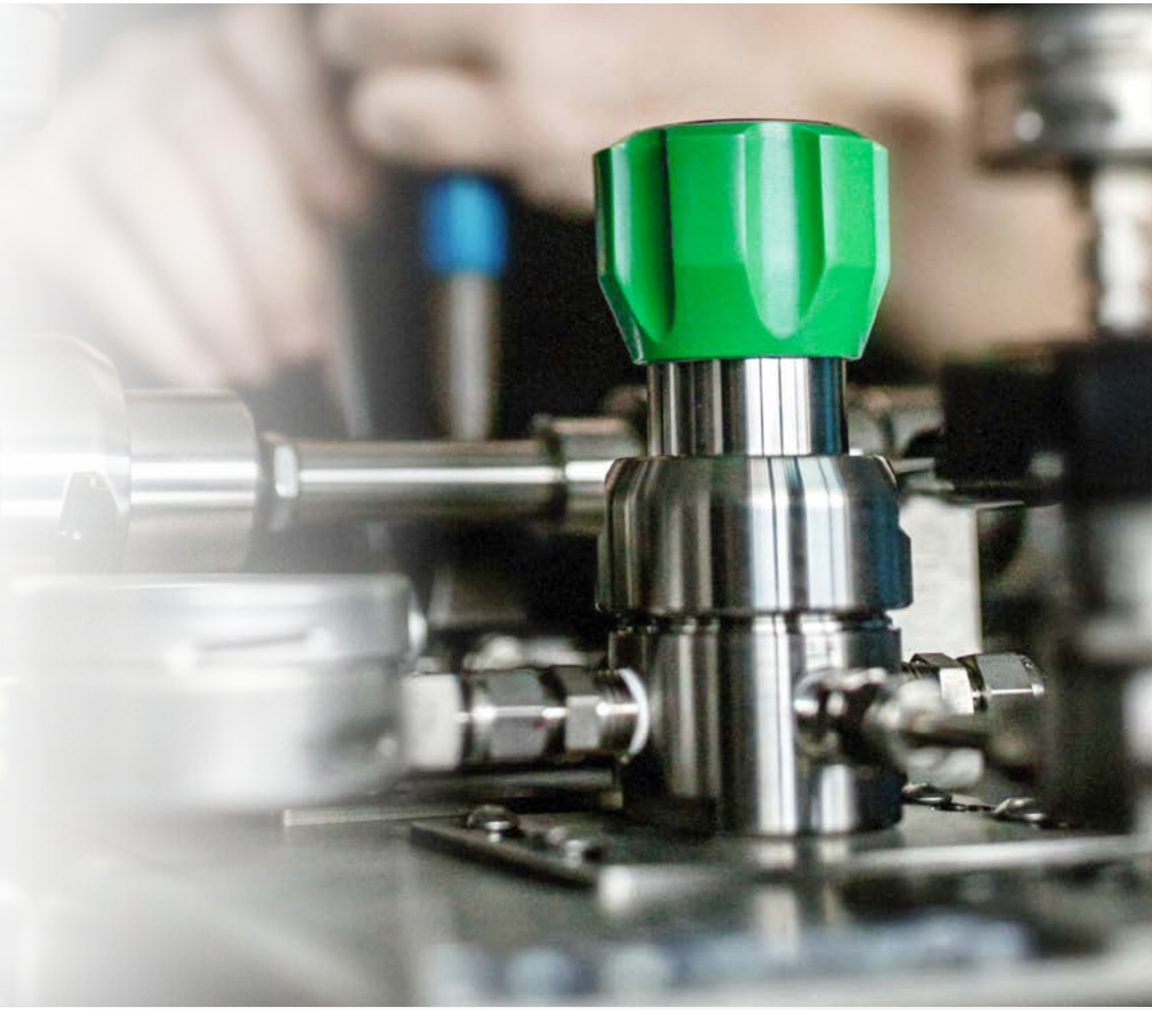
A loading element. Regulators may be spring-loaded or dome-loaded. The loading element applies a downward, balancing force on top of the diaphragm.

A sensing element, typically a diaphragm or piston. The sensing element allows the poppet to rise and fall in the seat, controlling inlet or outlet pressure.

A control element, including a seat and poppet. The seat contains pressure and prevents fluid from leaking to the opposite side of the regulator when flow is closed. Together with the seat, the poppet regulates pressure by maintaining a fine gap between the two while a system is flowing.

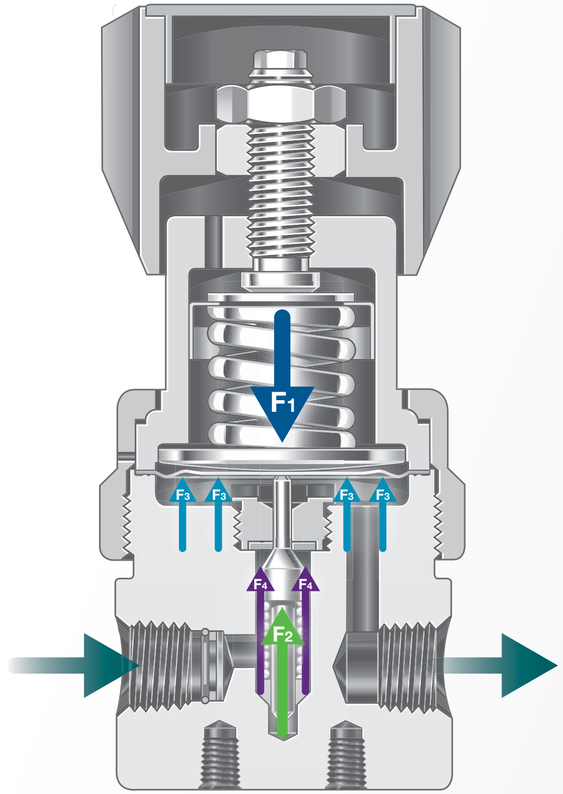
These elements work together to create the desired pressure control. The piston or diaphragm senses downstream (outlet) pressure. The sensing element finds balance with the set force from the loading element, which is adjusted by the user via a handle or other adjustment mechanism. The sensing element allows the poppet to move further from or closer to the seat to control the gap which regulates pressure.

These elements work together to remain in balance and achieve set pressure. If one changes, some other force must also change to restore balance.



Pressure-Reducing Regulators

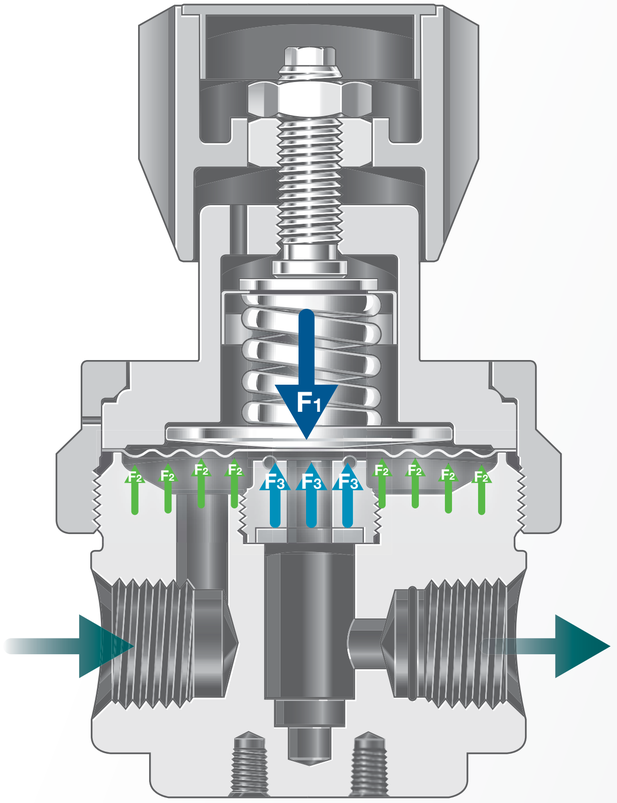
A pressure-reducing regulator decreases pressure and keeps it as constant as possible as inlet pressure and flow rate vary. Four different forces must be balanced. These include loading force **(F_1)**, inlet spring force **(F_2)**, outlet pressure force **(F_3)**, and inlet pressure force **(F_4)**. Total loading force must be equal to the combination of inlet spring force, outlet pressure force, and inlet pressure force.



$$F_1 = F_2 + F_3 + F_4$$

Back-Pressure Regulators

A back-pressure regulator keeps inlet pressure below a set pressure. It can either open when exposed to excess pressure or close when pressure drops below a desired level. These regulators must balance spring force **(F_1)**, inlet pressure force **(F_2)**, and outlet pressure force **(F_3)**, as shown. Here, the spring force must equal the combined force of the inlet pressure force and the outlet pressure force.



$$F_1 = F_2 + F_3$$

Five Steps to Regulator Success

Besides understanding regulator types and functions, choosing the right regulator for your system requires knowing how different operational factors influence regulator behavior.

At Swagelok, we have developed a **five-step process** you can follow to determine the best regulator for your needs. At the end of this guide, we will detail a few of our **regulator offerings** that can provide reliable service, all backed by service and support to ensure you make the right choice.

Start with Step 1.

Step 1:

Assess Your Process Conditions

Composition

The **composition** of your fluid (whether it is a liquid or a gas) can influence the required size of your regulator. For example, a regulator can handle a low-density gas at higher flows more readily than a high-density gas.

Pressure

Because your regulator is intended to control **pressure,** be sure it is appropriately rated for the maximum, minimum, and regularly anticipated pressures within your system. Pressure control ratings are demonstrated by a **regulator's flow curve**.

Temperature

Know your expected operating **temperature** and how pressure changes across the regulator may influence temperature. The Joule-Thomson effect can cause significant temperature fluctuations during pressure drop, for example.

Material Compatibility

Determine your regulator's **material compatibility** with your system media. Certain gases can cause damage to internal components, interfering with your regulator's operation.

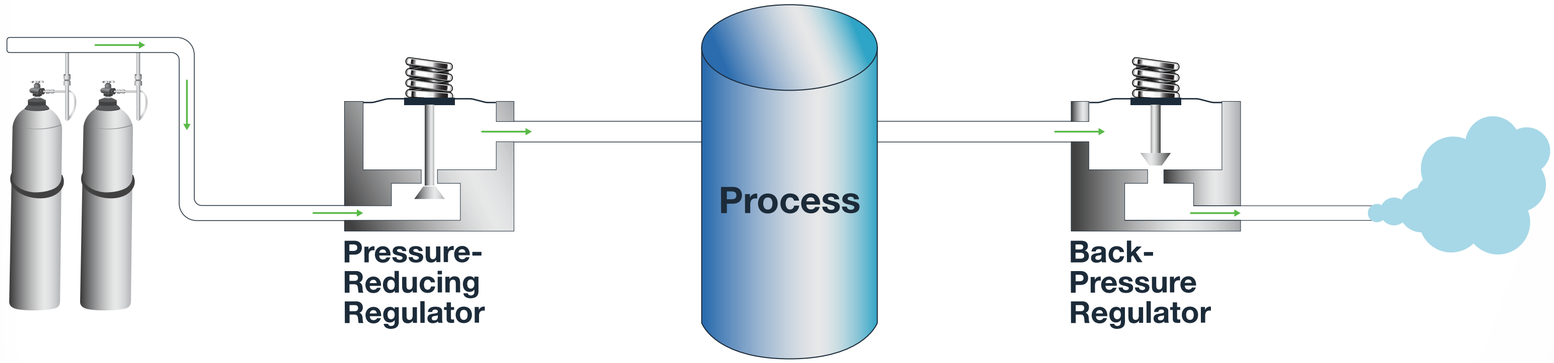
Move on to Step 2.

Want to read more about regulator selection?
Learn about **Swagelok regulator training**.

Step 2:

Determine What You Need to Control

Whether you need a pressure-reducing or back-pressure regulator depends on your process requirements:



If you need to reduce pressure from a high-pressure source before system media reaches the main process, a **pressure-reducing regulator** will be the correct choice.

If you need to control and maintain upstream pressure and prevent unwanted pressure increases, a **back-pressure regulator** is typically the right choice.

Used in the right context, these regulators can help you maintain desired pressures throughout your system.

Move on to Step 3.

Step 3:

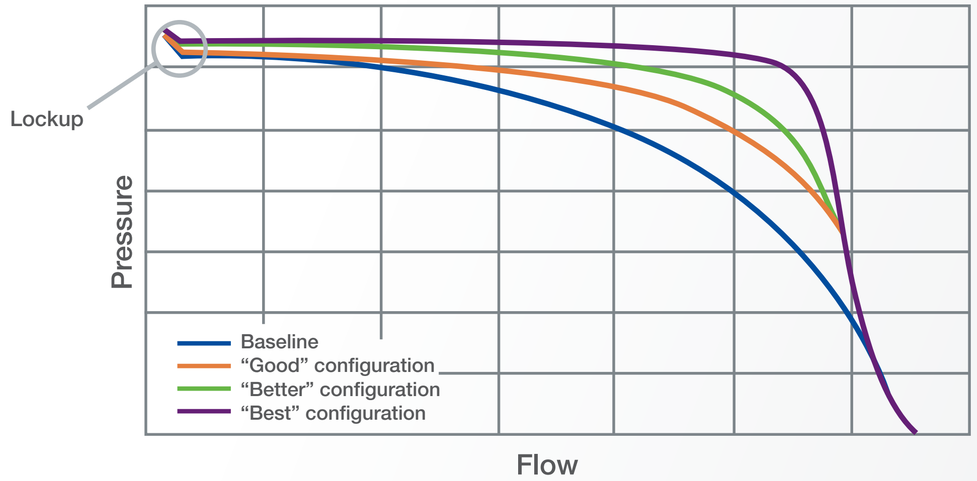
Get to Know Regulator Behaviors

Once installed, it is important to account for several commonly occurring operational behaviors.

Flow curve. The flow curve demonstrates a regulator's ability to maintain desired pressure as flow increases. The flattest part of the flow curve indicates where a regulator will perform best.

Lockup. Lockup refers to a pressure drop just above the set point that is required to shut the regulator off and stop flow. When flow is turned on, the flow curve will show a drop in pressure to the set point.

Droop. Droop occurs when flow requirements cause the regulator's poppet to open wider, eventually and necessarily leading to pressure loss. Droop is to be expected at certain flows with every regulator, but **maintaining a flow curve that is as flat as possible** before pressure drops off is ideal.



Supply pressure effect (SPE). SPE is a change in outlet pressure due to a change in inlet pressure. If inlet pressure decreases, there will be a smaller corresponding outlet pressure increase. Conversely, inlet pressure increases will lead to outlet pressure decreases. Though counterintuitive, system designers must account for this phenomenon when selecting their regulators. One effective way to mitigate SPE is to incorporate a two-stage pressure regulator into your system.

$$\Delta P(\text{outlet}) = \Delta P(\text{inlet}) \times SPE$$

This formula can be used to calculate outlet pressure variation, or SPE, for a given regulator.

Move to Step 4.

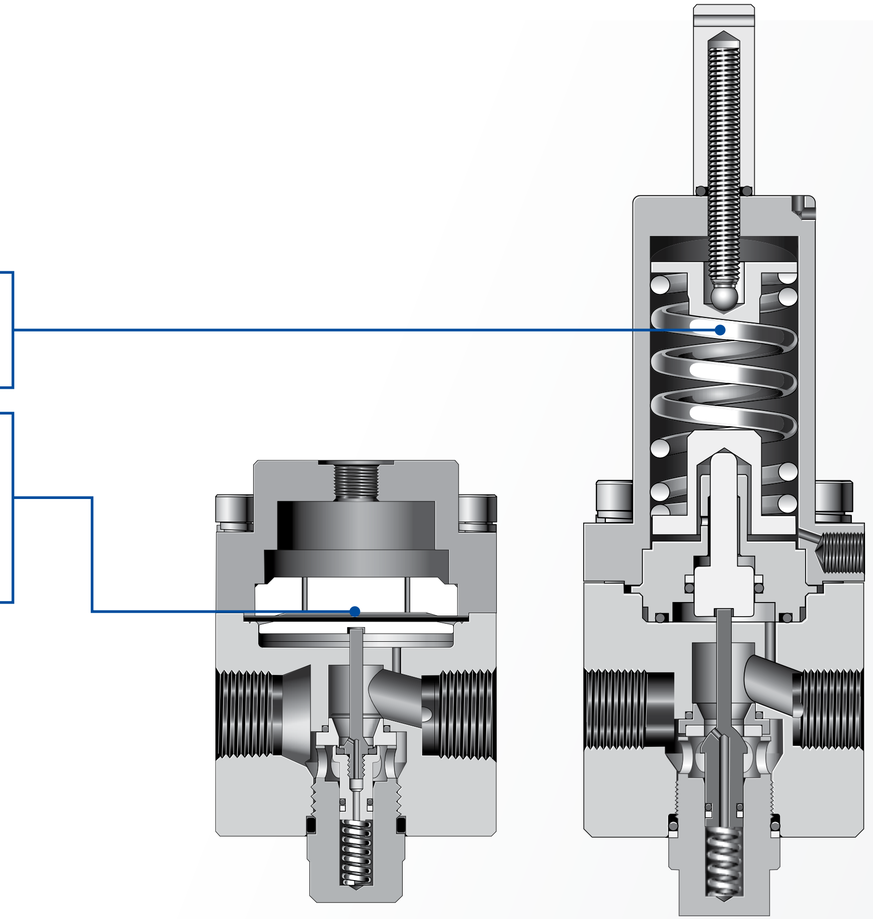
Step 4:

Identify the Appropriate Loading Element

A regulator's loading element provides a balancing force on top of the diaphragm or piston to control pressure. Two types are common:

Spring-loaded regulators are the most common. A spring applies force on the sensing element, controlling the downstream pressure. They are a reliable option for many **general-purpose applications.**

Dome-loaded regulators enable more dynamic pressure control. The loading force is controlled by a pressurized gas housed in a dome chamber. Gas flexes a diaphragm, which moves the poppet away from the orifice and controls the downstream pressure. They are well-suited for **applications where flow demands vary and precise pressure control is critical.**



No loading element can eliminate droop—depending on your system, some droop may be acceptable. When maintaining pressure where flow change is critical, more sophisticated setups incorporating feedback loops, pilot regulators, and other methods can help. When in doubt, consult with a regulator specialist.

Move to Step 5.

Step 5:
Follow Best Practices

Once you have selected and installed your regulator, properly maintaining it will help you maximize its performance.

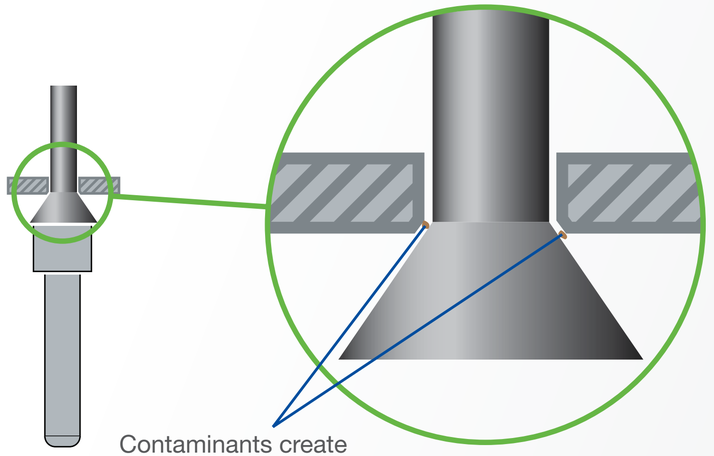
One issue that can arise is **creep**. Creep occurs when a contaminant creates a fine gap between the regulator's seat and poppet. This gap can prevent the poppet from creating a reliable seal, allowing media to flow to the low pressure side of the seat. System media will unintentionally flow across the seat, resulting in unwanted pressure increases downstream.

These measures can help mitigate creep:

Filtration. A good filter upstream of your regulator can help ensure that your regulator will only handle clean fluids.

Relief valves. A relief valve can be installed downstream of your regulator to help mitigate the effects if creep does occur.

Spare parts. Maintaining spare parts kits for your regulator can allow you to fix issues quickly, reducing downtime.



Ready to make your selection? Explore the available options and get assistance from **Swagelok specialists.**

Swagelok® Regulators

Swagelok manufactures regulators capable of handling a wide range of pressures, flows, and connection sizes and types. Plus, our **field engineers**, located at authorized Swagelok sales and service centers around the world, can help you identify the right configuration to maintain desired pressure and minimize droop in your systems.

Regulators by Type

We offer an extensive portfolio of regulators capable of safely and reliably controlling pressure across a wide range of flow rates in a variety of applications, giving you access to the regulators you need to achieve your goals.

Pressure-Reducing

Spring-Loaded

- Reduces and maintains downstream pressure
- Minimizes droop even when flow and pressures fluctuate

Dome-Loaded

- Minimizes droop by balancing outlet pressure with dome pressure
- Enables dynamic pressure control to provide more consistent downstream pressure as flow demands vary

Back-Pressure

Spring-Loaded

- Maintains upstream pressure control in analytical or process applications
- Protects sensitive equipment from costly damage
- Available in various styles based on your needs

Dome-Loaded

- Controls inlet or upstream pressure to protect sensitive equipment from damage
- Enables dynamic pressure control to provide more consistent upstream pressure as flow demands vary

Specialty

- Vaporizing regulators accommodate phase changes
- Automatic switching regulators ease the burden of manual gas changeovers
- Tank-blanketing regulators provide low pressure and high flow of an inert gas to the vapor space of a storage tank

Unsure about what you need? Swagelok advisors can help you find a configuration or subsystem that will maintain pressure and minimize droop or creep over a wide range of pressures and flows.

Process Regulators (RHPS Series)

RHPS series regulators are our process pressure regulators, designed to deliver the precise pressure control needed to help protect employees, equipment, and process output quality in a variety of industrial applications. These regulators provide reliable service in fluid systems up to 4 in. in diameter, even in the most challenging operating environments.

- Pressure-reducing models
- Back-pressure models
- Spring-, dome-, and air-loaded
- 1/4 to 4 in. end connections
- Working pressures up to 10 150 psig (700 bar)
- Temperatures from –49 to 176°F (–45 to 80°C)

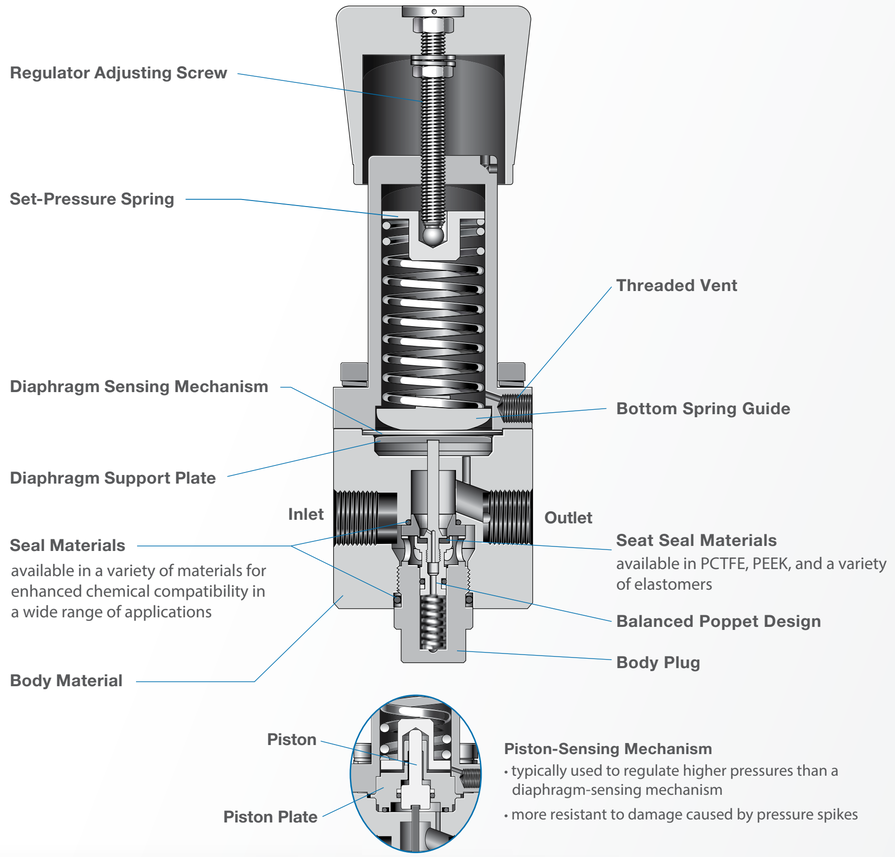
All RHPS series regulators are built to last under the most challenging process conditions.

- Regulator bodies are composed of 316L stainless steel, improving corrosion resistance
- Internal seals are available in a variety of materials and offer enhanced compatibility with different chemicals and pressures

For more detailed information on RHPS series regulators, **view our product catalog.**

Explore RHPS Series Options

RHPS Series Process Regulator Features



Process Regulators (RHPS Series) (continued)

Within the RHPS series, we offer multiple options that can be customized to meet your process pressure regulation needs.

RS series pressure-reducing regulators are suitable for most gases and liquids. The RS series regulators feature various poppet designs, a choice of sensing types (diaphragm or piston), and seat and seal materials to accommodate a variety of pressure, temperature, and flow conditions.

RD and RA series pressure-reducing, dome-, and air-loaded regulators are suitable for most gases and liquids, including acids and oils. These regulators feature various poppet designs, a pressure-sensing diaphragm (piston in RD2 series), and a choice of seat and seal materials to accommodate a variety of pressure, temperature, and flow conditions.

BS series back-pressure regulators are suitable for most gases and liquids. The BS series regulators feature a choice of sensing types (diaphragm or piston) and seat and seal materials to accommodate a variety of pressure, temperature, and flow conditions.

For more detailed information on RHPS series regulators,
view our product catalog.

Instrumentation Regulators (K Series)

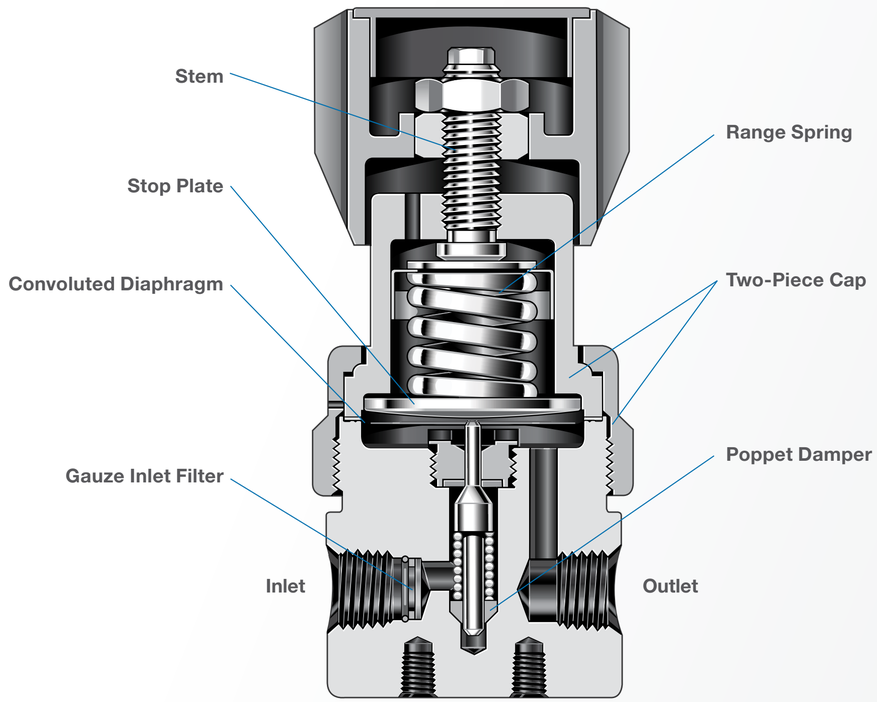
Swagelok® K series regulators are single- and two-stage spring-loaded analytical and instrumentation regulators designed to help you trust your test results and maintain predictable process outputs by achieving consistent pressure control. Swagelok K series regulators provide set pressure stability and are easy to adjust in small increments, allowing operators to maintain the pressures they desire with minimal effort over extended component life spans.

Swagelok K series regulators are available for high-flow and high-pressure applications where robust performance is a necessity. They are also available with vaporizing capabilities for specialty applications.

- Pressure-reducing models
- Back-pressure models
- Gas cylinder changeover model
- Vaporizing models

All K series regulators are designed and engineered to promote safe, reliable, and precise performance for the long term. For more detailed information on K series regulators, **view our product catalog.**

Swagelok K Series Regulators Features



Explore K Series Options

Instrumentation Regulators (K Series) (continued)

Swagelok's K series regulators include solutions to reliably meet a range of pressure regulation needs in analytical instrumentation applications.

KPR series options are general-purpose regulators, designed to provide reliable pressure control. These compacted regulators have excellent accuracy, sensitivity, and set point pressure stability.

KCY series regulators are designed for use in applications requiring constant outlet pressure even with wide variations in inlet pressure. These dual-stage arrangements minimize the supply-pressure effect caused by fluctuating inlet pressure, such as with a depleting gas cylinder.

KHF series options are high-flow, high-sensitivity diaphragm-sensing, pressure-reducing regulators. The KHF series combines the high-flow capabilities—1.0 Cv—of a bulk distribution regulator with the high sensitivity and accuracy of a point-of-use regulator.

KPP series regulators meet the demands of a wide range of gas or liquid applications in a lightweight, compact installation footprint. These features make the KPP pressure regulator an ideal pressure control solution within high-density OEM equipment.

For more detailed information on K series regulators, **view our product catalog.**

Ready to Choose Your Regulator?

Swagelok regulator specialists are at the ready to help you properly identify the right regulator solution for your pressure control needs. These certified advisors have the technical expertise to help you with component sizing, material selection, on-site troubleshooting, and system design support. Get in touch to find the assistance you need to keep your pressurized fluid systems operating dependably.

Contact your local Swagelok sales and service center.

Your Guide to Pressure Regulator Selection

Making the right choice for the needs of your industrial fluid system