Choosing the Proper Pressure Control Device for your Application

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Introduction

In almost all process applications, there are going to be controlled variables that will be monitored to ensure proper operation of the system. What these variables are depends on the process itself, but in most cases the control of these variables is facilitated through the use of a system of control valves and regulators.

Control valves are defined as valves that open and close in response to signals that are monitoring a specific process variable. Examples of these variables include pressure, temperature, flow and many other application criteria. Control valves are typically actuated either pneumatically, hydraulically or electrically. This means a control valve is connected to some sort of plant operating system, for remote operation and for plant operation signaling.

Pressure regulators are self-contained valve and actuator combinations that limit flow through a restricting element to match flow demand downstream. The desired performance of a regulator is to meet any downstream flow demand while maintaining a constant outlet pressure. Pressure regulators do not require any type of external actuation, which is where the self-contained portion of the definition comes into play. Unlike control valves, they operate solely by sensing pressure fluctuations and making corrective adjustments. This means they are usually limited to applications where pressure is the controlled variable.

A common issue when selecting process equipment is knowing whether a control valve or a regulator is more suited to control a process variable. The goal of this document is to provide a breakdown of the pros and cons of each device, so the right device is chosen.

Properties of Pressure Regulators

Pressure regulators consist of 3 key parts: a restricting element, a measuring element and a loading element. The restricting element is what actually controls pressure in the system. It restricts the amount of flow that can travel through the regulator, thereby keeping pressure limited downstream. This is done through a combination of a disc and orifice. The disc can be a soft elastomeric material for a tight seal, or a hardened metal material. The orifice can be varied to allow different flow rates through the same regulator body.

The measuring element is what senses pressure changes in the system and tells the regulator to open or close to meet system demand. If the required demand increases, the measuring element tells the regulator to open, allowing more flow downstream. If the demand decreases, the measuring element tells the regulator to close. Usually the measuring element consists of a diaphragm. The diaphragm is similar to the regulator disc in that it can also be made of an elastomeric or metal material. Pressure changes downstream of the regulator can cause the diaphragm to rise or fall, thereby controlling the disk and orifice (restricting) element.

The loading element is the part of the regulator that actually controls what the downstream pressure will be. This is done through calculations involving the diaphragm element area times the downstream pressure. This will give a force value pressing in the upwards direction on the diaphragm.

The loading element is the force that resists the upwards push. Typically, the loading element consists of a spring. The spring pushes against the upwards force provided by the system, allowing the regulator to stay open keeping the downstream pressure at a set value.

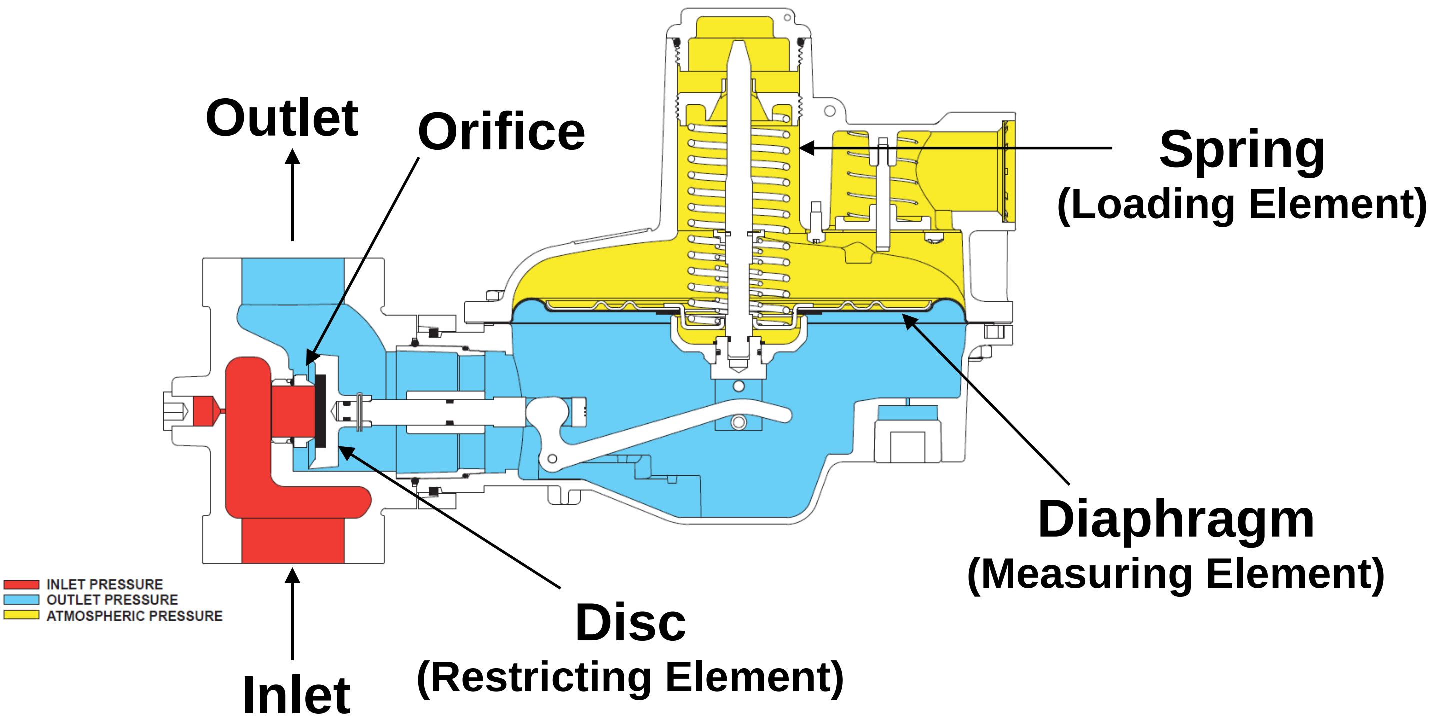

Figure 1: Elements of a Pressure Regulator

Properties of Control Valves

Control valves typically consist of multiple components: the valve itself, the actuator and the positioner. The valve consists of mostly the same elements as a regulator. Positioners commonly are used to move a control valve to a determined open position to meet the specified process variable being controlled. The actuator is the device that actually performs this opening or closing action.

The process variable being controlled is usually measured by some sort of data transmitter, which then forwards this information to some sort of controller. The controller then sends a signal to the control valve, which must then open or close to allow the process variable to be controlled to the specified value.

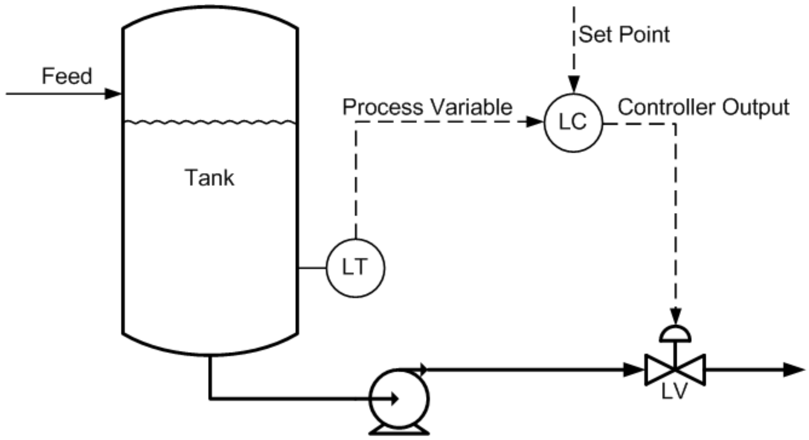

Figure 2: Typical Control Loop for Tank Level Control

Characteristics and Applications

Because of the extra components of a control valve, they tend to be more complex than a pressure regulator. They also have some distinct advantages over regulators. Because they are externally powered, maximum valve size is not an issue. Pressure and temperature limits are also higher, because you can isolate the process fluid from the actuation device. The ability to control process variables other than pressure broadens the application range. All of these characteristics mean that control valves have a broader application range than that of pressure regulators. However, this does not mean that in all cases a control valve should be used.

A key difference between pressure regulators and control valves is that regulators are self-contained devices. This means that they are powered by system pressure and require no outside inputs. Because of this, regulators are normally limited to only controlling process pressure. However, they do offer a unique property: the ability to operate even if outside power goes down to a system. Because of this, regulators provide “off-the-grid” pressure control solutions that can be used to power essential plant operations that need to continue to operate in the event of plant power or air failure. Examples of this include key safety elements, like fire suppression or positive pressure systems.

Speed of response is also a determining factor when choosing regulators or control valves. Because a control valve is being controlled through a loop, several different mechanisms have to sense process changes before the control valve position is changed to match the process variable set point. Since the regulator is directly controlled by the process variable being measured, it can typically respond in a more rapid fashion. Applications where this could be important are processes where pumps are rapidly being turned on or off, or snap acting solenoids are controlling process flow demands.

The below table is a quick run-through of some important process considerations and how control valves are regulators compare in these categories.. When detailing a system, it is important to note which attribute is most important to the system’s operation.

Table 1: Attributes of Regulators Compared to Control Valves

Attribute	Pressure Regulator	Control Valve
Complexity	Simplest	Typically More Complex
Power Source	None required	External Power
Cost (typical)	Typically Lower	Highest
Flow Turndown	100:1 or more	20:1
Response Time	Fast	Typically slower
Fluid Versatility	Clean fluids	Almost any fluid
Pressure Limits	Up to ANSI 600	Up to ANSI 2500
Temperature Limits	Yes - Elastomers	Higher temperatures
Sizes	Up to 10"	No limit to size
Control function	Pressure	Pressure, flow, temperature and others
Materials and Trim	Selection of special materials and trim	Broader selection of materials and trim

Conclusion

When addressing system control design, many factors can go into making your decision. If your concerns are speed of response, simplicity of operation, cost, or the ability to maintain pressure even when there is no power being supplied to your system, then a regulator is the ideal solution. If you are trying to control a variable other than pressure, have a dirty fluid, or need the ability to remotely operate the device, then a control valve is the preferred solution. While the operations of both these types of devices are similar, there are distinct advantages to each. Specifying the right device from the onset of a project can save both time and money.