

Hydronic Control Valves

Sizing, Specification, and Technologies



Learning Objectives

- Understand the language of valve specifications and how vendors and engineering firms may utilize different terms
- Explore various flow characteristics in valves, and which are most desirable for a given application
- Learn the proper method for sizing control valves for liquid water
- Investigate several common control valves, understand their design intent, their function, and for which applications they are best suited

Ratings and Definitions



Ratings and

C _v	Valve Nominal Size		2-way Flanged	
	Inches	DN [mm]	ANSI 125	ANSI 250
70	2½	65	B6250S-070	B6250S-070-250
110	2½	65	B6250S-110	B6250S-110-250
110	3	80	B6300S-110	B6300S-110-250
186	4	100	B6400S-186	B6400S-186-250
290	5	125	B6500S-290	B6500S-290-250
400	6	150	B6600S-400	B6600S-400-250



5
5-year warranty

CCV

Equal Percentage Characteristic

Mode of Operation
The Characterized Control Valve is operated by a rotary actuator. The actuators are controlled by a standard voltage for on/off control, a modulating signal, or floating point control system which move the ball of the valve to the position dictated by the control system.

Product Features
The equal-percentage characteristic of the flow is ensured by the integral characterizing disc. This characteristic provides linear heating or cooling output from the coil improving energy efficiency and comfort.

Actuator Specifications

Control type	on/off, floating point, 2...10 V, multi-function technology (MFT)
Manual override	AR, GR, AFR and GKR series
Electrical connection	3 ft. [1 m] cable with ½" conduit fitting or covered screw terminal strip

Valve Specifications

Fluid	chilled or hot water, up to 60% glycol max.
Flow characteristic	A-port equal percentage
Controllable flow range	75"
Sizes	2½", 3", 4", 5", 6"
End fitting	ANSI Class 125 flange, flat face*, ANSI 250
Materials	cast iron GG25
Body	stainless steel
Ball	stainless steel
Stem	Teflon® PTFE
Seats	EPDM rubber
Seat o-rings	EPDM rubber
Characterizing disc	stainless steel
Stem o-rings	EPDM
Fluid temp. range	0...250°F [-18...+120°C]
Body pressure rating	ANSI 125, Class B, ANSI 250
Close-off pressure	175 psid, 310 psid (-250)
Maximum differential pressure (ΔP)	50 psid
Leakage	0% for A to AB

*125 psi flanges have a plain flat face and should not be bolted to a raised face flange.
Tefzel® and Teflon® are registered trademarks of DuPont™.

Pressure and Temperature Ratings

- Body Pressure
- Close-Off Pressure (and leakage)
- Maximum Differential Pressure
- Fluid Temperature Range

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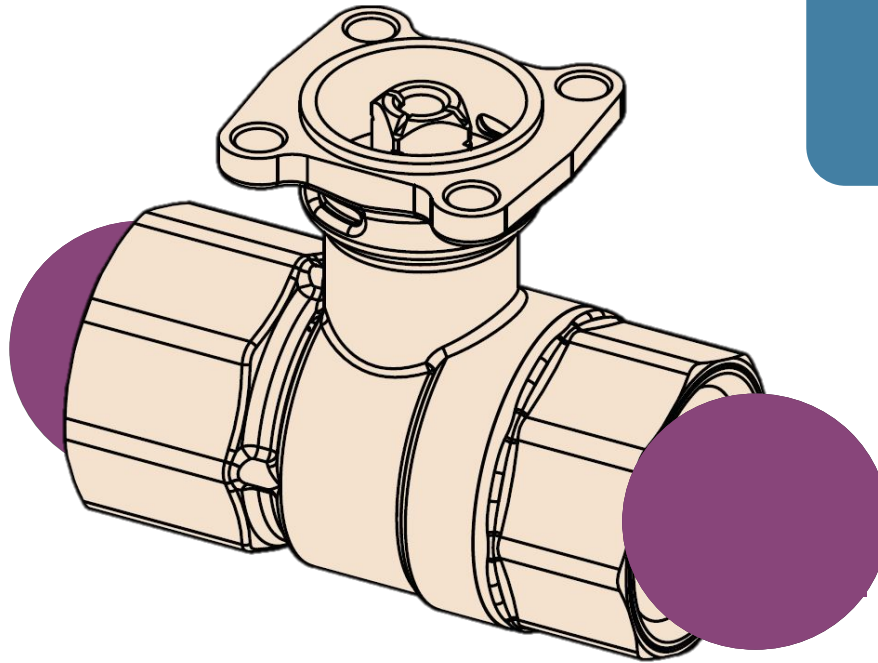
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Body Pressure Rating

ANSI Rating

or

Measured in PSI



Body Pressure Rating

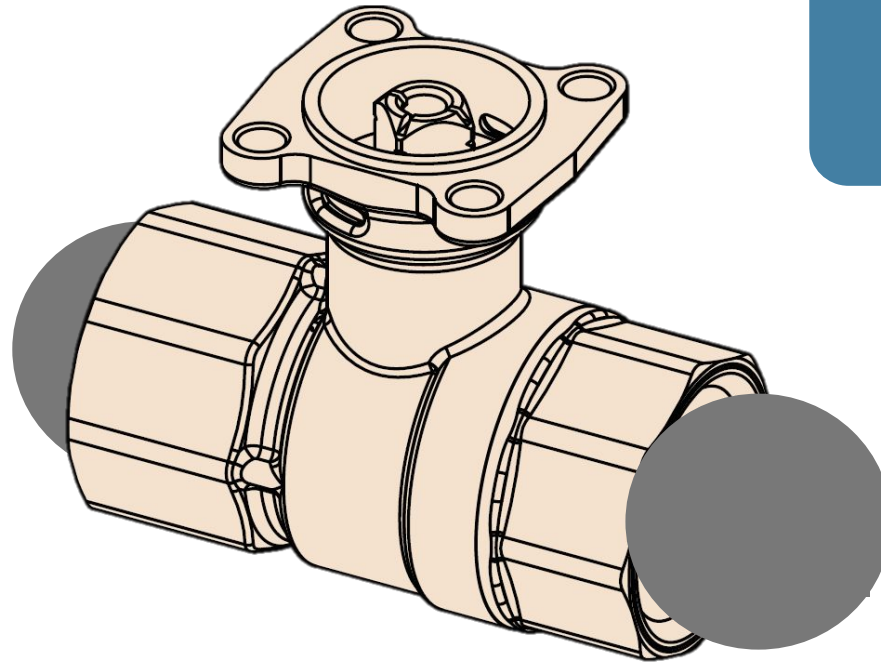
ANSI 250

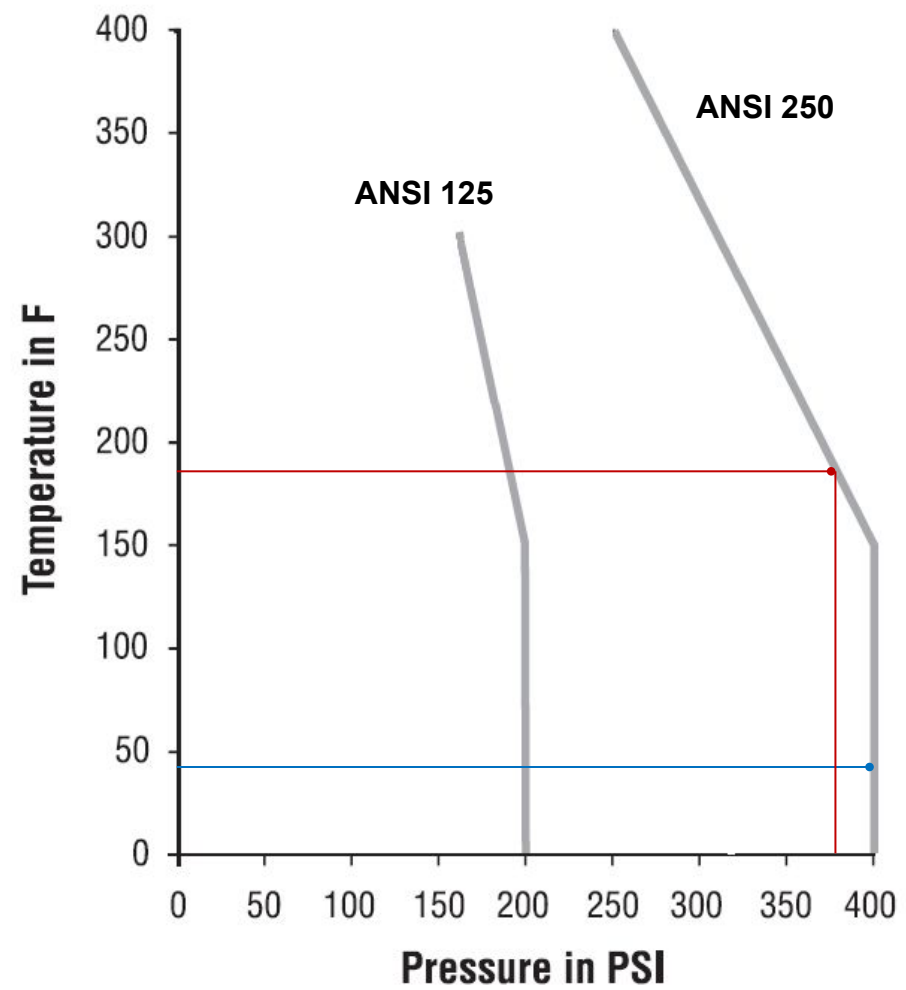
ANSI Rating

or

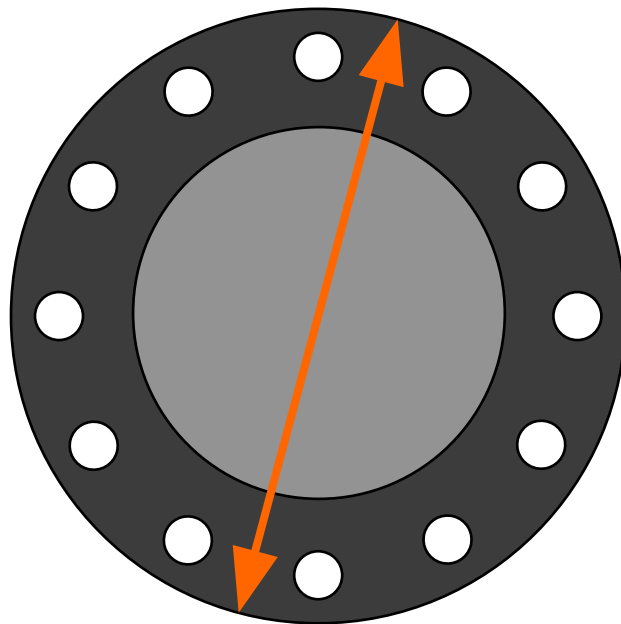
Measured in PSI

ANSI 125



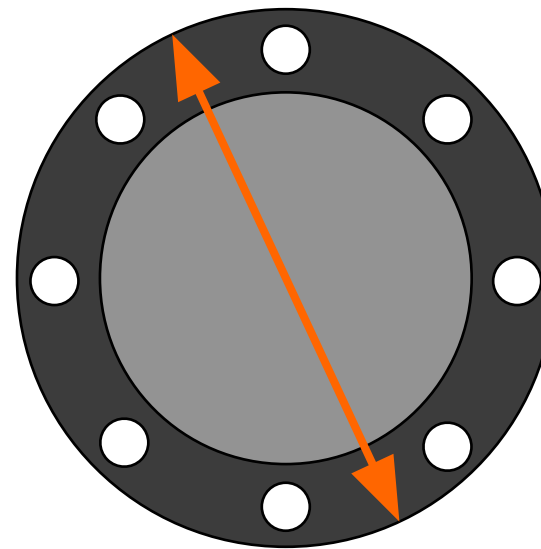


6" ANSI 250
Flange



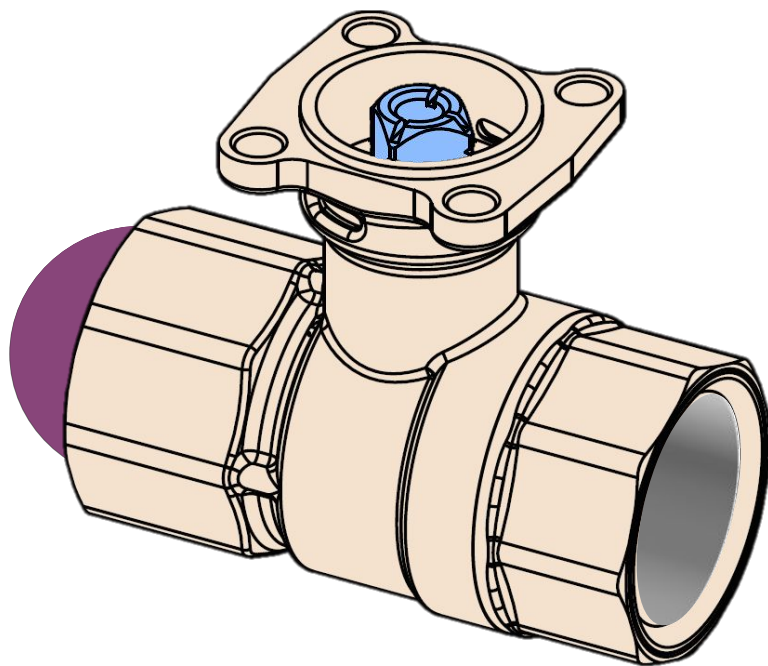
Ø = 320 mm
12 Bolts

6" ANSI 125
Flange

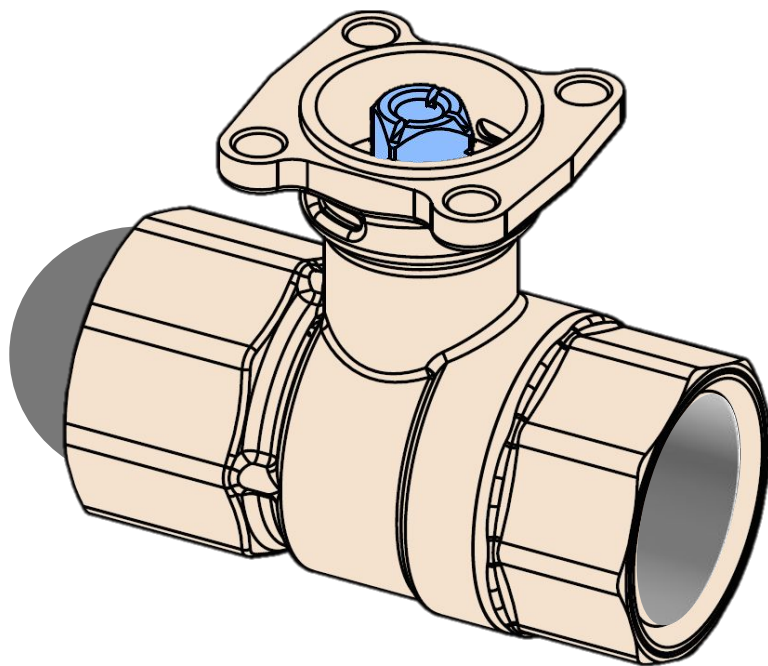


Ø = 280 mm
8 Bolts

Close-Off
Pressure Rating



Close-Off
Pressure Rating



Rules of Thumb – Close-Off Pressure

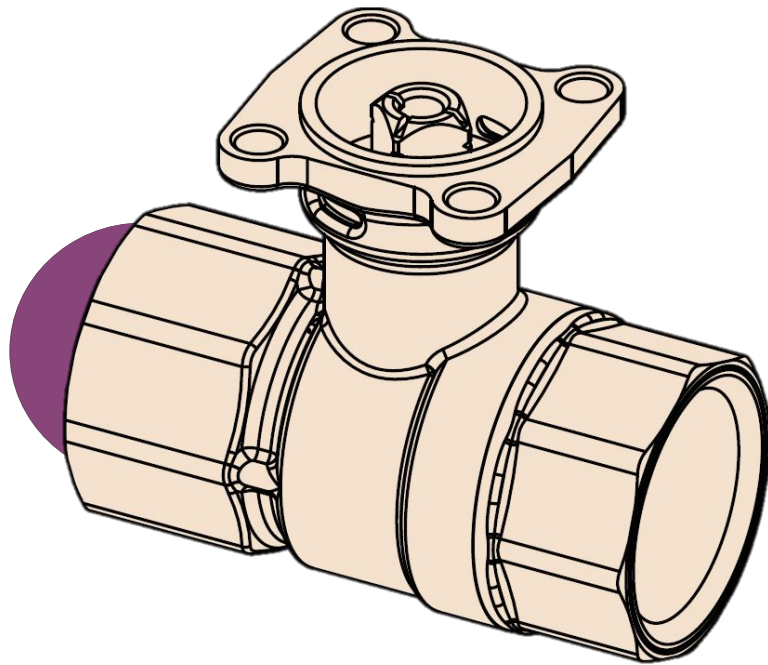
2-Way \geq Head of circulating pump

3-Way Mixing \geq System differential

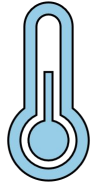
3-way Diverting \geq Head of circulating pump



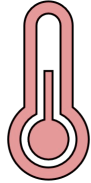
Maximum
Differential
Pressure Rating



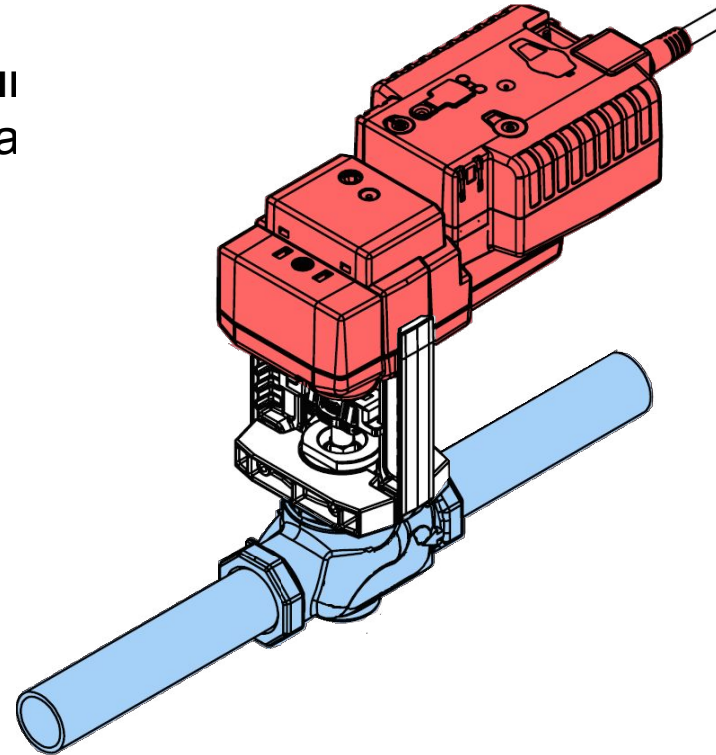
Temperature Ratings



Media Temperature
– Acceptable fluid temperature range for the valve



Ambient Temperature
– Rating for the actuator



Valve Flow

- Flow Characteristic
- Rangeability / Turndown

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Valve Specifications

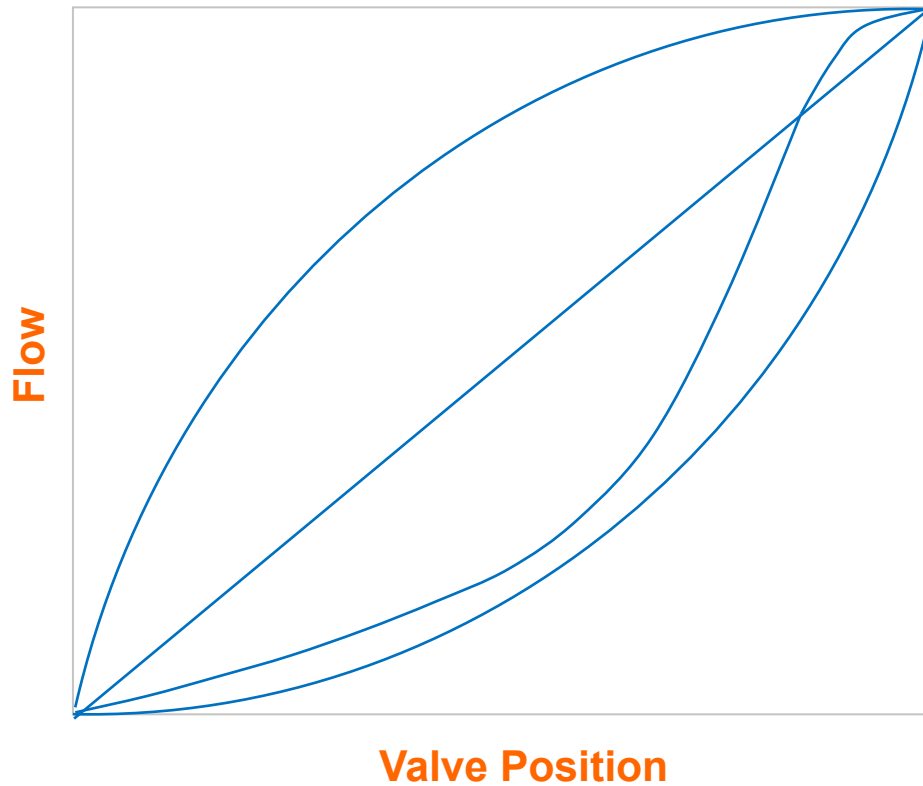
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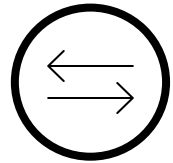
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Tefzel® and Teflon® are registered trademarks of DuPont™.

Flow Characteristic

- Quick Opening
- Linear
- Equal Percentage
- Modified Equal Percentage???



Rangeability & Turndown



$$\text{Rangeability} = \frac{\text{Maximum Flow}}{\text{Minimum controllable Flow}}$$

***Valve body only with constant
 ΔP (Lab Conditions)**



$$\text{Turndown} = \frac{\text{Maximum Usable Flow}}{\text{Minimum controllable Flow}}$$

***Installed Valve Assembly**

A black and white photograph of an industrial facility, likely a water treatment plant. The image shows a complex network of large, corrugated metal pipes running parallel to each other. Several large valves with handwheels are visible, mounted on the pipes. The pipes are supported by a metal framework. The background shows more industrial structures and equipment.

Valve Sizing

2-Way

Model #	Cv	Size [mm]
B207B	0.3	½" [15]
B208B	0.46	
B209B	0.8	
B210B	1.2	
B211B	1.9	
B212B	3	
B213B	4.7	
B214B	7.4	
B215B	10	
B216B*	16	

Flow Coefficient Formula

$$Cv = \frac{GPM}{\sqrt{\Delta P}}$$

- Coil Requires 8 GPM
- $\Delta P = 4\text{psi}$

$$Cv = \frac{8 \text{ GPM}}{\sqrt{4}} = 4$$

Calculating Pressure Drop

$$\Delta P = \left(\frac{GPM}{Cv} \right)^2$$
$$\Delta P = \left(\frac{8}{3.0} \right)^2 = 7.1 \text{ psi}$$

$$\Delta P = \left(\frac{8}{4.7} \right)^2 = 2.9 \text{ psi}$$

2-Way

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B216B*	16	

Rules of Thumb – ΔP for Valve Sizing

- Should be greater than coil ΔP for modulating
- Typically between 3psi - 5psi for modulating
- Typically 1psi for on/off

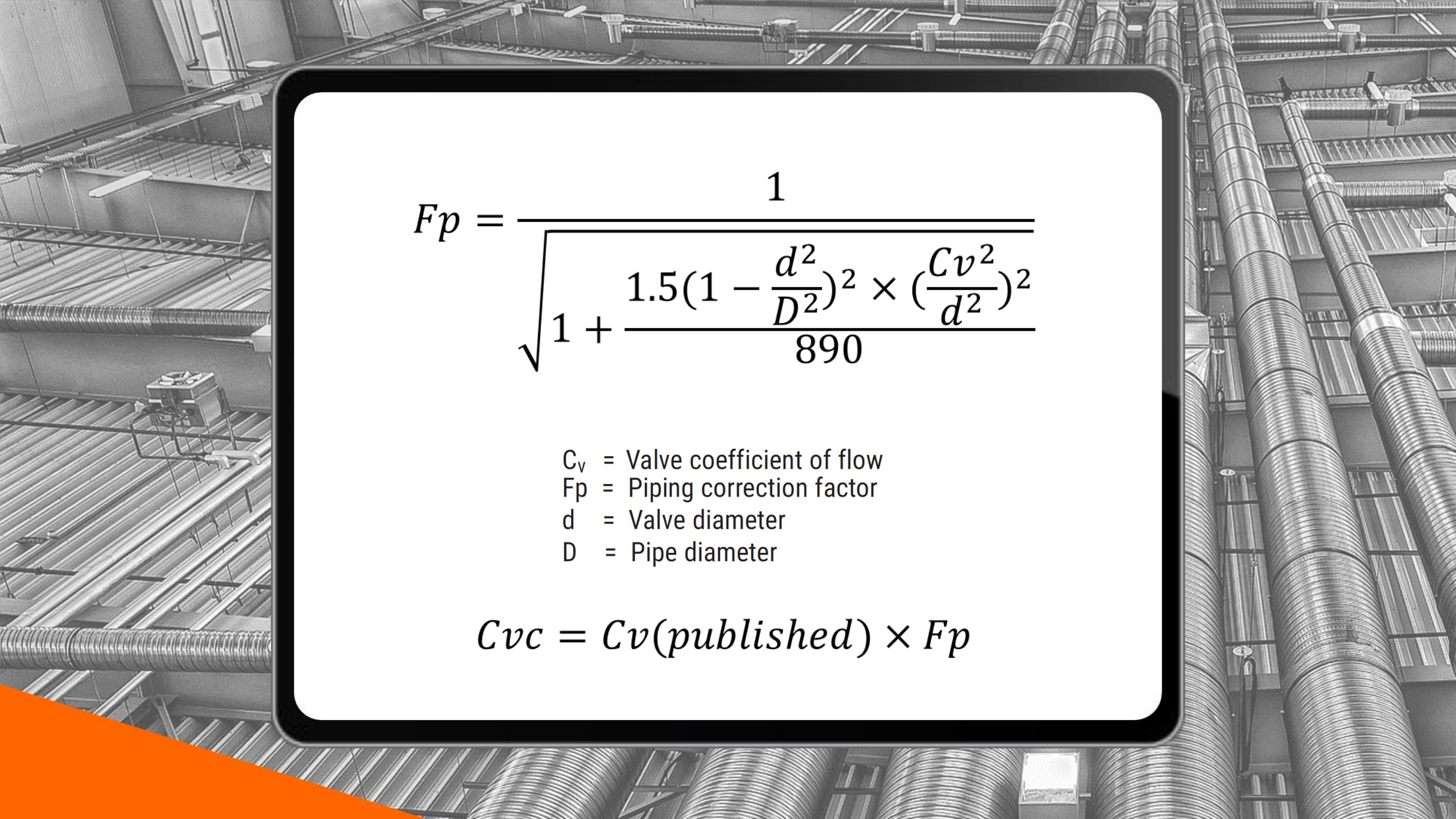


~~$C_v = 16$~~

$C_v = 7.2$

χ_2

A technical drawing of a valve assembly. It shows a horizontal pipe with a valve handle on top. The valve handle is a circular plate with four mounting holes. The valve body is a cylindrical component with a flange on the right side. The drawing is in a perspective view, showing the front and side of the assembly. The pipe is labeled with χ_2 in orange text.


$$Fp = \frac{1}{\sqrt{1 + \frac{1.5(1 - \frac{d^2}{D^2})^2 \times (\frac{Cv^2}{d^2})^2}{890}}}$$

C_v = Valve coefficient of flow

Fp = Piping correction factor

d = Valve diameter

D = Pipe diameter

$$Cvc = Cv(\text{published}) \times Fp$$

Microsoft Excel interface showing a formula in cell C13:

$$=1/\text{SQRT}(1+((1.5*(1-(\$C\$11/\$C\$12)^2)/890)*((C10/\$C\$11)^2))$$

The spreadsheet contains the following data and formulas:

Formula for F_p :

$$F_p = \frac{1}{\sqrt{1 + \frac{1.5(1 - \frac{d^2}{D^2})^2 \times (\frac{C_v^2}{d^2})^2}{890}}}$$

Legend:

- C_v = Valve coefficient of flow
- F_p = Piping correction factor
- d = Valve diameter
- D = Pipe diameter

Table of C_v values:

C_v	Corrected
16	7.2
10	6.3
7.4	5.5
4.7	4.1
3	2.8
1.9	1.9
1.2	1.2
0.8	0.8
0.3	0.3

Formula for C_{vc} :

$$C_{vc} = C_v(\text{published}) \times F_p$$

Rules of Thumb – Pipe Reduction Factor

- The control valve shall be no less than $\frac{1}{2}$ the pipe size...

- However, it's best to keep the reduction to 2 pipe sizes or less.

(Large pipe reductions can increase the effects of cavitation)



A photograph of a complex industrial piping system, likely in a refinery or chemical plant. The system features numerous horizontal and vertical pipes, many of which are equipped with orange actuators and pressure gauges. The pipes are organized into rows, and the background shows more of the facility's infrastructure. An orange rectangular overlay is positioned on the left side of the image, containing the text 'Valve Technologies' in white.

Valve Technologies

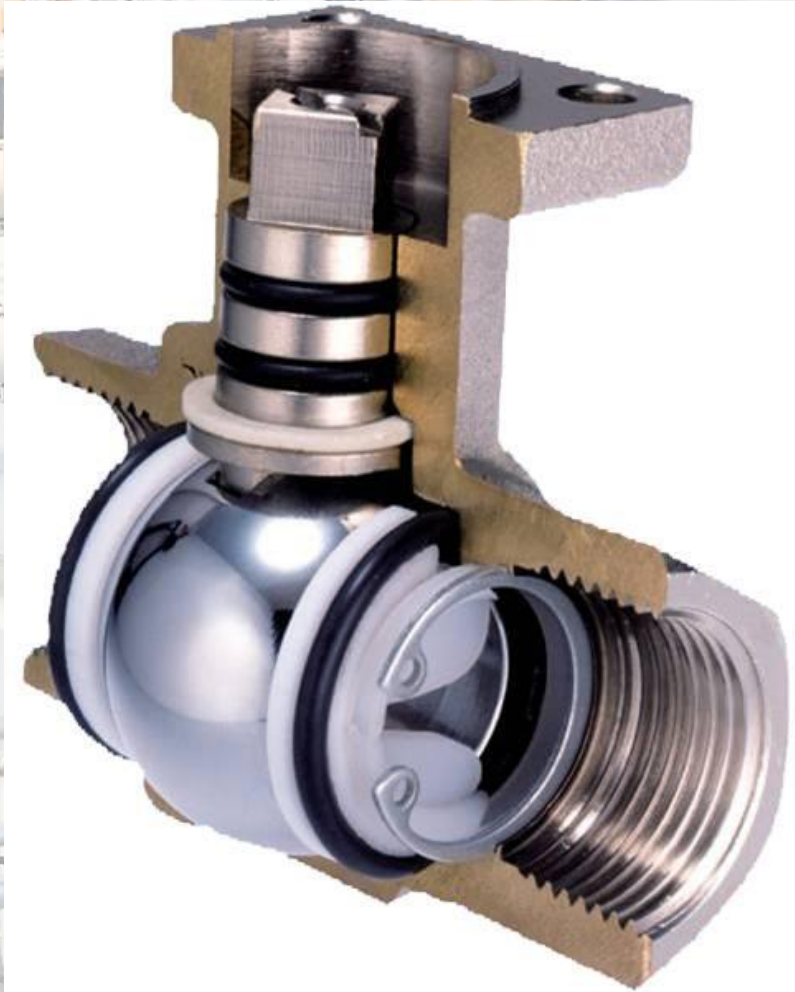
Characterized Ball Valve



Rotary Action



Characterizing Disc



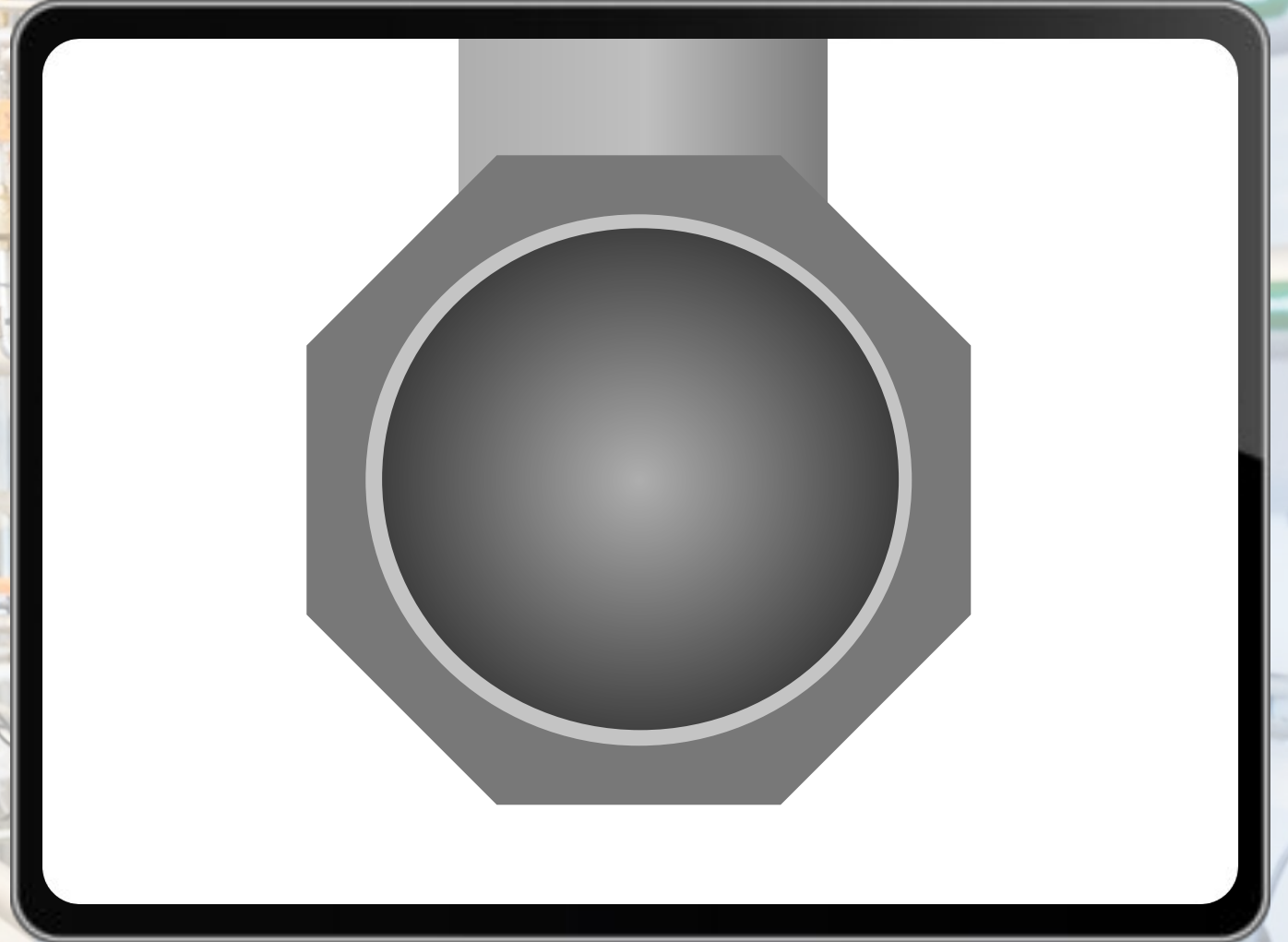
Characterized Ball Valve



Rotary Action



Characterizing Disc



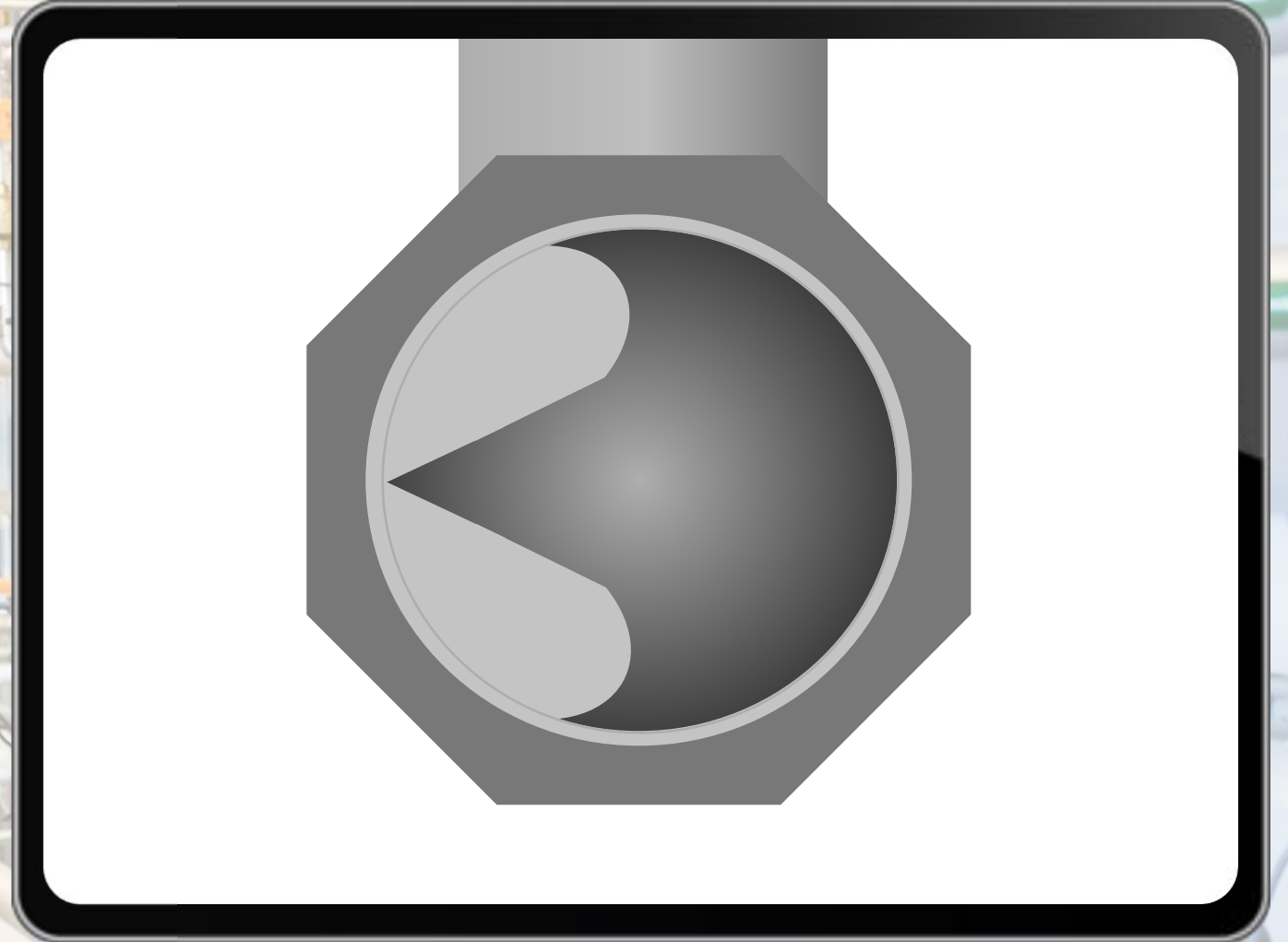
Characterized Ball Valve



Rotary Action



Characterizing Disc



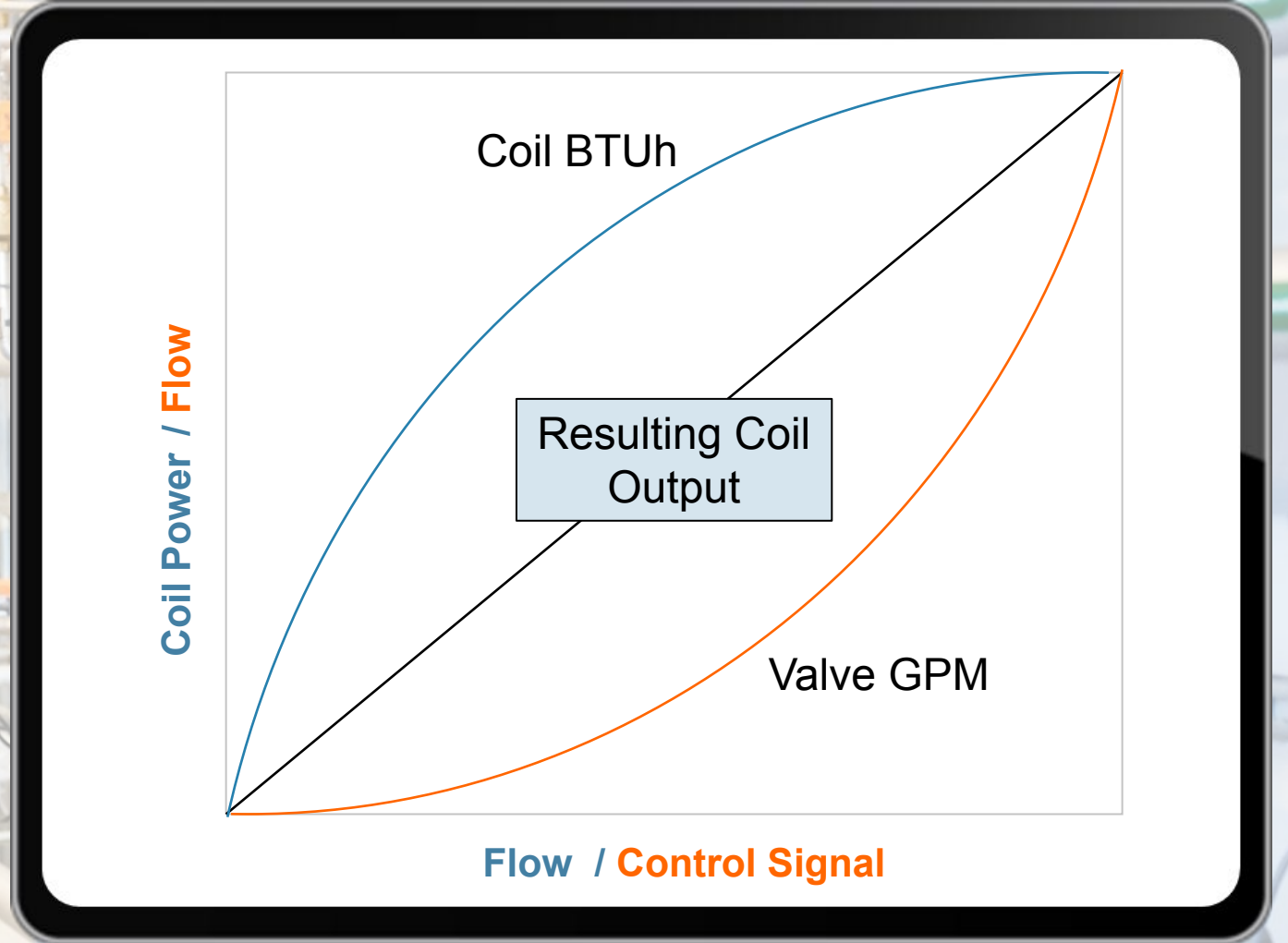
Characterized Ball Valve



Rotary Action



Characterizing Disc



Ball Zone Valves



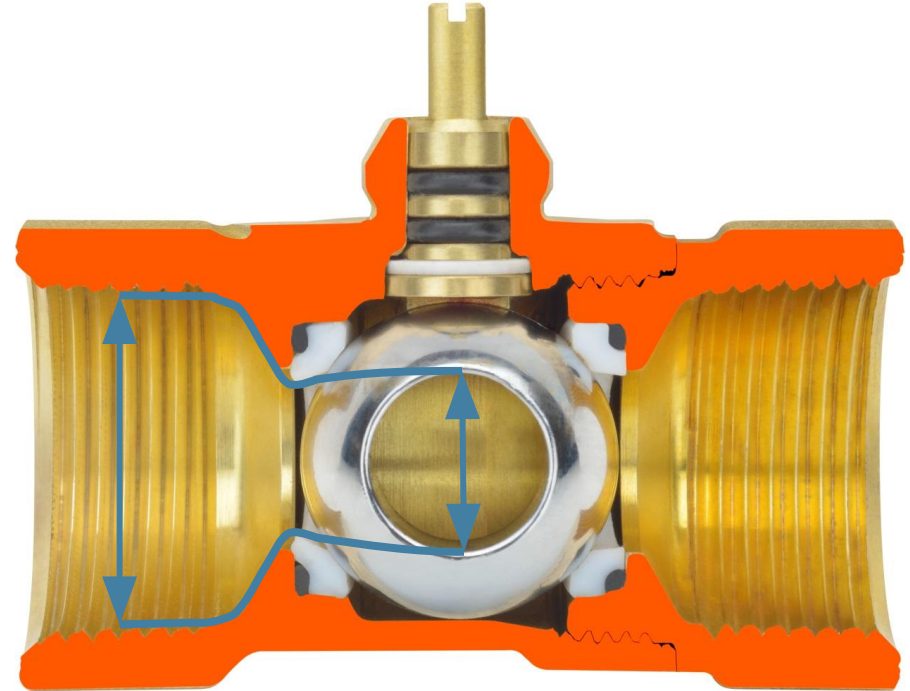
Rotary Action



Compact Size



Equal Percentage



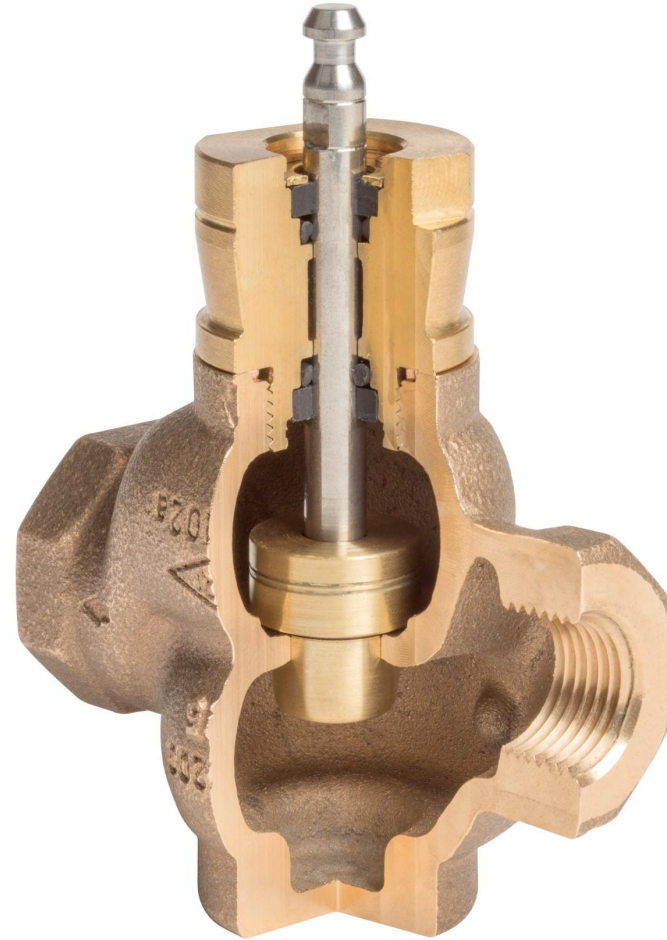
Globe Valve



Linear Action



Plug Design



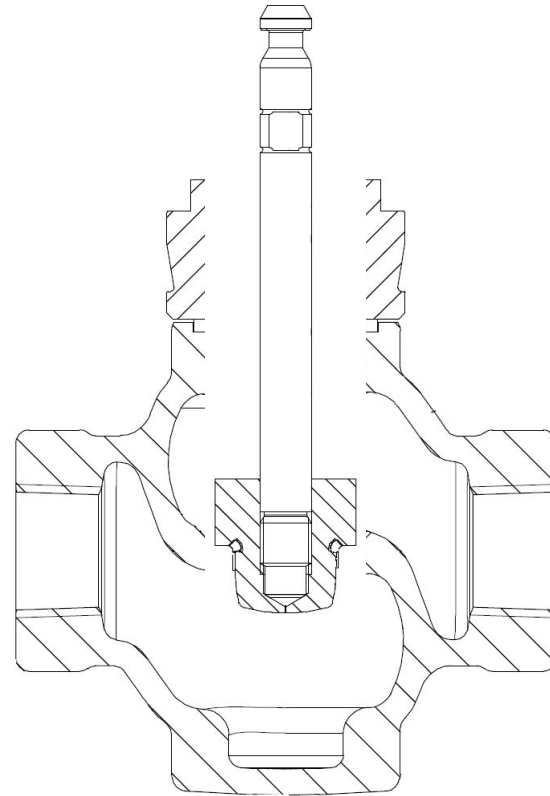
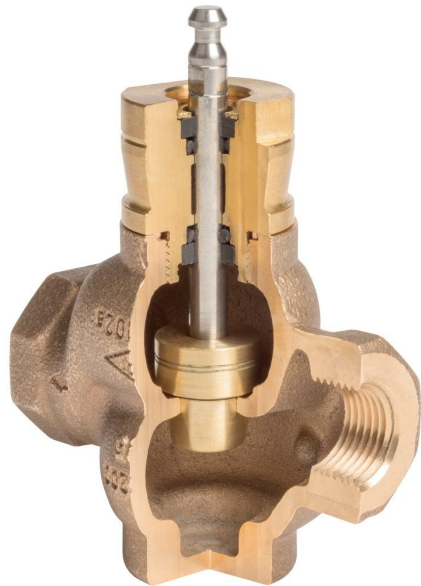
Globe Valve



Linear Action



Plug Design



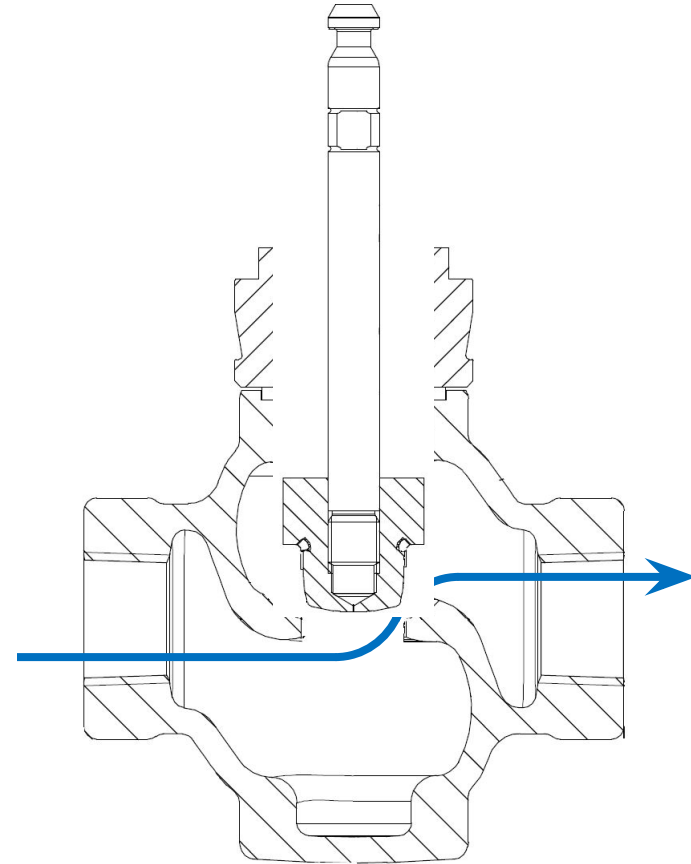
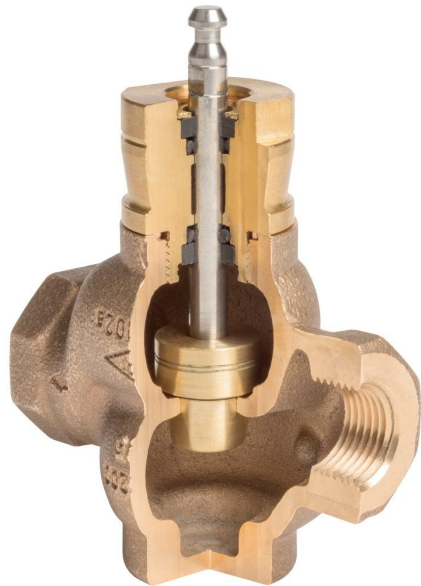
Globe Valve



Linear Action



Plug Design



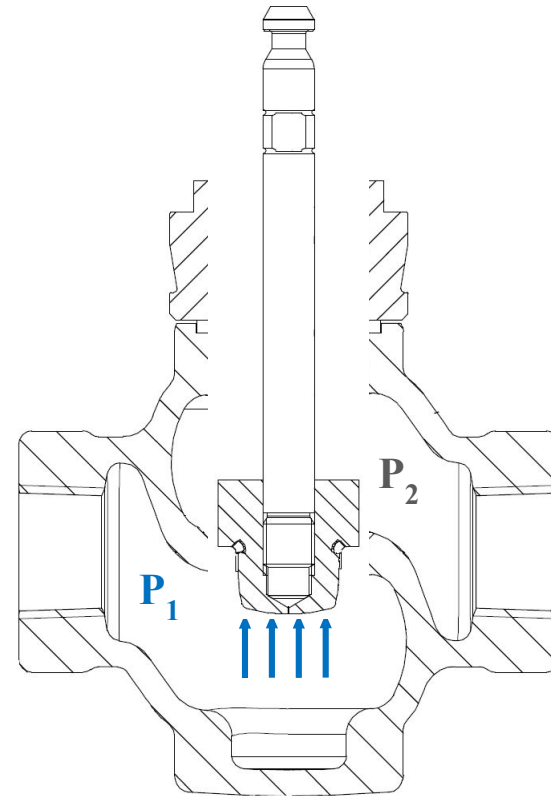
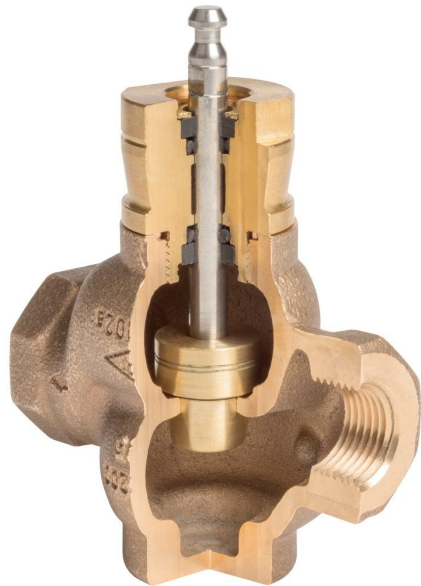
Globe Valve



Linear Action



Plug Design



Globe Valve



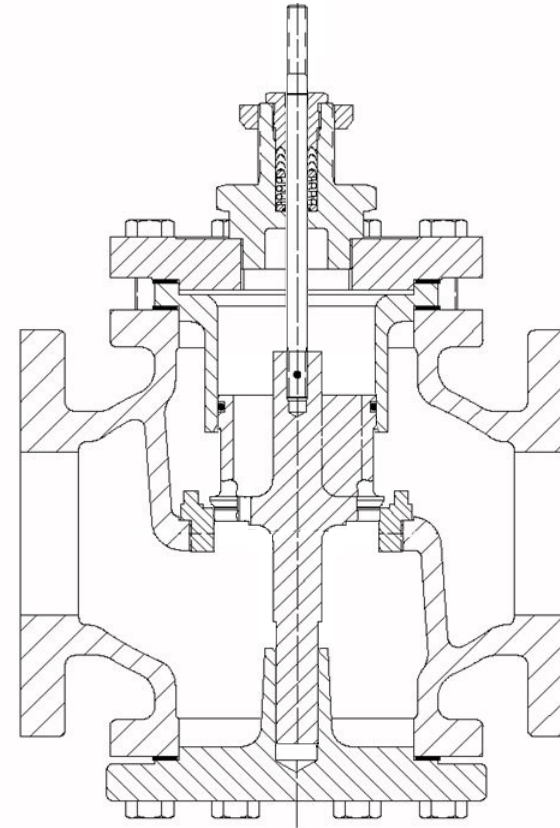
Linear Action



Plug Design



**Pressure
Compensation**



Globe Valve



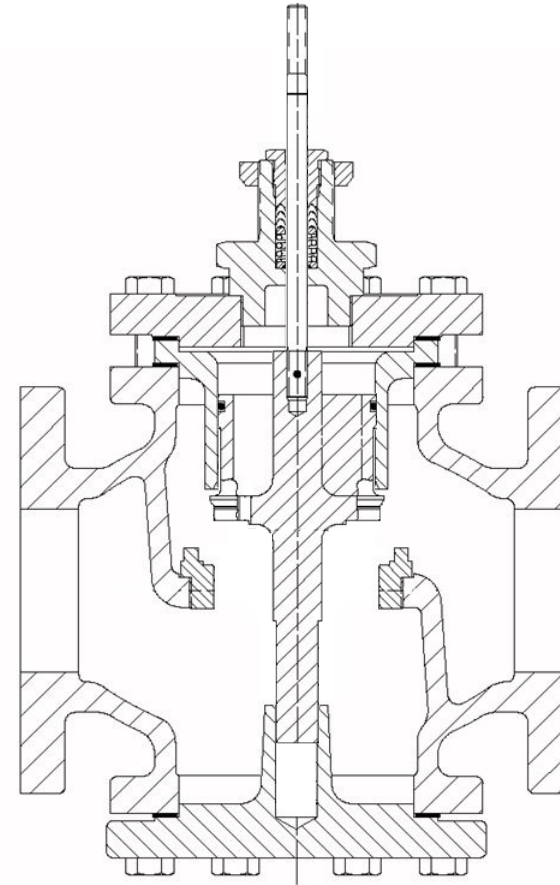
Linear Action



Plug Design



**Pressure
Compensation**



Globe Valve



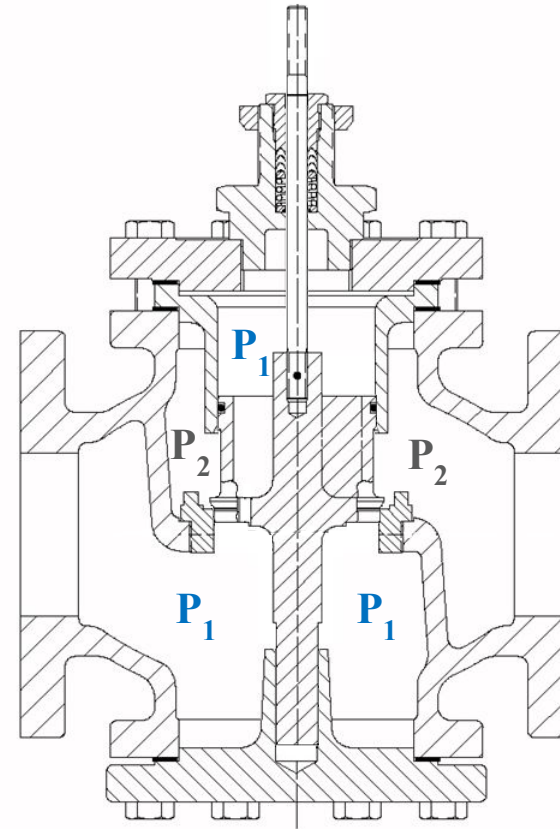
Linear Action



Plug Design



Pressure
Compensation



Globe Valve



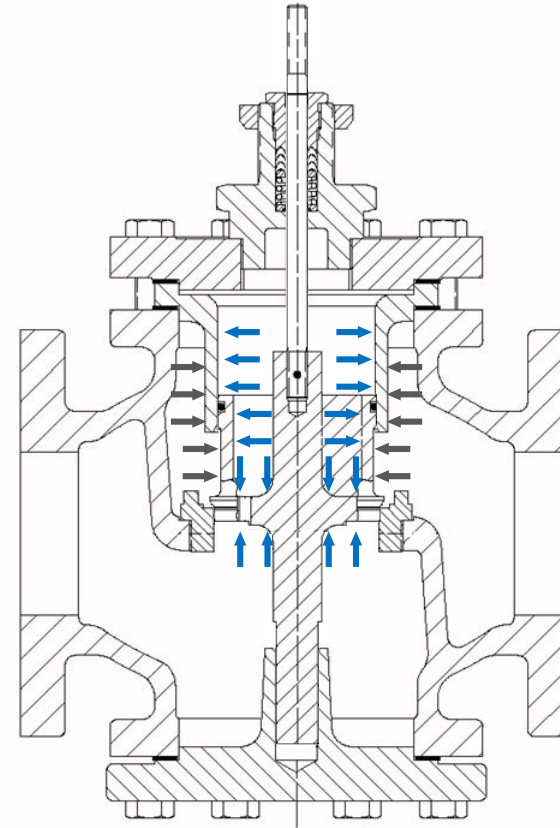
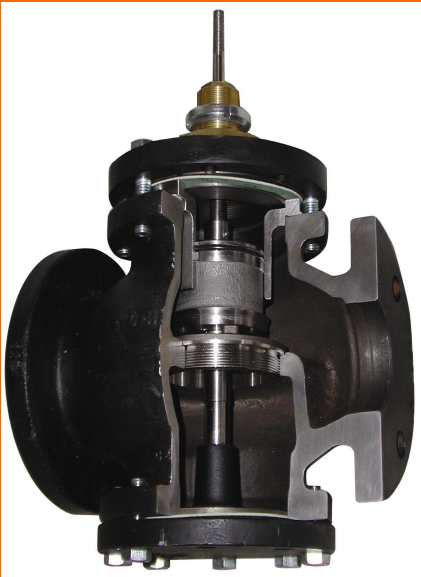
Linear Action



Plug Design



Pressure
Compensation



Globe Valve



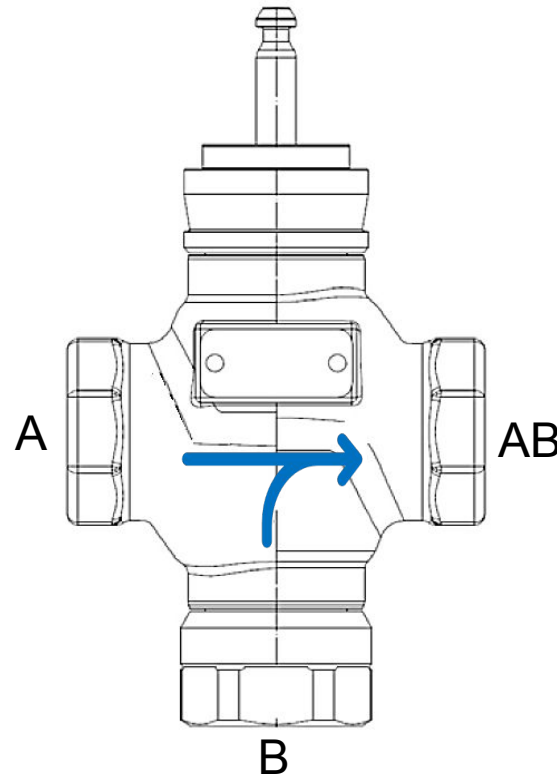
Linear Action



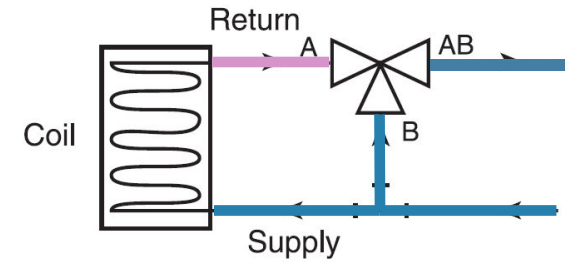
Plug Design



3-Way Applications



3-Way Mixing



Globe Valve



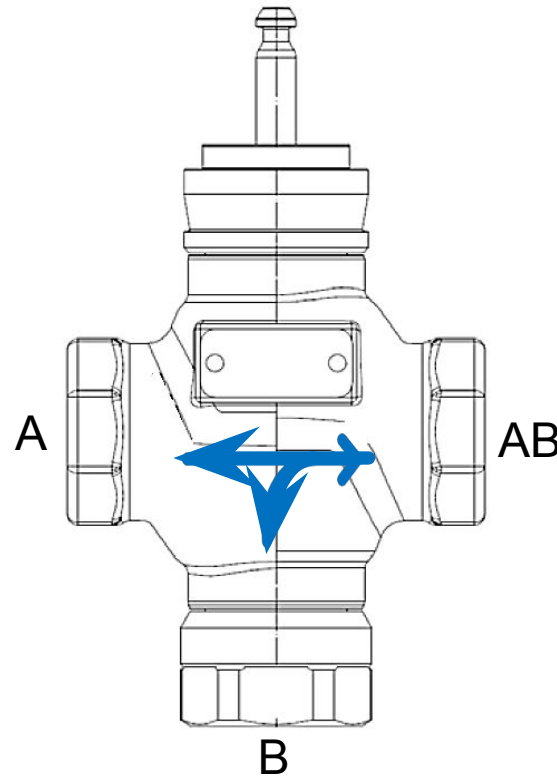
Linear Action



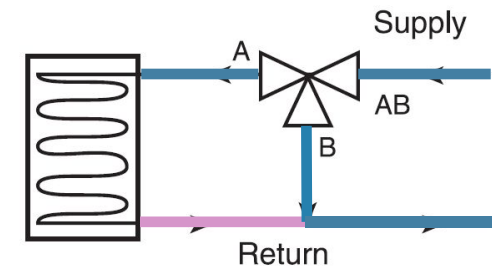
Plug Design



3-Way Applications



3-Way Diverting



Globe Valve



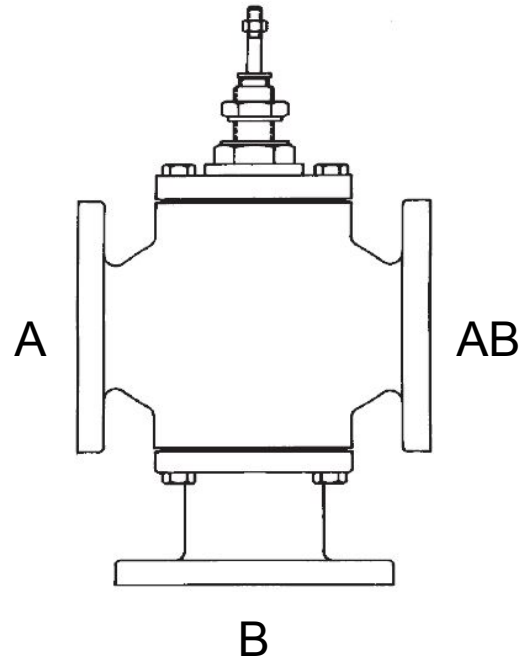
Linear Action



Plug Design



3-Way Applications



3-Way
Diverting Only

Globe Valve



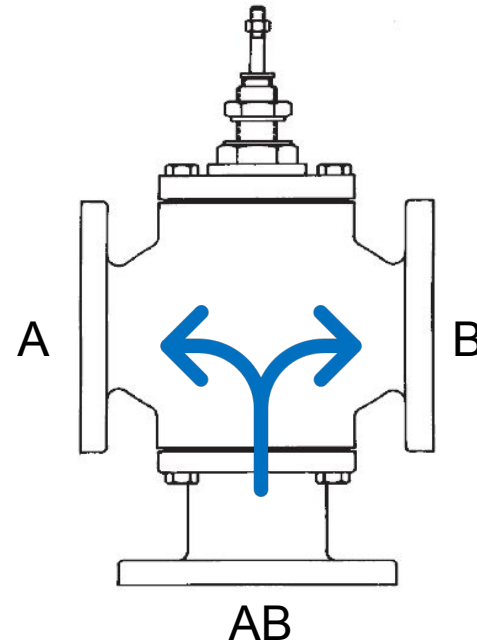
Linear Action



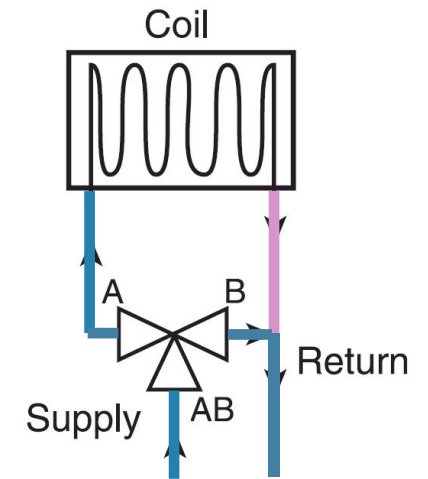
Plug Design



3-Way Applications



3-Way
Diverting Only



Butterfly Valve



Rotary Action



**Rotating Disk and
Resilient Seat**



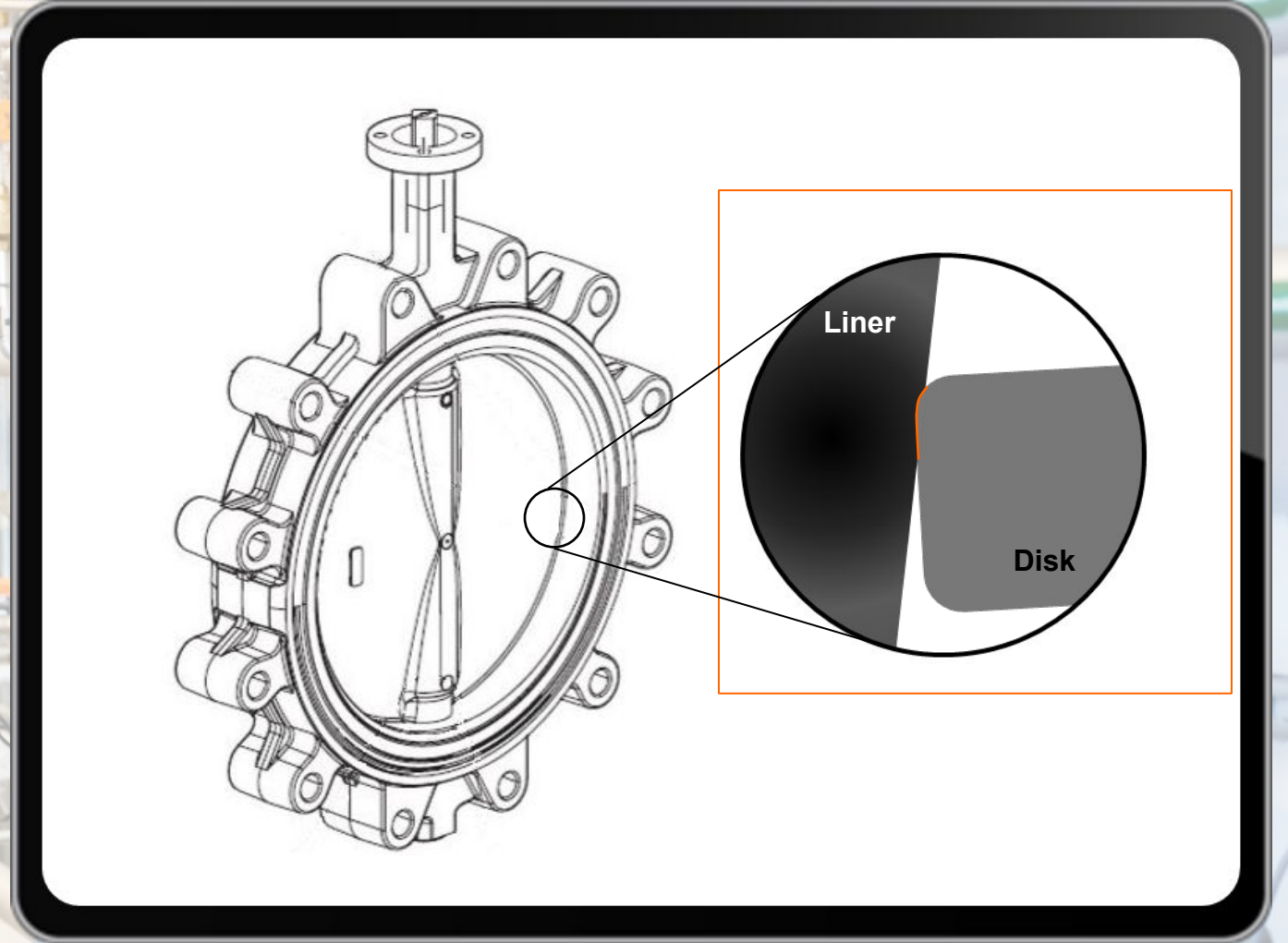
Butterfly Valve



Rotary Action



**Rotating Disk and
Resilient Seat**



Butterfly Valve



Rotary Action



Rotating Disk and
Resilient Seat



Sizing

2-Way Full Rated Disc

Model #	Cv 90°	Cv 60°	Size [mm]
F6100HD	600	230	4" [100]
F6125HD	1022	392	5" [125]
F6150HD	1579	605	6" [150]
F6200L	3136	1202	8" [200]
F6250L	5340	2047	10" [250]
F6300L	8250	3162	12" [300]

Rules of Thumb –Valve Sizing

- Modulating Applications are sized to 60° Cv
- On/Off Applications are typically line size



Butterfly Valve



Rotary Action



Rotating Disk and
Resilient Seat



Sizing

Flow in Schedule 40 Pipe (Fluid Velocity in GPM).			
SIZE	4 FPS	8 FPS	12 FPS
2"	39	78	118
2½"	61	122	184
3"	88	176	264
4"	157	313	470
5"	245	490	734
6"	352	705	1058
8"	627	1253	1880
10"	979	1958	2738
12"	1410	2820	4230
14"	1919	3838	5758
16"	2507	5013	7520
18"	3173	6345	9518
20"	3917	7834	11750
24"	5640	11280	16921

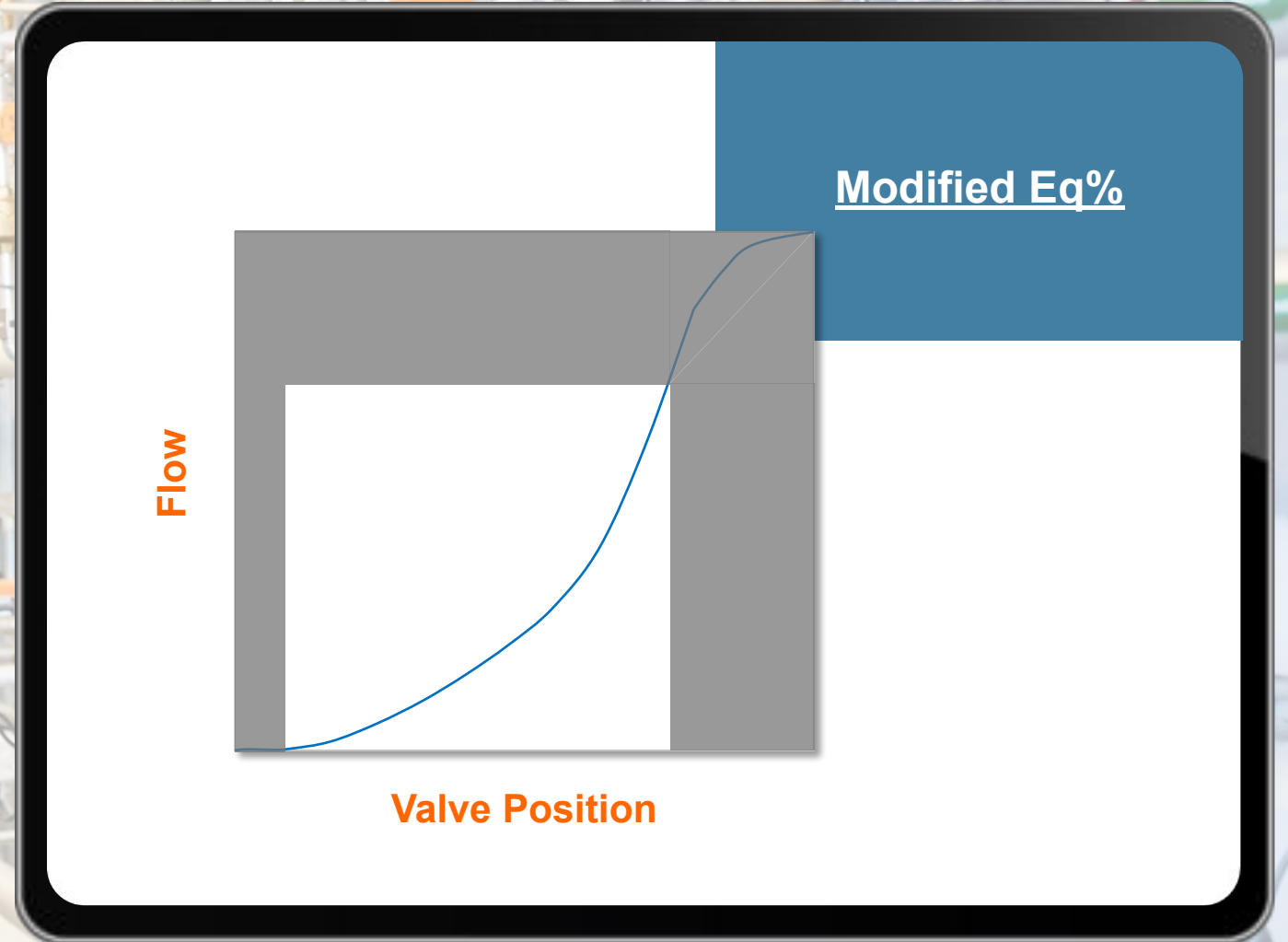
Butterfly Valve



Rotary Action



Rotating Disk and
Resilient Seat



Butterfly Valve



Rotary Action



Rotating Disk and
Resilient Seat



High Performance Butterfly Valve



High Temp, High
Pressure Applications



High Fluid Velocity
up to 32 ft/s



High Performance Butterfly Valve



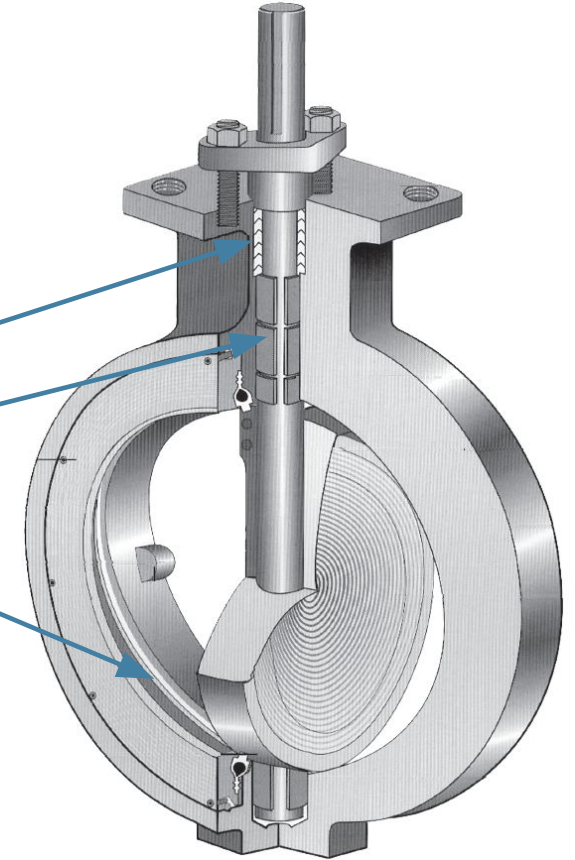
High Temp, High
Pressure Applications



High Fluid Velocity
up to 32 ft/s



Heavy Duty
Packing, Bearings,
Body & Stem



6-Way Control Valve



Single Point of
Control



4-Pipe System with
Single Coil
Equipment



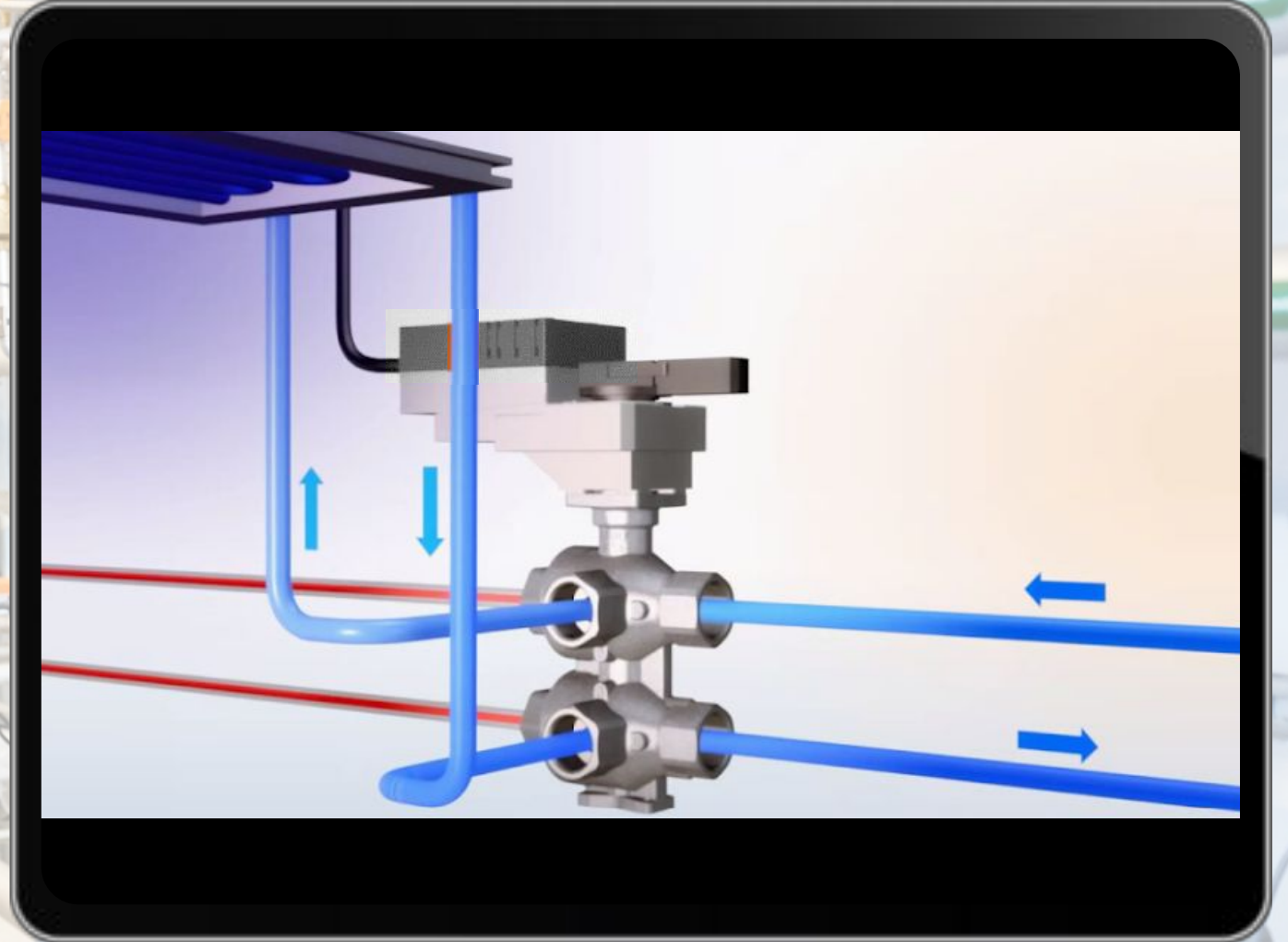
6-Way Control Valve



Single Point of
Control



4-Pipe System with
Single Coil
Equipment

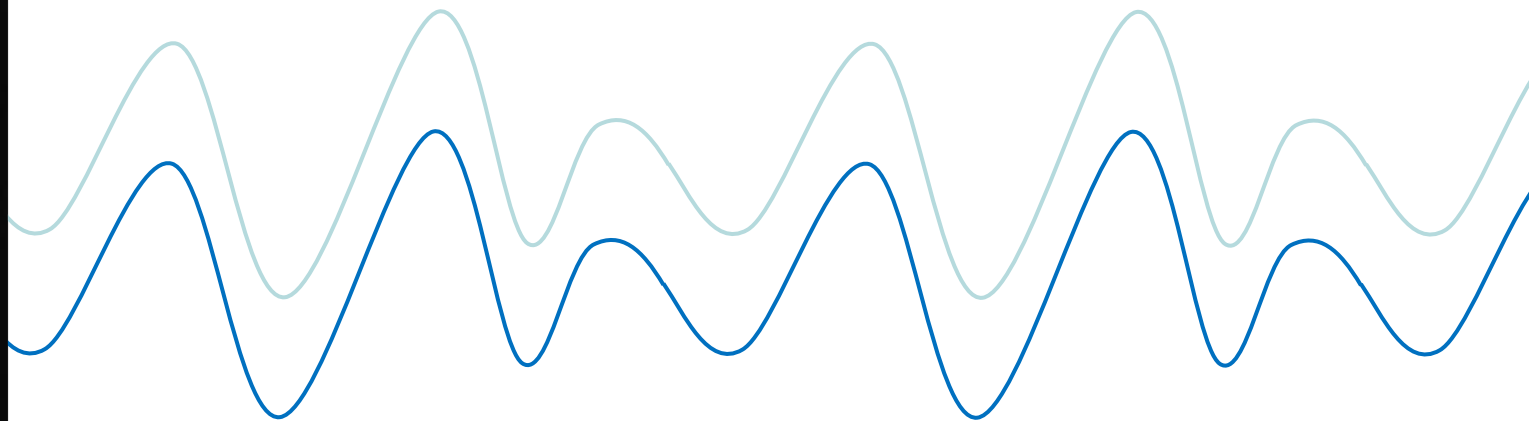


Pressure Independent Control Valves



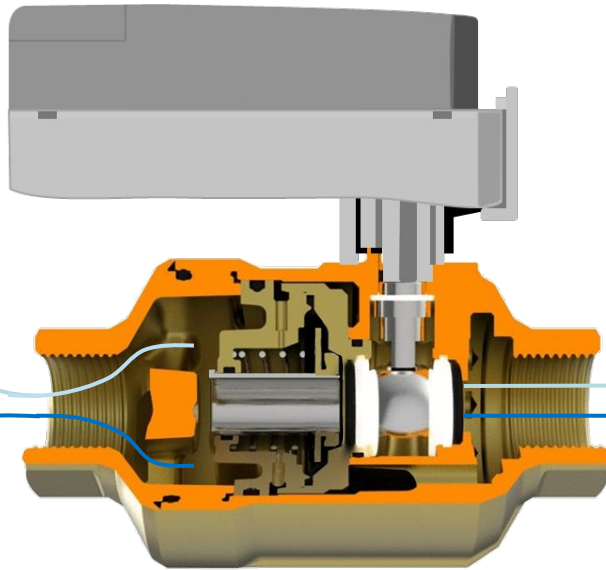
Pressure

Flow



Pressure

Flow



Pressure Independent Control Valves

Key Take-Aways

1. ANSI Body Pressure ratings relate pressure and temperature
2. Equal Percentage flow characteristics are perfect for liquid water coils
3. 6-Way control Valves offer a unique solution for single-coil equipment
4. Pressure Independent Valves provide more reliable control in every application

Hydronic Control Valves

