## DFT Valves

# Selecting Control Valves

## Evaluating Process Conditions in Control Valve Selection

A one-size-fits-all approach is not the best way to go about choosing the proper control valve for a particular production process. There are an enormous number of variables to consider when determining which type of valve provides the best combination of performance, price, and reliability. Flow rates, operating temperature and pressure, the type of fluid that will be controlled, and how the fluid must be manipulated are all critical considerations that come into play when narrowing the wide selection of valves down to the ideal control valve for the application.

What follows is a quick guide to understanding the fluid conditions that will most heavily impact the control valve selection process. This isn't meant to be a comprehensive survey; we don't want to delve too deeply into the principles of fluid dynamics, and there's no substitute for meeting with consulting engineers and valve manufacturers and discussing specific conditions in detail. But this information may help you understand what conditions are most critical to valve selection and why.

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## Process Conditions Overview

The following discussion refers to “control” valves, which can be thought of as the main or primary valves in an application. They aren’t just “on/off,” but they regulate the flow of fluid through the system. In fact, control valves are normally the most complex valves in the system in regard to their design and function.

When we talk about “process conditions,” we’re simply referring to the environment in which the valve operates. What are the temperature extremes? How dense is the fluid that flows through it? Is the fluid corrosive? How fast does the fluid flow through the system? At what pressure level does the valve need to maintain the fluid to ensure trouble-free production? What pressure range will the valve be expected to operate in?

Generally, for purposes of clarity, the media that travels through the process system is referred to as a “fluid,” which encompasses the different states that the media can assume: gas, liquid, and steam. Each fluid has its own unique characteristics—density, the points at which it transitions between gas and liquid, under what circumstances it can be considered “incompressible”—and each characteristic of the fluid to be controlled affects the type of control valve that is most appropriate for a particular situation.

It can all seem a bit complicated, but by understanding how the process conditions affect the choice of control valve, you’ll be in a much better position to grasp the alternatives and recommendations that valve manufacturers provide.

## Types of Valves

Before we get into the different factors that affect which type of valve is appropriate for a given set of conditions, let's quickly list the primary types of control valves available.

There are four major types, and each has their own individual strengths and weaknesses:

- Butterfly Valve: Butterfly valves are rotary valves that rotate a flat disk into the flow of fluid. They are well suited in situations where the flow is high and straight, and a minimal pressure drop is desired. They are economical but torque can be a factor when throttling the flow through the valve.
- Ball Valve: Ball valves are rotary valves that use a sphere with a hole through the center. The ball is rotated in the flow to adjust the flow of the fluid. They are well suited for on/off applications, such as emergency shut-offs.
- Globe Valve: Globe valves are rising stem valves that raise and lower a plug in the fluid stream. They are called globe valves because they generally have a round body. The design helps reduce noise and turbulence, and the control element is often designed specifically for the task to be performed. They are the best choice for harsh environments. Since the control element assembly can often be easily removed from the globe-shaped housing, they tend to be simple to maintain.
- Plug Valve: Plug valves are rotary valves that employ a cylinder to obstruct the fluid flow. Similar to ball valves, they feature one or more holes through the cylinder. Flow is regulated by rotating the cylinder within the valve chamber. Like ball valves, they are well suited for on/off applications.

## Process Condition: The Relationship Between Flow Rate and Pressure

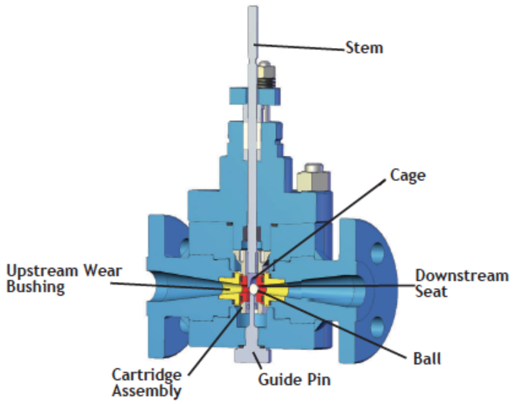
All control valves have one basic characteristic in common: they affect the rate of the flow of fluid through the valve. It may help in understanding the effects of a valve on the fluid (and vice versa) if you imagine one of the most basic examples of a valve in action. We're all familiar with watering a lawn or a flower bed with a garden hose. If you wish to block the flow of water, you can cover the nozzle with your thumb. When you do that, you've created a control valve. In this case, the fluid is water and your thumb—in combination with the hose nozzle—is the control valve.

The change of a fluid's velocity through a partially closed valve provides some insight into the relationship between throttling the flow rate of the fluid and the amount of pressure in the system. In our garden hose example, the highest flow rate is seen when the nozzle is not blocked by the thumb. You'll get the most water on the lawn this way, but it will not travel very far.

If you want to reach a distant spot in the flower bed, you can partially cover the nozzle with your thumb. This increases the pressure in the hose and the velocity of water through the nozzle, but it also decreases the amount of water leaving the hose. As you cover more of the nozzle with your thumb, less water will spray further.

If the flow rate and line pressure of the water is low, it can be fairly easy to completely block the flow. But as the flow rate and line pressure increases, it becomes impossible to block the flow using just your thumb. This gives us our first clue to concerning the impact of conditions on your valve choice. The higher the flow rate and pressure drop, the more robust the valve must be in order to control it.

The combination of flow rate and pressure drop is the primary consideration when choosing a control valve—a poor choice can result in dramatic pressure variations in the process system.



## Process Condition: The Relationship Between Temperature and Pressure

There is another important relationship to be considered as well, that of pressure and temperature on fluids. Have you ever wondered why some food packages have special “high altitude” directions? It’s because all liquids possess a vapor pressure, which, to put it simply, is the pressure at which the liquid boils for a given temperature. When the external pressure equals the vapor pressure for a given temperature, the fluid begins to gas off.

To illustrate this relationship, let’s again consider a familiar fluid: water. At the atmospheric pressure existing at sea level, water boils (becomes vapor) at about 100 degrees Celsius. However, change the pressure, and the temperature at which water boils also changes. For example, in the “Mile High” city of Denver, Colorado, the atmospheric pressure is reduced, which allows water to boil at 95 degrees Celsius.

This is one of the reasons that a process system and the valves that comprise it must carefully account for both pressure and temperature within the system. It is especially crucial for systems that manage the conversion of water to steam, such as those that drive steam turbines. Changing the temperature within the system changes the vapor pressure of the water - the pressure at which it changes to steam.
Valves which control flow rate and pressure must be designed with the operating temperature in mind.

## Process Condition: Type of Fluid

One final process condition that has a significant bearing on proper control valve selection is the type of fluid the valve will handle. We've talked a bit about gases and liquids, but there is, of course, more to it.

Some liquids have particulates in suspension that place special burdens on the valve—oil and petroleum products, for example. In addition, some fluids are highly corrosive and require a valve made of special materials that can survive in a harsh environment. Such considerations will dictate if the valve needs to be particularly robust and how often it will need to be maintained or replaced.

Another fluid characteristic to consider is its "compressibility." A fluid is compressible—i.e., its volume can be reduced by adding pressure—when it's in a gaseous state. Liquids cannot be compressed and are said to be incompressible; this distinction is important, because if a fluid changes its state within the system, serious problems can occur.

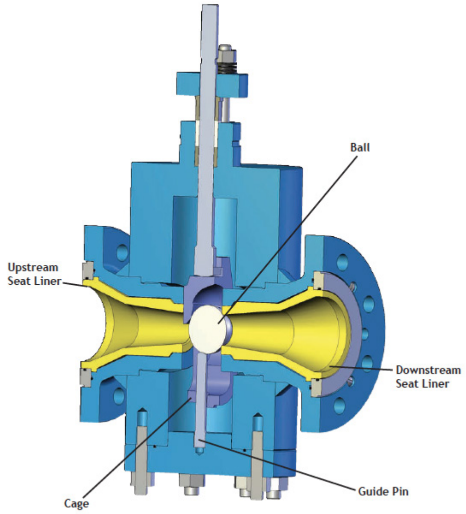
# Process Condition: Challenges Posed By Controlling High Pressure Flow

Beyond the factors discussed so far, selecting the appropriate control valve for a particular function also involves accounting for potential technical and physical problems associated with controlling especially at high velocities, temperatures and pressures. Here are the chief challenges to address:

Noise: Noise in a system becomes a concern when a valve restricts, or “throttles,” fluid movement. Noise and vibration produced by impeding high flows can be extreme, up to and including damaging equipment and even the hearing of nearby workers. In general, noise generated by valves can be reduced by choosing designs that control outlet velocities.

Cavitation: As we discussed earlier in our garden hose example, when the flow rate is at its maximum, pressure is at its minimum (e.g., no thumb in front of the nozzle). However, if the pressure in the process system falls below the liquid’s vapor pressure, parts of the fluid “flash” or transition to vapor, creating bubbles. If the pressure rises downstream of the valve, the vapor reverts back to a liquid. As the bubbles collapse, they create shock waves in the system that can be extreme enough to not only create noise, but to even damage equipment—this is called cavitation.

Choking: Flow becomes choked when any further reduction in downstream pressure does not increase the flow rate. In liquids, this generally occurs when the liquid flashes. The vapor formed blocks the passage of more liquid. Sonic velocities cause choking in gaseous flow, this is also known as “critical flow.”



## Next Step: Finding Proper Information

As you can see, there are many variables to consider when determining the type of control valve that is most appropriate for specific conditions. However, those listed above are far from the only considerations. Other, more obvious ones include:

- Pressure rating
- Optimum size and flow capacity
- Operating temperature range
- Shutoff response times
- Trim Characteristic
- Compatibility with existing equipment and pipes
- Operating life and durability
- Ease of maintenance
- And not least importantly: cost

Unfortunately, getting the information needed to make a good control valve decision is not always an easy thing to do. All the required information is rarely housed in one place. Procurement departments may have records of what equipment has been purchased in the past, and perhaps even why that equipment was originally acquired. But it's unlikely that they'll have the detailed information needed to determine which new valves to buy, or even to determine the best replacement for an old valve.

What's worse, making a bad decision using inaccurate or insufficient information can have far-reaching consequences. Small discrepancies in flow rates and pressures can create big problems resulting from downtime, inadequate performance, equipment failure and even damage to property or the environment.

It can be a daunting task, and that's where valve manufacturers like DFT Valves can help. We can provide data sheets that can help you get started gathering the information needed to make an informed decision. We'll also work with your staff or consulting engineers to determine what conditions and challenges you face and the best options available to address your needs.

Selecting the proper control valve based on your process conditions is an important decision. It's critical to get the best advice and information available to make an informed choice.