Choose the right valve for the best hydronic system performance

This guide will help you understand the mechanics of valves, how they work and some basics on how to size and select the right valve.

Table of Contents:

1. Valve components
2. How valves work
3. Sizing and selection basics
Valve components

An HVAC valve assembly has two major components: the valve body and the valve actuator.

Actuator
The actuator is the “engine” that powers the valve. The valve actuator is responsible for receiving a control signal, and moving the components in the valve body to the position required by the controller.

Valve
The valve body is the outer housing and components through which the fluid we control will flow.
Valve components

**Ball Valve**

*Ball* = trim component that varies the area of the flow within the valve body.

*Ball seals* = outside, on either side of the ball, to prevent leakage.

*Flow characterizer, or integral flow insert* = provides ball valves with their equal percentage flow characteristic.

*Stem and packing* = are at the top connects the valve to the actuator and prevents leakage around the stem.

*Mounting bracket* = where the actuator gets mounted to the valves.

**Butterfly Valve**

*Valve body* = contains the plate at the top, which is also used for mounting the actuator. The most common type of butterfly valve is the lug type, which is the valve type pictured.

*Stem* = connects the actuator to the valve.

*Disc* = component which makes contact around the resilient seat. The position of the disc, controls the amount of flow, and closes into the rubber seat to provide close off.

*Seat* = provides that surface for the plug to seal and stop flow.

**Globe Valve**

*Bonnet* = top of the globe valve which contains the packing and is where the actuator attaches to the valve plug.

*Stem guide* = supports the stem

*EPDM packing cartridge* = prevents leakage around the stem.

*Trim* = refers to the material of the plug and the seat components.

*Plug* = varies the area of flow within the valve body, and determines the flow characteristic of the valve.

*Seat* = provides a surface for the plug to seal and stop the flow.
Valve components

**Magnetic Valve**

Magnetic valves have two components, the actuator and the valve.

- **Actuator** = composed of the electronics, is where the actuator receives power, and the control signal to determine the electrical signal required by the magnet to move the stem to the correct position.

- **Valve** = has the stem that connects the actuator to the valve disc. The disc varies the area of flow through the valve body.

**Pressure Independent Control Valve (PICV)**

- **Flow limiter** = the maximum flow allowed through the valve is determined by the flow limiter, and is preset to order in the factory, but is easily adjustable in the field by hand. The flow limiter is independent of the stroke of the valve, thus maintaining full stroke and full controllability regardless of the maximum flow setting.

- **Control valve** = is composed of a plug, stem and seat. It’s used to adjust the flow through the valve based on the load or demand.

- **Automatic pressure regulator** = makes the PICV pressure independent. It dynamically adjusts an orifice in response to pressure changes to maintain the desired demand.

**Zone Valve**

- **Stem** = connects the valve actuator to the valve plug.

- **Bonnet** = contains the packing, and attaches the valve to the actuator.

- **Plug** = varies the area of flow through the valve body.

- **Seat** = provides a surface for the plug to seal and stop the flow.
How valves work

Number of openings in a valve

- 2-way for water/steam
- 3-way for water only

A two-way valve can be either normally open, or normally closed. Three-way valves can be mixing, or diverting.

Position of valve upon power failure when using a fail-safe actuator

**Normally Open (NO):** Stem up to open

**Normally Closed (NC):** Stem up to close

Valve Action is whether the valve is NO or NC upon power failure. The normal position, is the flow position that the valve will be positioned when a fail-safe actuator is connected to the valve or the position of the valve when zero volts is applied to a modulating actuator.

A 2-way valve body can be either stem-up-to open, which is NO, or stem-up-to-close, which is NC. For example, for steam, you’d always want the valve to be NC or to fail closed, not open.

In the image above on the left, a normally open valve stem up is open, and on the right in the stem up position is normally closed. This also is where the valve will fail, if it’s on power failure with a fail safe actuator.

For mixing the stem up position will close the bypass port (AB-B). For diverting the stem up position will close the through port (A-AB).

There are two types of 3-way valves: Mixing and Diverting. The internal design of the 3-way valve classifies it as a mixing or diverting valve.

**Diverting Valves** – Diverting means there is one input and two outputs, diverting the input to one or both of the outputs. In this example on the left, the plugs are on the top and the bottom, closing off against the direction of the flow.

**Mixing Valves** – Mixing means there are two inputs and one output, mixing the two inputs into the single output. Again, the plug closes against the flow, either against A or against B.

Although mixing and diverting valves look similar from the outside, they have very different trim assemblies and their applications are not interchangeable by re-piping in the field.
How valves work

2-Way piping

When looking at two way piping, go from left to right. Typically, there’s an isolation valve on each end of the system. Next, is a strainer to remove particulate, such as rust or corrosion. The heating/cooling coil is for air/water heat exchange and a balancing valve equalizes the water flow through the various branches of the system. The control valve and actuator are next in the system and regulates flow through the coil.

In these systems, normally open/normally closed is relevant with a spring return, or fail-safe type actuator. When power fails, the actuator will position the valve in the normal position. The top example is closed with no flow.

Note that the normally closed valve is indicated by the darkened inlet port. The bottom example is normally open, with flow for heating and cooling during power failure.

Other arrangements are possible, for example, the valve could be located on the inlet side of the coil. The best place to put the control valve is after the coil, which allows the pressure drop first through the coil, and also extracts the heating or cooling energy from the media, before passing through the valve.

3-Way piping

Mixing
This arrangement allows for constant flow through the system. The valve is modulating, and determines how much water is flowing through the coil, and how much water is bypassing the coil. The flow is constant.

Note: the normally closed port is indicated by the darkened triangle.

In the top example, the valve is in the stem up position and flow is closed to the coil. The water is being bypassed around the coil. In the bottom example, the valve is stem down and the bottom port is closed. The flow is through the coil and not through the bypass.

Diverting
In a typical piping arrangement, for 3-way valves in a diverting application, the valve is on the front side of the coil.

The functionality and flow through the coil is the same in this diverting configuration as in the mixing configuration on the left. The only difference is the location of the valve, relative to the coil.
Sizing and selection basics

Steps in selecting valve assembly

1. Determine valve type
2. Determine medium being controlled
3. Calculate/find the Cv or flow coefficient. In the case of a PICV, determine the flow that is needed through the valve.
4. Determine close-off psi to select the actuator

Valve type by equipment and system
This overview shows what types of valves work with generation, distribution and consumption equipment.

### Variable Volume

<table>
<thead>
<tr>
<th></th>
<th>Generation</th>
<th>Distribution</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Butterfly</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Globe</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Magnetic</td>
<td></td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>PICV</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>Zone</td>
<td></td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>

### Constant Volume

<table>
<thead>
<tr>
<th></th>
<th>Generation</th>
<th>Distribution</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Butterfly</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>Globe</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Magnetic</td>
<td></td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>PICV</td>
<td></td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>Zone</td>
<td></td>
<td>☑</td>
<td>☑</td>
</tr>
</tbody>
</table>
Valve type by application

This application matrix identifies which type of valve is required by each application.

<table>
<thead>
<tr>
<th>Fan Coil Unit</th>
<th>Unit Ventilators</th>
<th>Variable Air Volume</th>
<th>Air Handling Unit</th>
<th>Critical Environments</th>
<th>Campus Distribution</th>
<th>Boiler Plant</th>
<th>Chiller Plant</th>
<th>Cooling Tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butterfly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Globe</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
<td>•</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PICV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone</td>
<td>•</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose the right valve and actuator for the best hydronic system performance.
Siemens offers a full line of valves and actuators designed for precise regulation and control of water, steam and other media. With Siemens, achieve reliable equipment control and energy savings at every stage: generation, distribution and consumption. Valve selection can make the difference in boiler and chiller efficiency; in maintaining flow regardless of pressure fluctuation and in achieving the right comfort level throughout the building.

Rely on Siemens for the best possible system performance.
The right HVAC device matters to make your perfect place a reality.