Advantages of Quarter-turn Control Valves for Modulating Control

June 03, 2020

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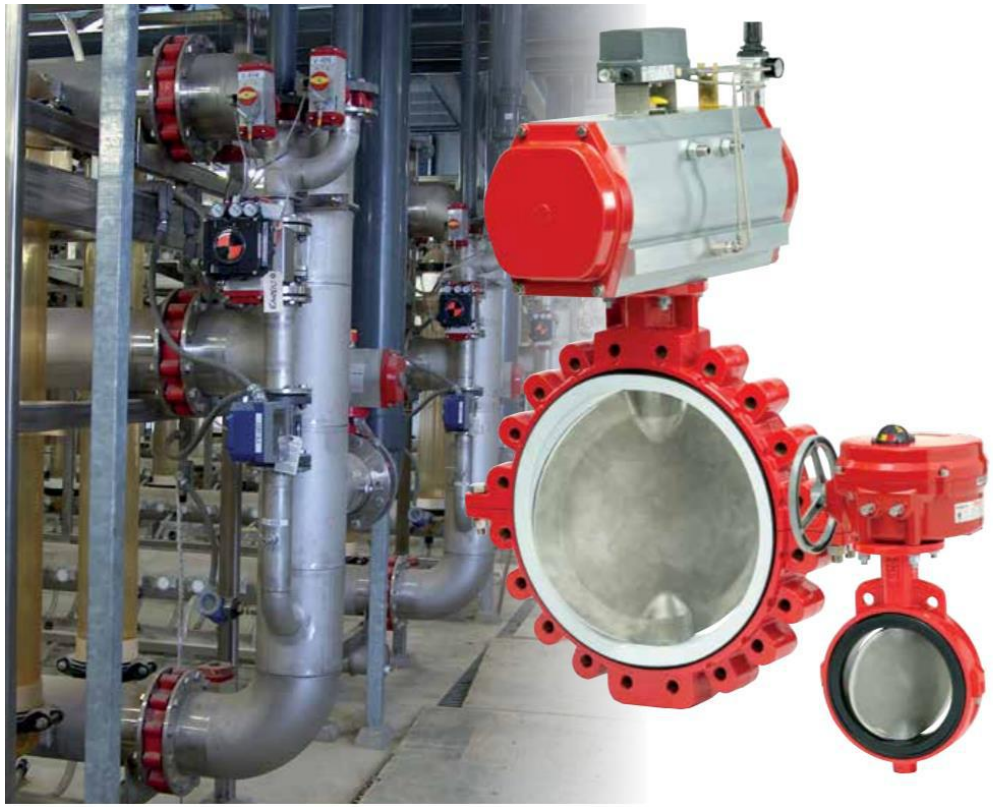
What We Will Cover in this Presentation

- What is a Control Valve?
- What is a Control Loop?
- Control Valve Types
- Control Valve Characteristics
- Advantages of Quarter-turn Control Valves
- Questions



What is a control valve?

- A control valve varies flow by introducing a restriction in the fluid flow for dissipating a portion of the energy developed by a pump, compressor or other pressure source.
- The control valve restriction must vary in area by some means to adjust the process.
- The control valve must experience a pressure drop through the valve to initiate a flow.
- A control valve is the Final Control Element in a control loop.

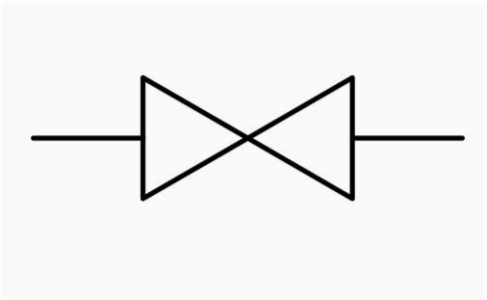
What is a control loop?

- A measurement device reads a process condition.
- The process condition measurement is transmitted to a controller that is programed with a set point for that process condition.
- The controller transmits a change signal to a final control element (control valve) to change its position to maintain the set point process condition.
- The process communication is either analog (4-20 mA) or digital (HART, Profibus, Modbus, DeviceNet) or it can be discrete (power on or off)

How are valves controlled?

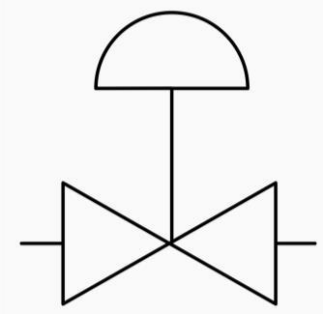
On/Off Batch Control

- Used in recipe process to add ingredients in certain quantity.
- Usually operates in the fully open position for a period of time until the ingredient amount is reached then closed.
- Usually operated by Solenoid Valve.

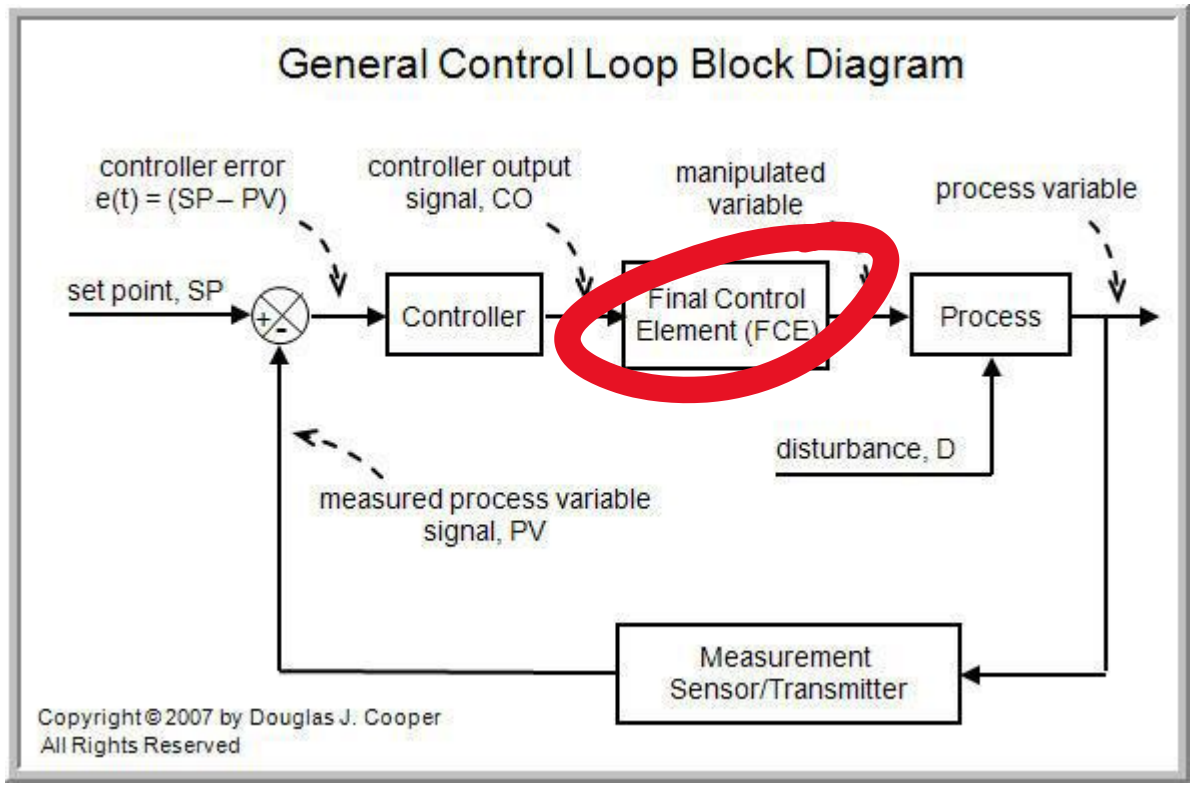


Continuous Control

- Used to control a measured variable in a continuously flowing process.
- Operated by a positioner that takes an input signal to move the valve to a percent open.
- The positioner adjusts the valve percent open to maintain the process set point.

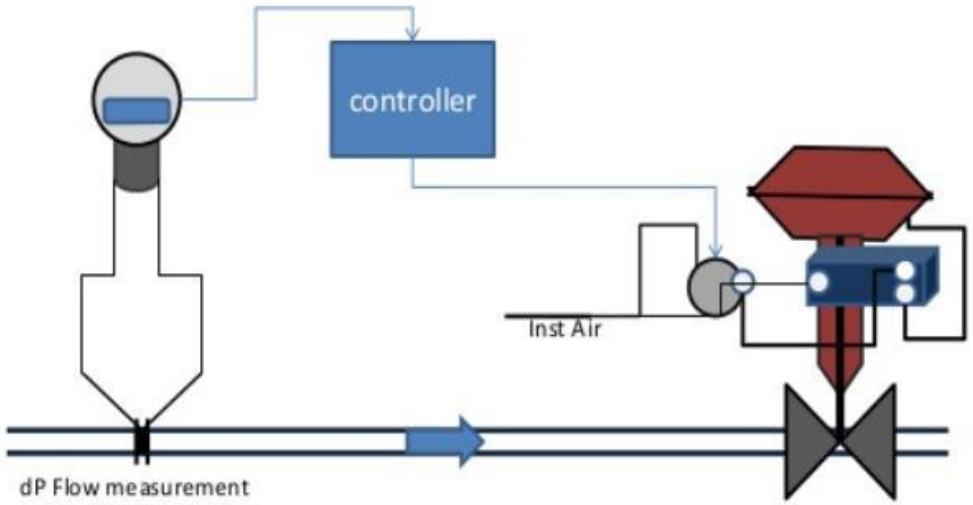


Control Loop

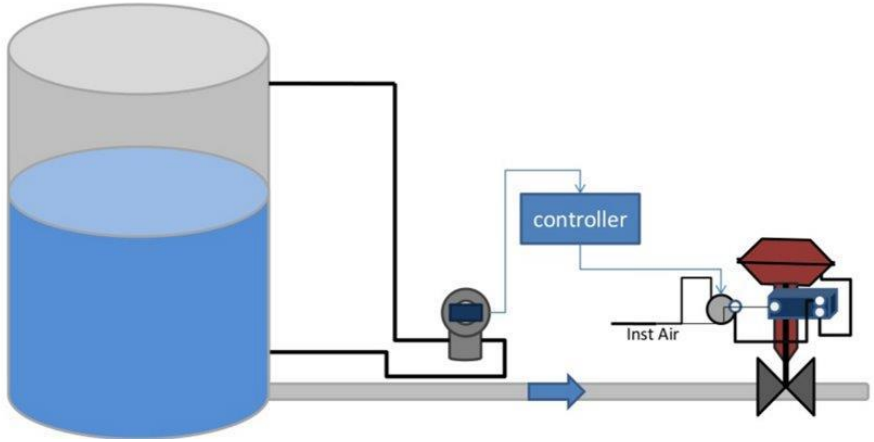


How are valves controlled?

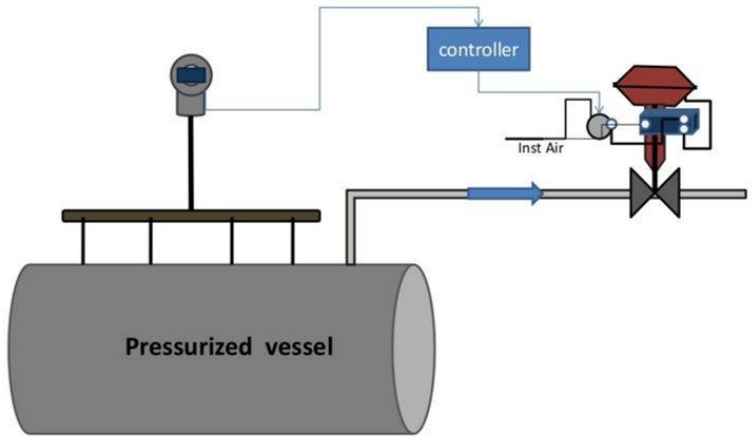
Control Valve in FLOW CONTROL



Control valve in LEVEL CONTROL

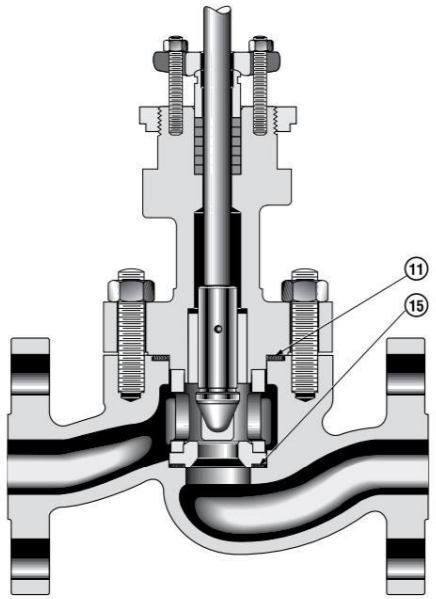


Control valve in PRESSURE CONTROL

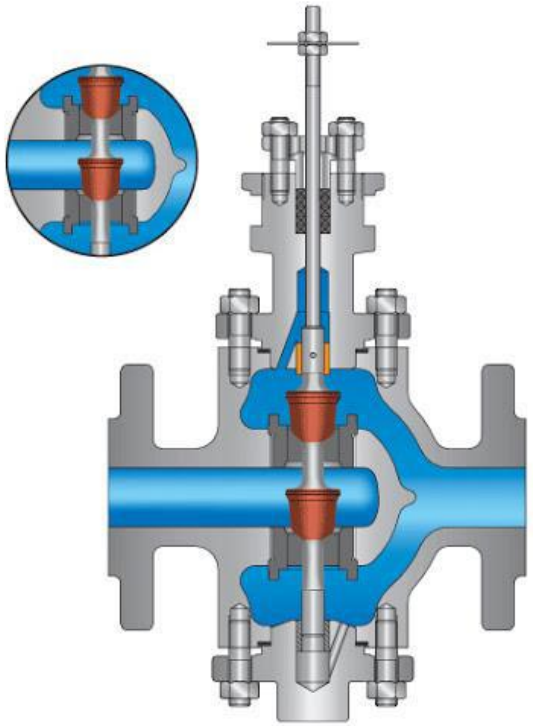


Types of Control Valves

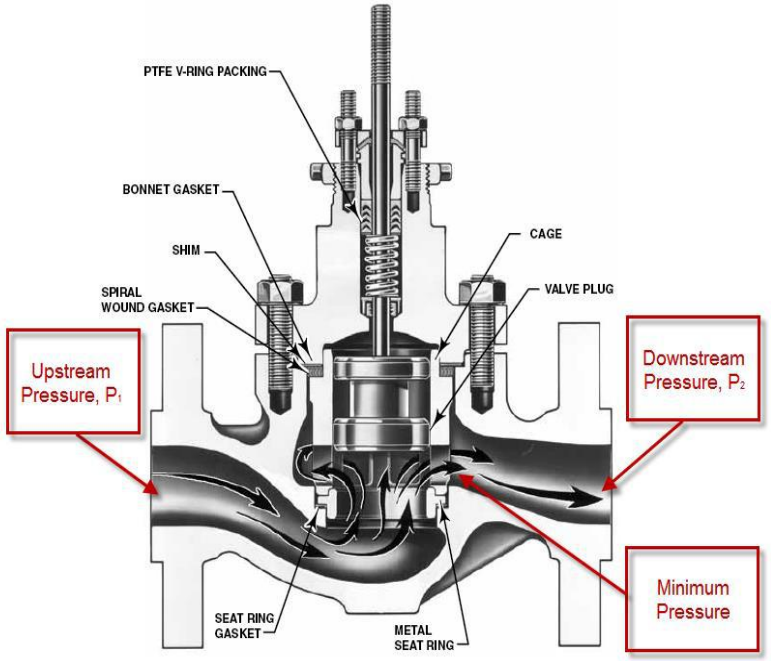
- **Linear Control Valves**



Unbalanced Trim Globe Top Guided



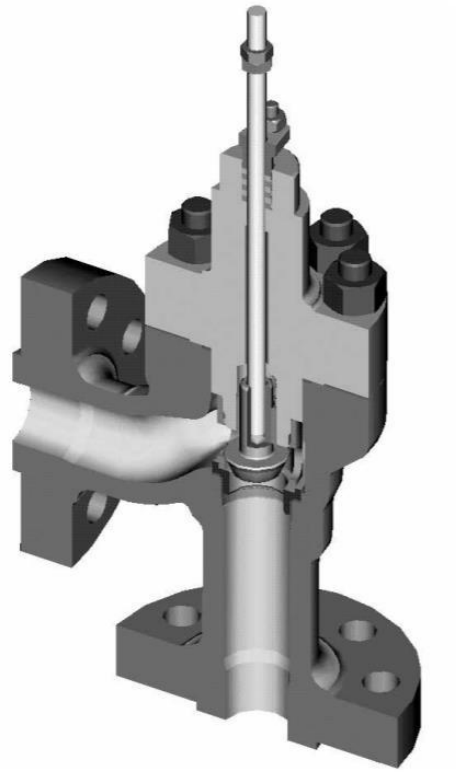
Balanced Trim



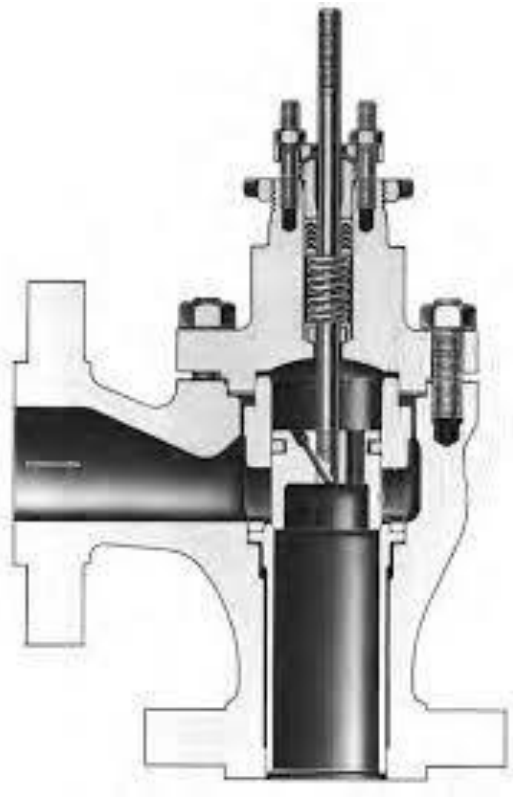
Cage Guided Trim

Types of Control Valves

- **Linear Control Valves**



Unbalanced Trim Angle Control Valve

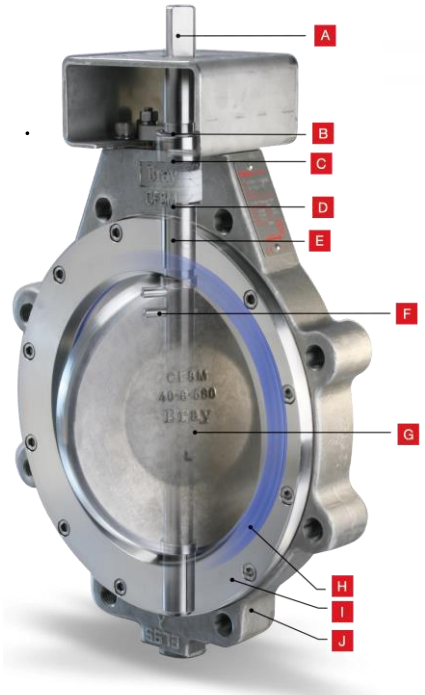


Balanced Cage Guided Trim Angle Control Valve

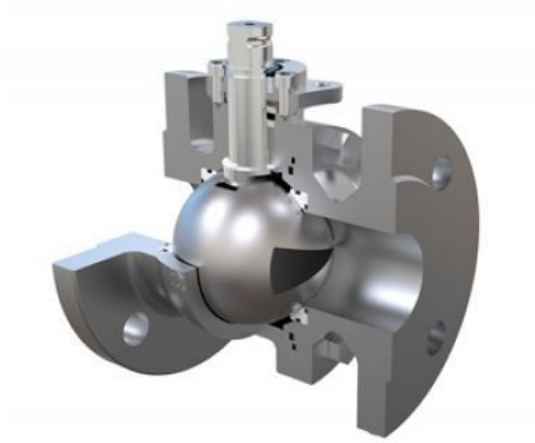
Types Control Valves

- **Rotary**

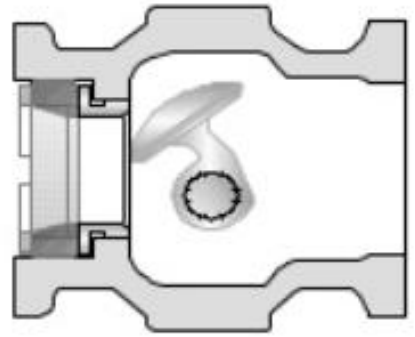
Butterfly Valve



Double Offset Butterfly



V-Ball Valve



Eccentric Plug

Segmented Ball Valve

Rotary Control Valve Solutions

Series 21

Series 31

Series 39

Series 40

Series 41

Series 41
Cryogenic

Series 19

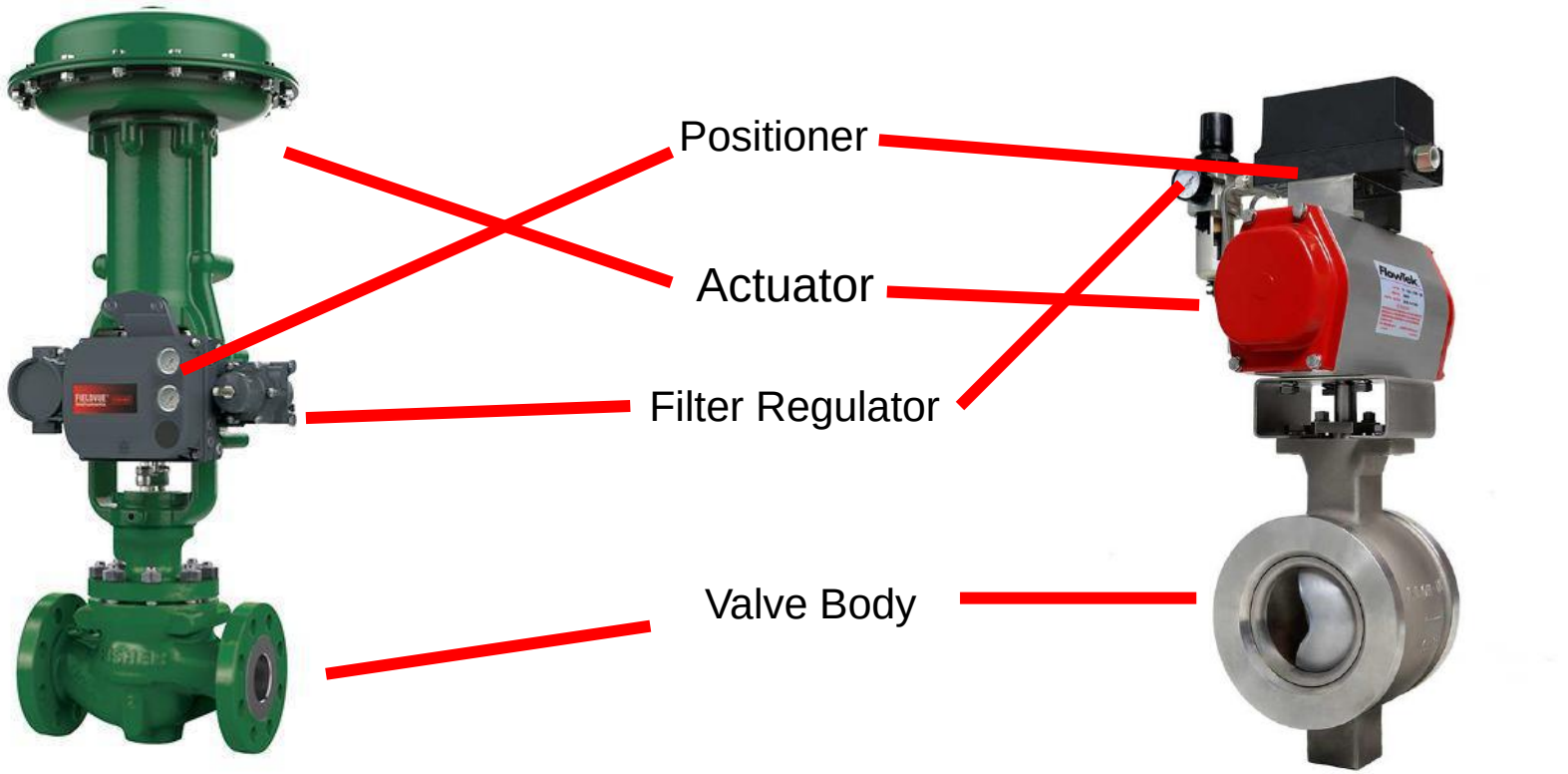
Series F15

Tri Lok

Components of a Control Valve

Globe Valve

Ball Valve



How do control valves control flow?

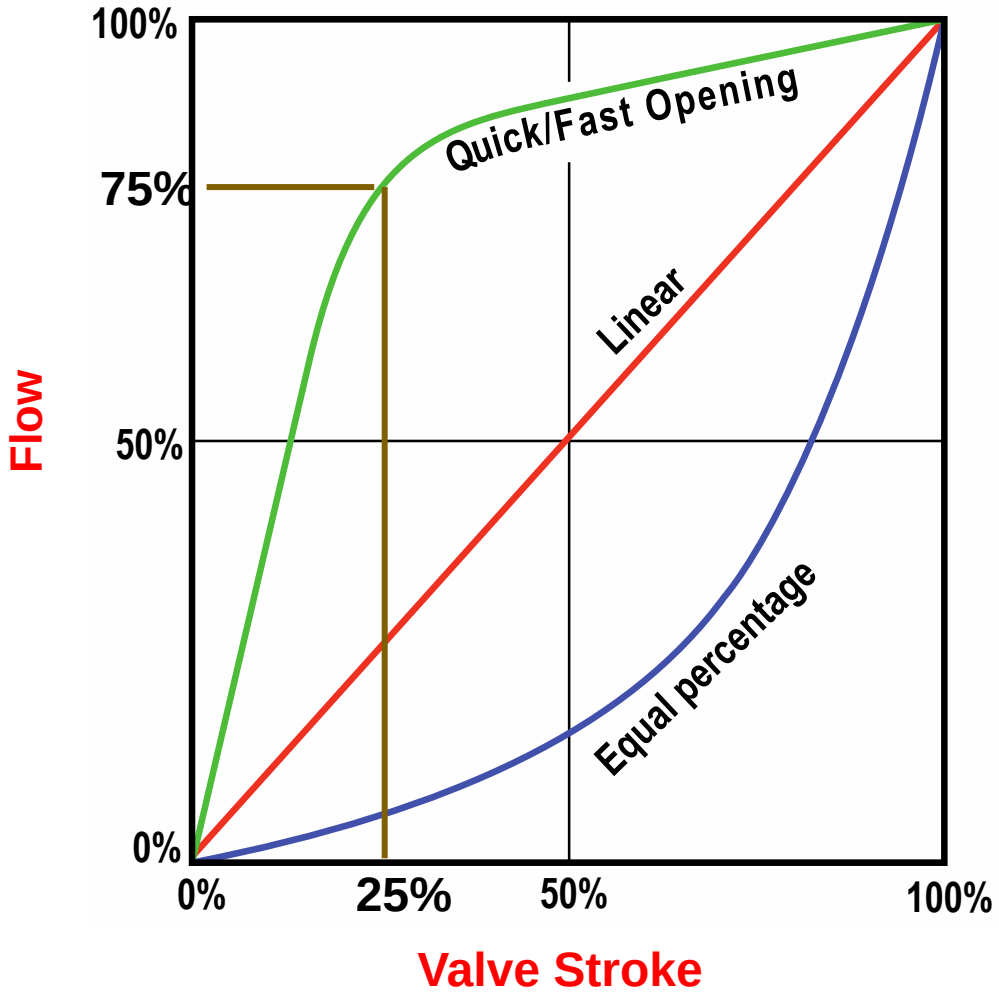
Control Valve Flow Characteristic

The definition of Flow Characteristic is the relationship between the open flow area through the valve trim and valve stroke between 0 to 100% or 0 to 90 degrees rotation in rotary control valves

Inherent Flow Characteristics

Fast or Quick Opening

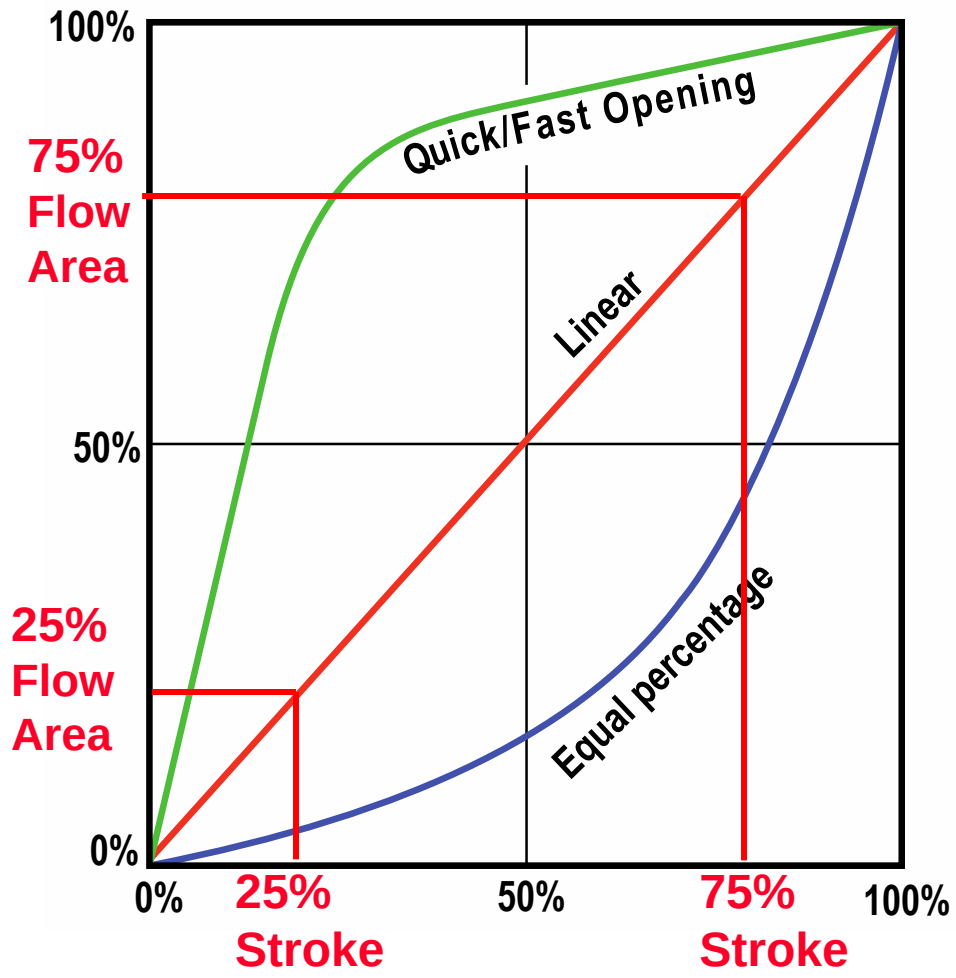
- Maximum flow area at minimum travel
  - 25% stroke = 75% flow
- Used in on/off applications –e.g. flair, vent, safety, cooling water systems
- Maximum Cv must be obtained quickly
- High flow for small valve openings



Inherent Flow Characteristics

Linear

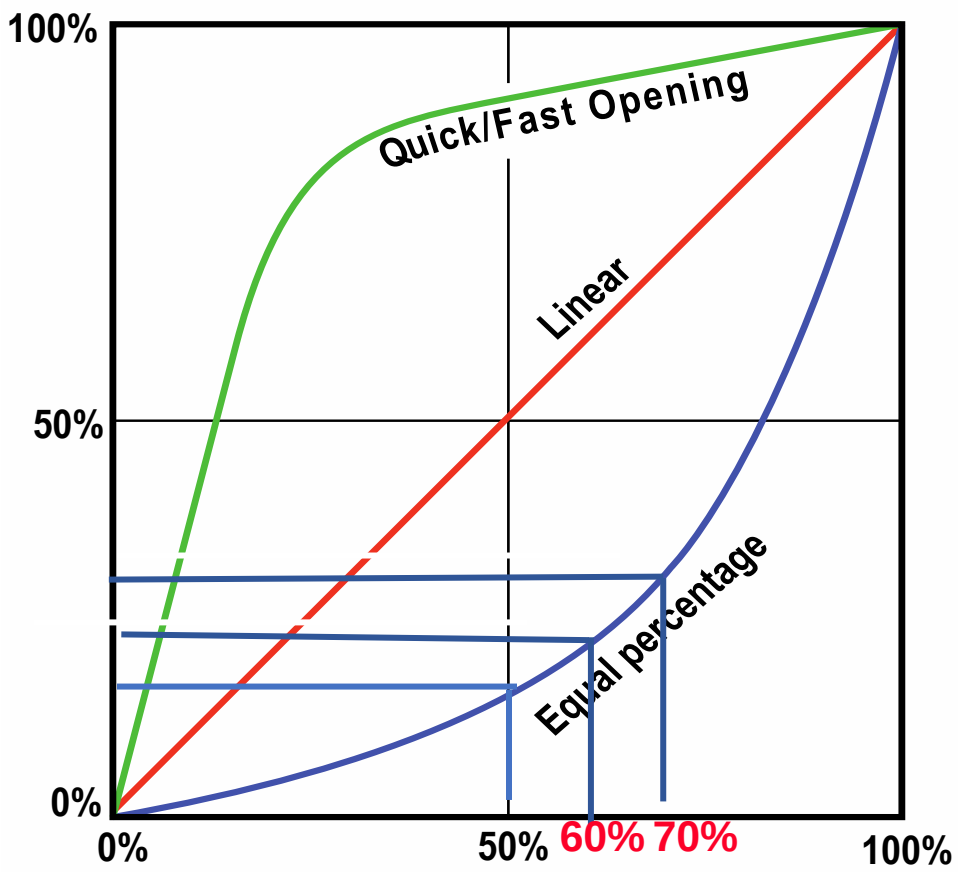
- Flow characteristic where
  - Change in stroke produces the same change in flow
- Used in slow process with constant pressure drop across valve (less piping used)
- Level control and flow control loops
- Equal flow for Equal Stroke Change



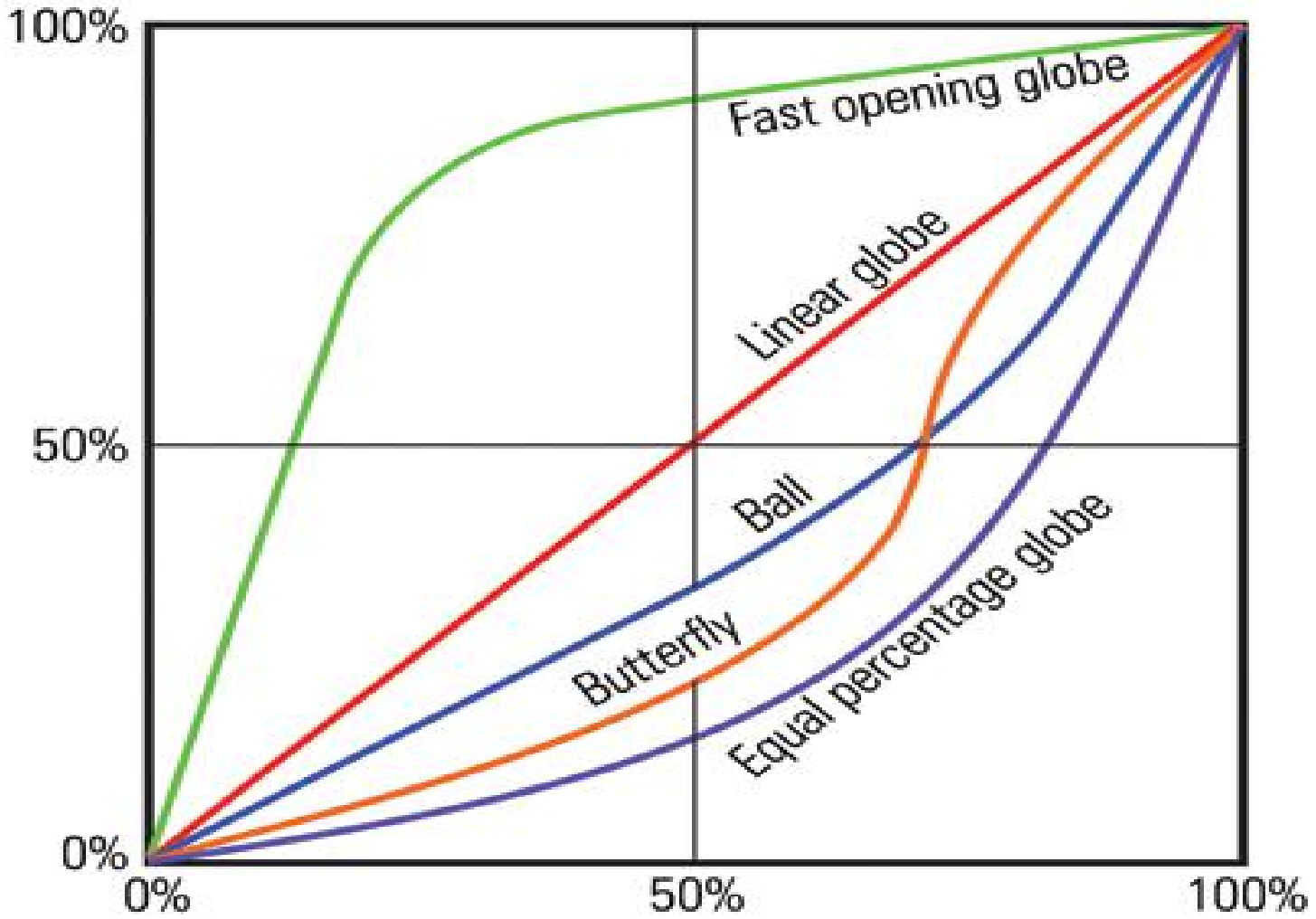
Inherent Flow Characteristics

Equal Percentage

- **Equal % change in stroke produces equal % change of existing flow**
- **Ex: Valve goes from 50% to 60%**
  - Δ Stroke = 10%
  - Flow @ 50% = 1200 gpm
  - Flow @ 60% = 2040 gpm
  - Δ Flow = 840 gpm (70%)
  - **Valves goes from 60% to 70%**
  - Δ Stroke = 10%
  - Flow @ 60% = 2040 gpm
  - Flow @ 70% = 3470 gpm
  - Δ Flow = 1430 gpm (70%)
- **Low Flow for smaller valve openings and Higher Flow for bigger valve openings**

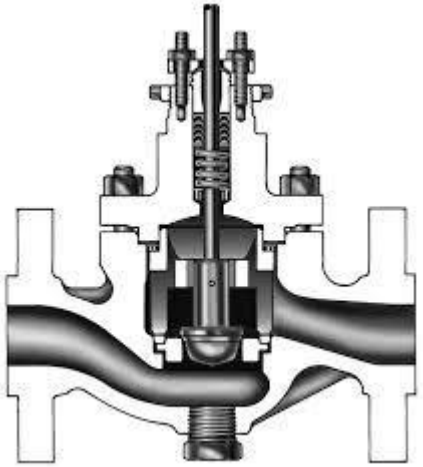


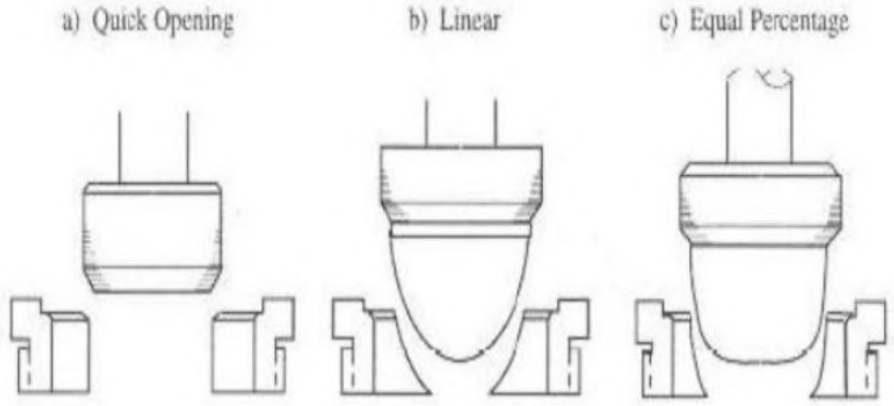
Inherent Flow Characteristics



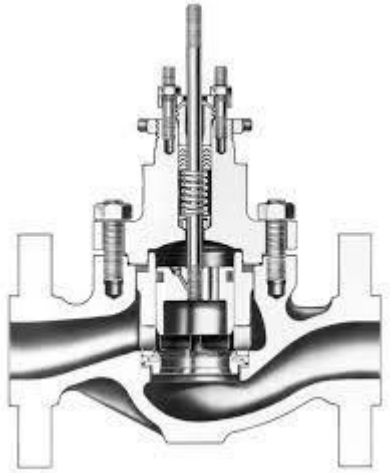
Linear Control Valve Trim Geometry Defines Characteristic

- **Plug Guided**



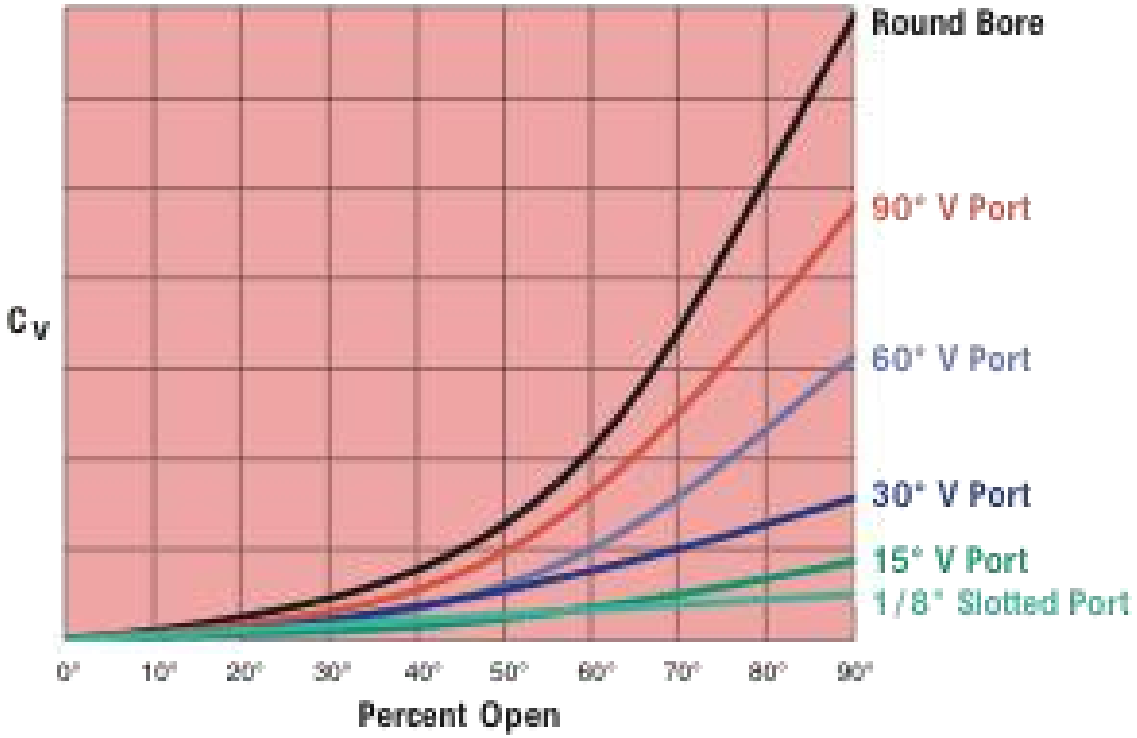


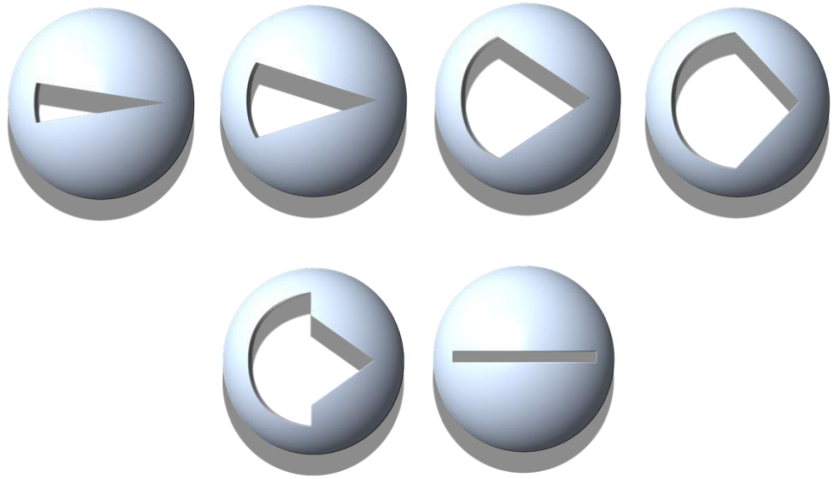
- **Cage Guided**



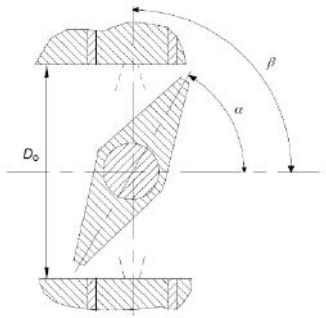
V-Ball Valve Trim defines Characteristic

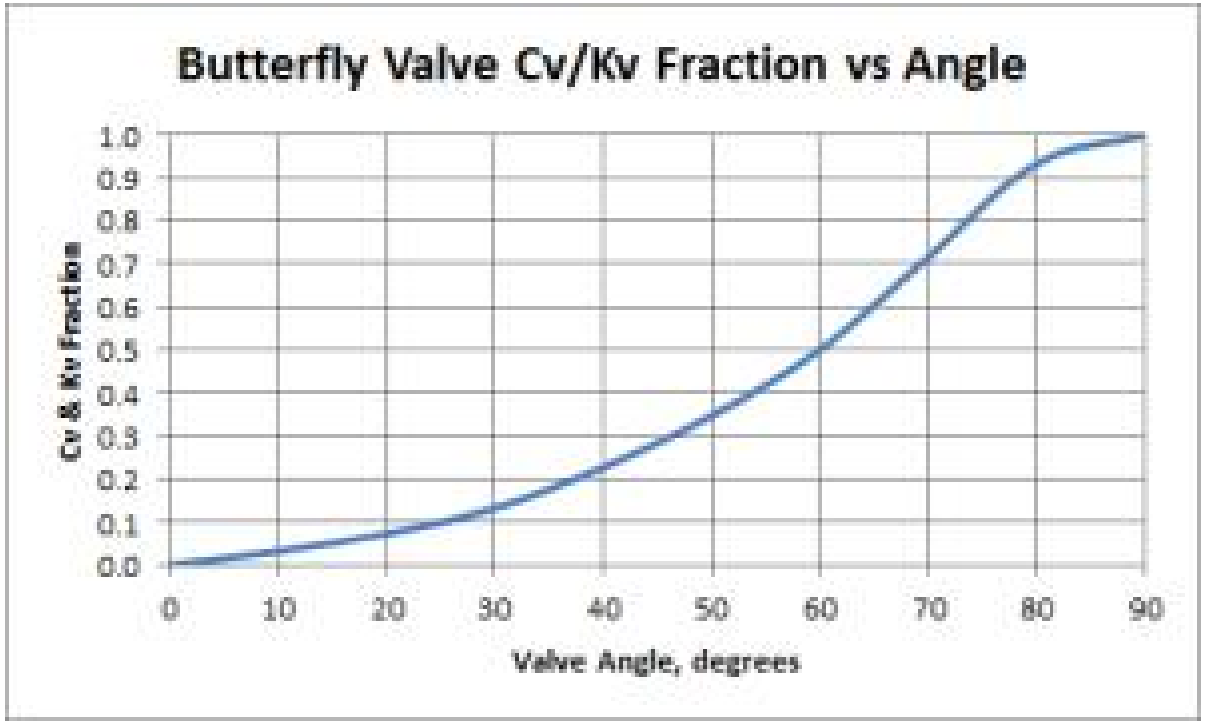
V-Ball Characteristic Curves



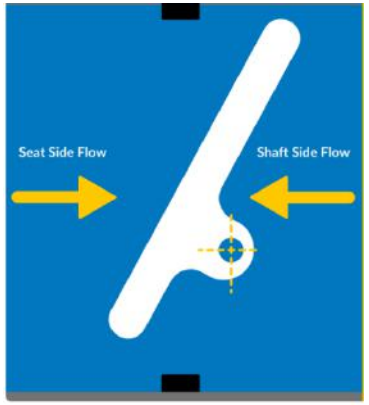


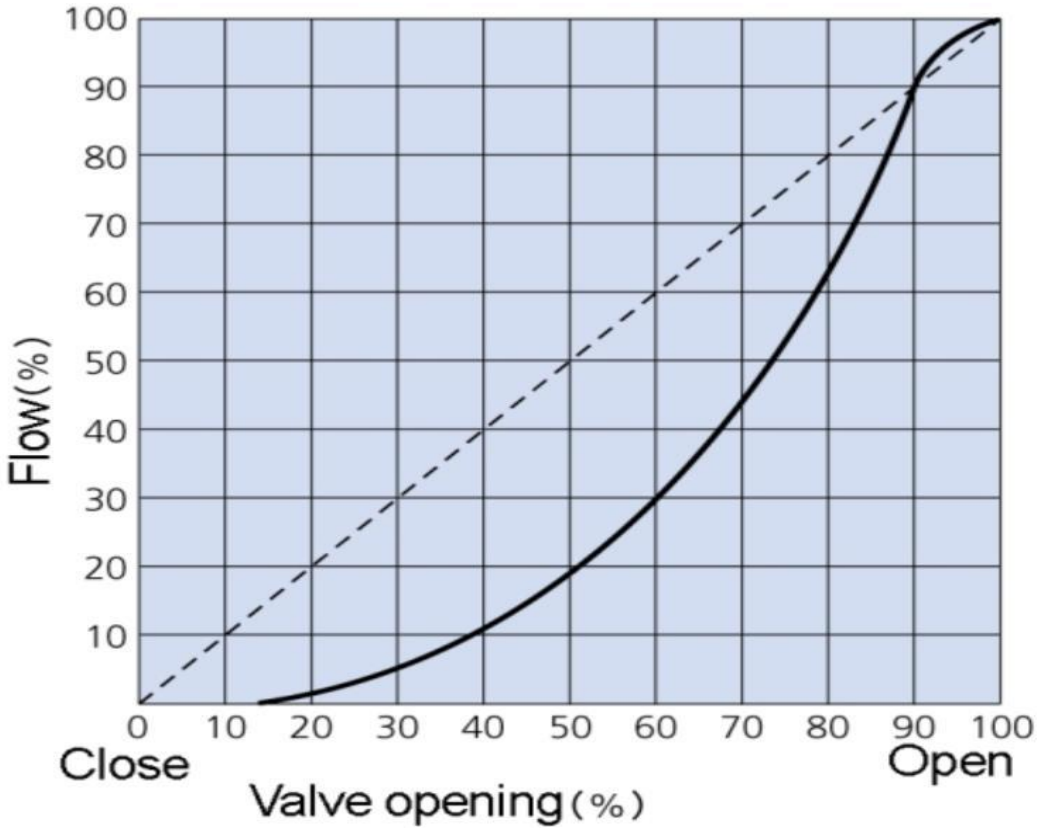
Concentric Butterfly Valve Characteristic Curve





Double Offset Butterfly Control Valve Curve





Application of Control Valve Characteristics

Bray

Fast or Quick Opening:

Good for Batch Processes, on/off control, Pressure Relief, Drains

Linear:

Good for fast reaction quick change in flow, Level Control, Pump Recirculation, constant pressure drop

Equal Percentage:

Very precise change is flow in small increments, good for Chemical pH control, Temperature Control, Low available pressure drop

Application Consideration

Application	Preferred Characteristic	Globe	Butterfly	Double Offset	Segmented Ball	V-Ball
Level Control	Linear	Yes	Yes	Yes	Yes	
Temperature Control	Equal Percentage	Yes	Yes	Yes	Yes	Yes
Chemical Addition	Equal Percentage	Yes				Yes
Pressure Control	Equal Percentage	Yes		Low Pressure Drop	Low Pressure Drop	Low Pressure Drop
Flow Control	Linear	Yes	Yes	Yes	Yes	Yes
Slurry	Linear	Angle Design	Ceramic Trim Butterfly		Yes	

Control Valve Leakage Classification - ANSI/FCI 70-2

Leakage Class	Maximum Leakage Allowable
Class I	No test required
Class II	0.5% of rated capacity
Class III	0.1% of rated capacity
Class IV	0.01% of rated capacity
Class V	0.0005 ml per minute of water per inch of port diameter per psi differential
Class VI	Bubbles/min by port size

Isolation/Block Rotary Valve Shutoff Standards

LEAKAGE COMPARISON

UNITS ARE IN DROPS OF LIQUID OR BUBBLES OF AIR

Diameter		API 598 Metal Seated		MSS SP61 Metal Seated		API 598/API 6D Soft Seated	FCI 70-2 Class VI
MM	INCH	Liquid	Air	Liquid	Air	Liquid/Air Diameter	Air
80	3	12	24	0.5	160	0	6
100	4	12	24	0.7	200	0	11
150	6	12	24	1	300	0	27
200	8	20	40	1.3	400	0	45
250	10	20	40	1.7	500	0	63
300	12	20	40	2	600	0	81
350	14	28	56	2.3	700	0	-
400	16	28	56	2.7	800	0	-
450	18	28	56	3	900	0	-
500	20	28	56	3.3	1000	0	-
600	24	28	56	4	1200	0	-

Globe Valve vs Rotary Control Valve

Globe Valve

Pros

- Low Recovery
- Can Handle Higher Pressure Drop
- Higher temperature capability
- Go to higher Pressure classes
- Trim Characteristic Flexibility
- Inline maintainable

Cons

- Higher Cost
- Lower Capacity
- Lower Rangeablilty
- Rising Stem Harder to seal against fugitive emissions.
- Larger envelope dimension
- Higher weight
- Most designs do not have blow out proof stems
- Are not tested to API firesafe standard

Rotary Valve

Pros

- Lower Cost
- Higher Capacity
- High Rangeability
- Smaller Profile
- Rotary shaft better sealing for fugitive emissions to API-641
- Shutoff Tested to Block Valve Standard API-598
- Can be Firesafe to API-607
- Blowout proof shaft per API-609
- Designed as to function as a block valve and control valve

Cons

- High Recovery
- Limited to 30-50% pressure drop
- Limited to lower Pressure Classes
- Can be limited by Temperature
- Most designs must be removed from pipe for maintenance

Why is control valve selection & sizing important?

- Cost
- Control
- Service Life
- Process Demand
- Future Considerations
- Safety

Resilient Seat Butterfly Control Valves

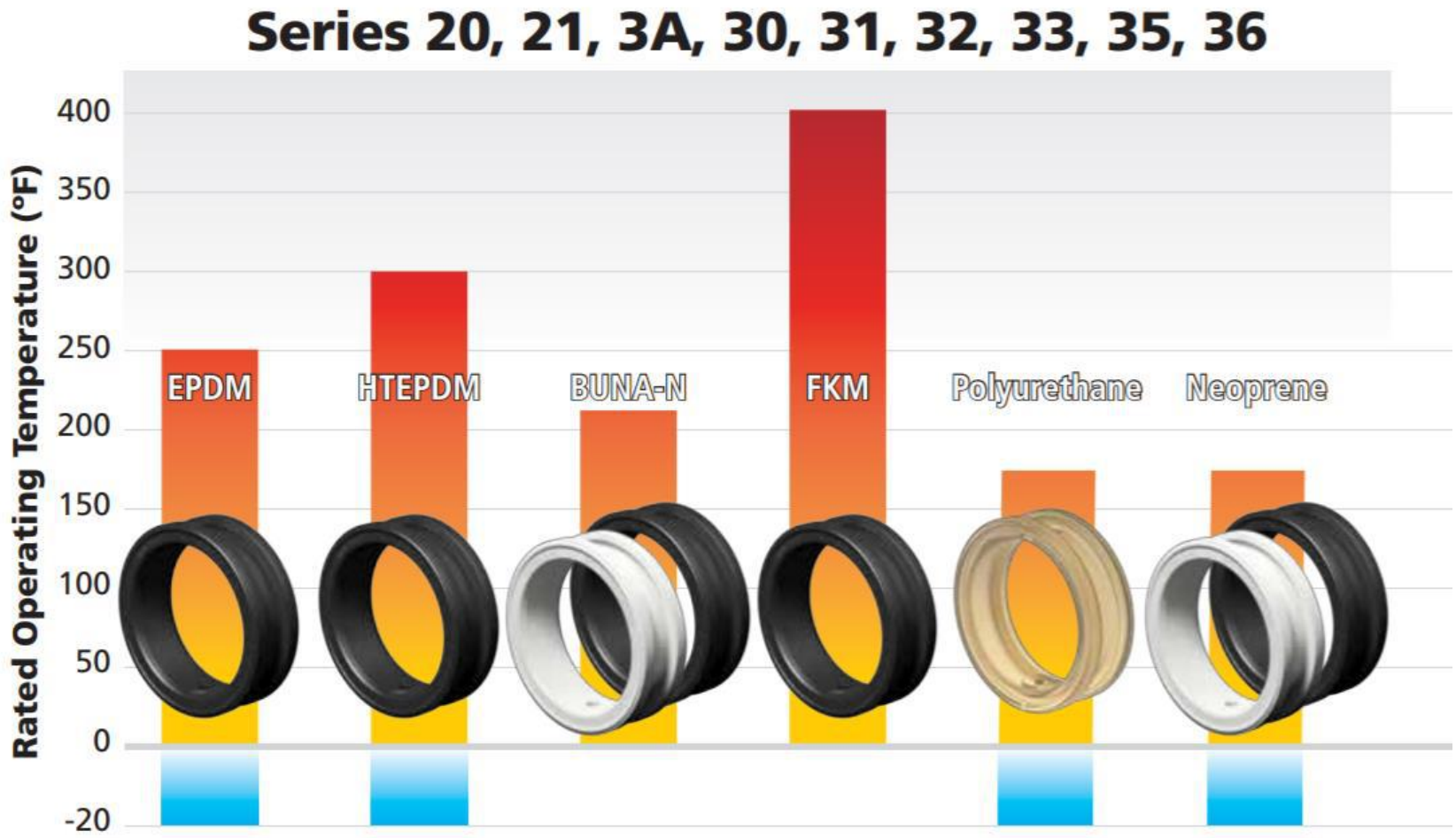
Butterfly Control Valves

- **Type**
  - **Concentric Resilient Seated Butterfly Valve**
    - **Body Material isolated from media**
  - **Double-offset High-Performance Butterfly Valve**
    - **Full ASME pressure rated**

  - **Both types of Butterfly valves offer:**
    - **Low cost & easy maintenance**
    - **Highest Capacity- Flow**
    - **=% Flow Characteristic**
    - **Quick Delivery**

- **Limitations:**
  - **Prone to Cavitation & Noise at higher pressure drops typically greater than 40% of upstream Pressure**

Resilient Seat Butterfly Valve Material Options



Corrosive Service Resilient Seat Butterfly Control Valves

ASME Rated High Performance Butterfly Control Valves

Double-Offset Valve

CONTROL BALL VALVES

Flow-Tek
A Subsidiary of BRAY INTERNATIONAL, Inc.

V-Ball Control Valve

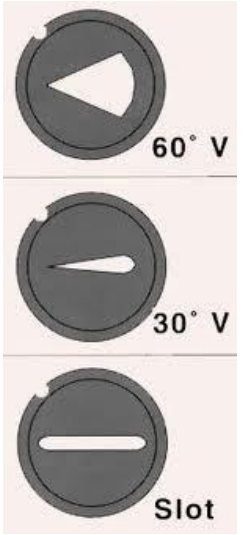
Series 19 Segmented Ball Valve

Bray

V-ball and Segmented Ball Valves

- **Advantages:**
  - **Trim options**
    - **Round port**
    - **V-port**
    - **Segmented**
  - **High Capacity Ratio-Cv**
  - **Less Weight than Globe valves**
  - **Erosive/Slurry/Abrasive service**
  - **High Range ability (up to 500:1)**
  - **Easy maintenance**
  - **Modified =%, =%, linear flow characteristics**

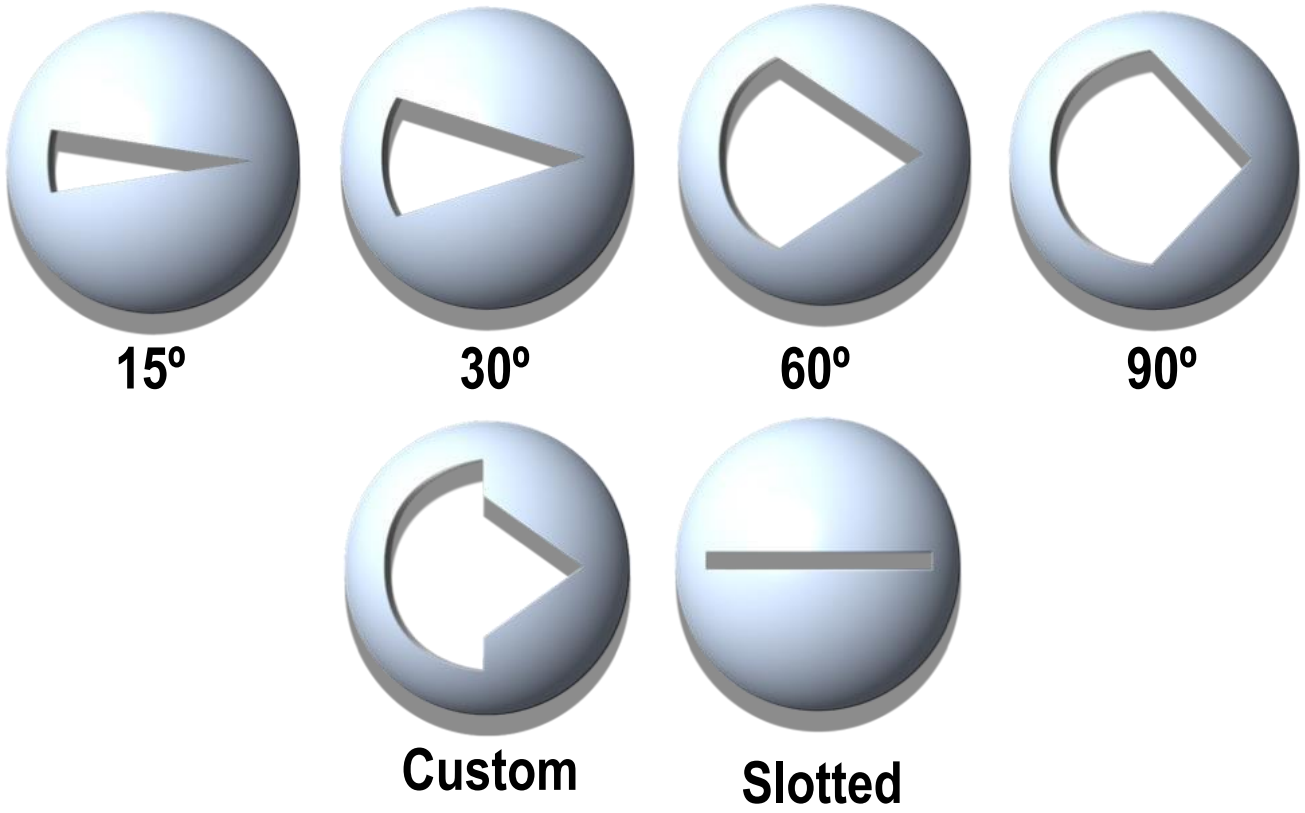
- **Limitations**
  - **Limited dP and temperature capabilities**



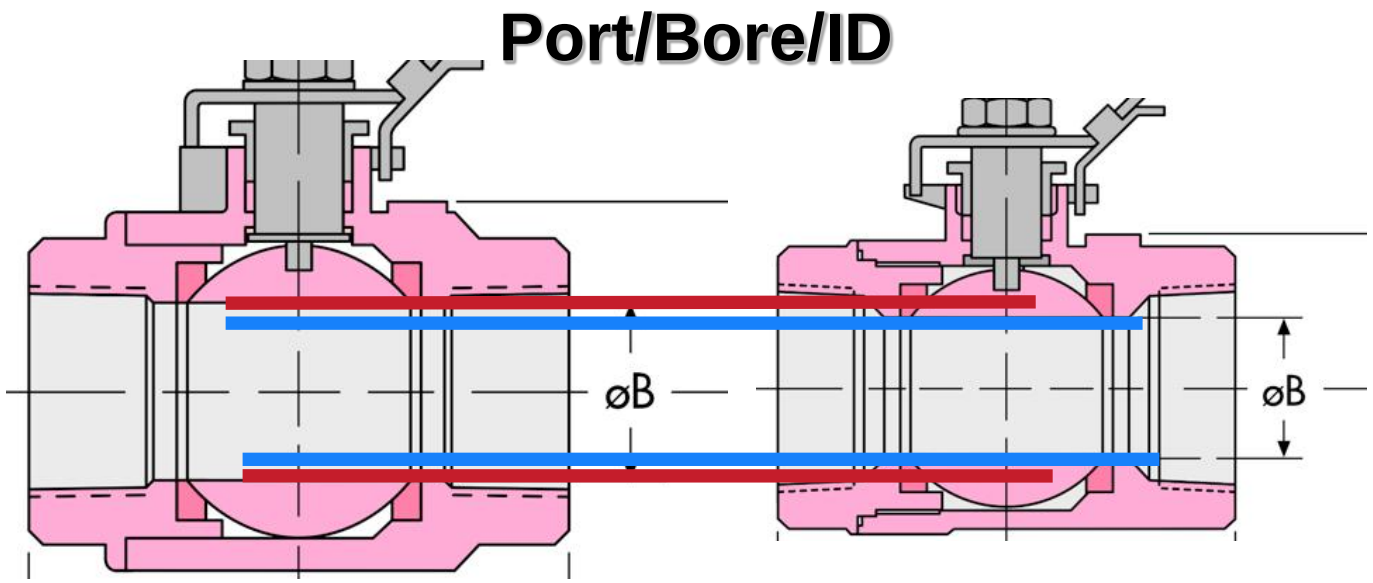
Corrosive Service V-Control Ball Valves

60° V-Port Ball Shown

Standard V-Ball Ports



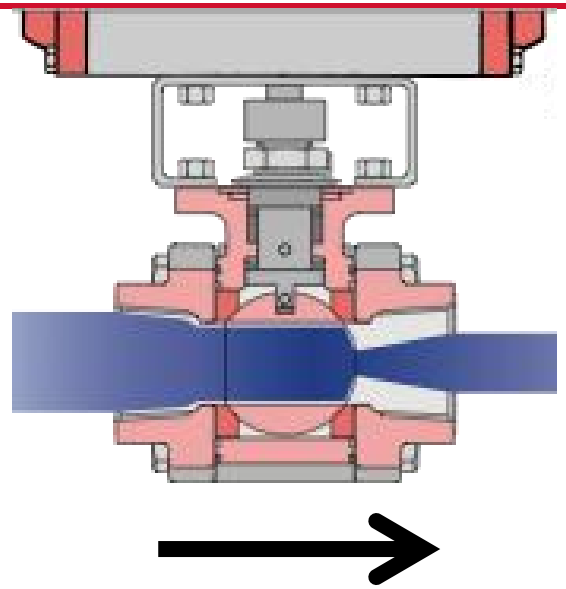
Ball Valves Offer a Reduced Bore Option



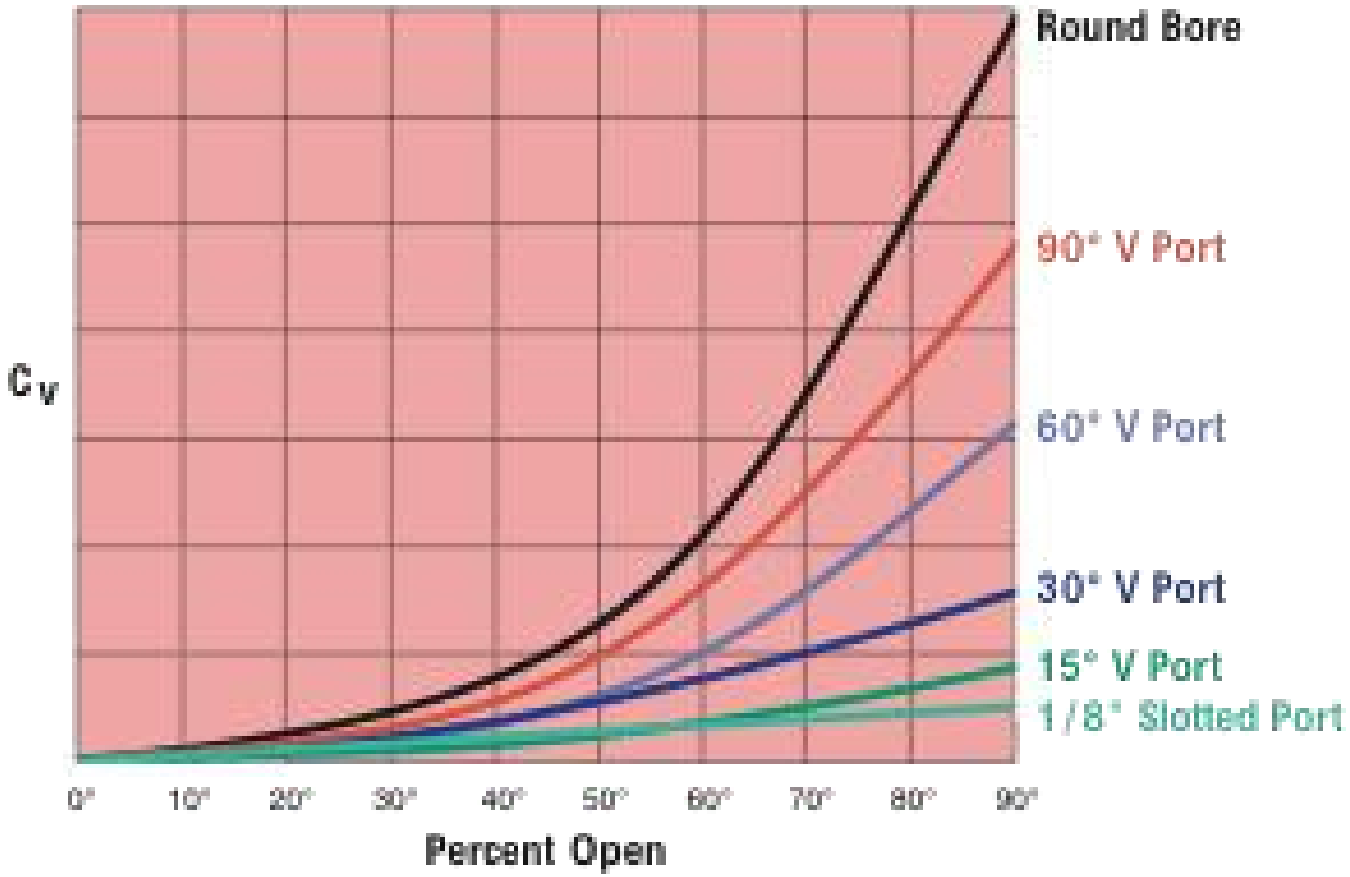
1” Full Port
1” Ball (Red Line)

1” Standard Port
3/4” Ball (Blue Line)

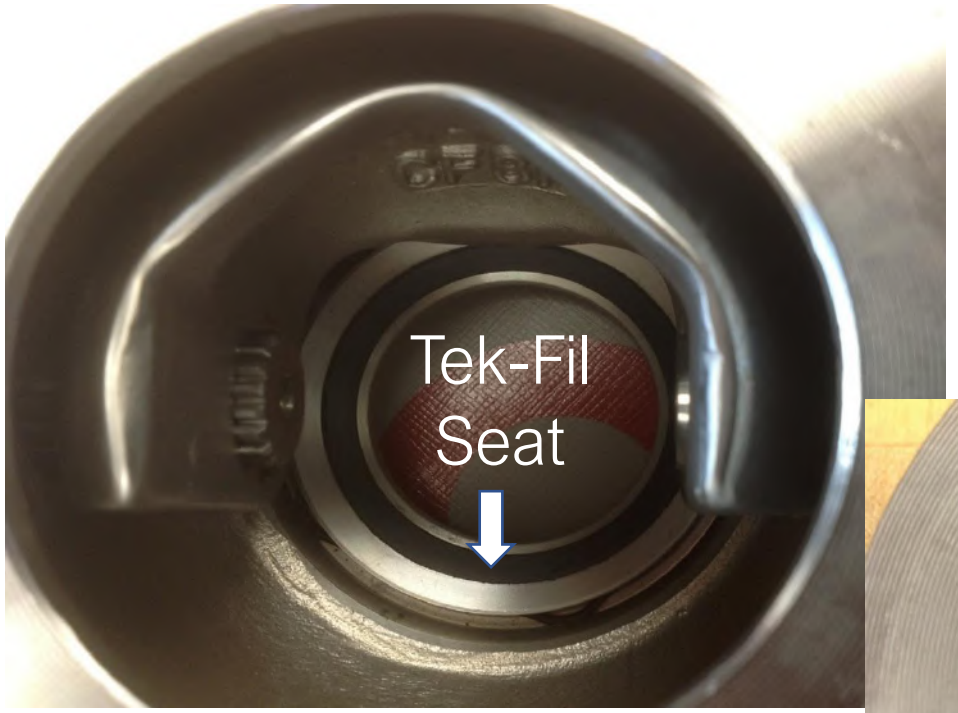
V-Ball Characteristic Curves

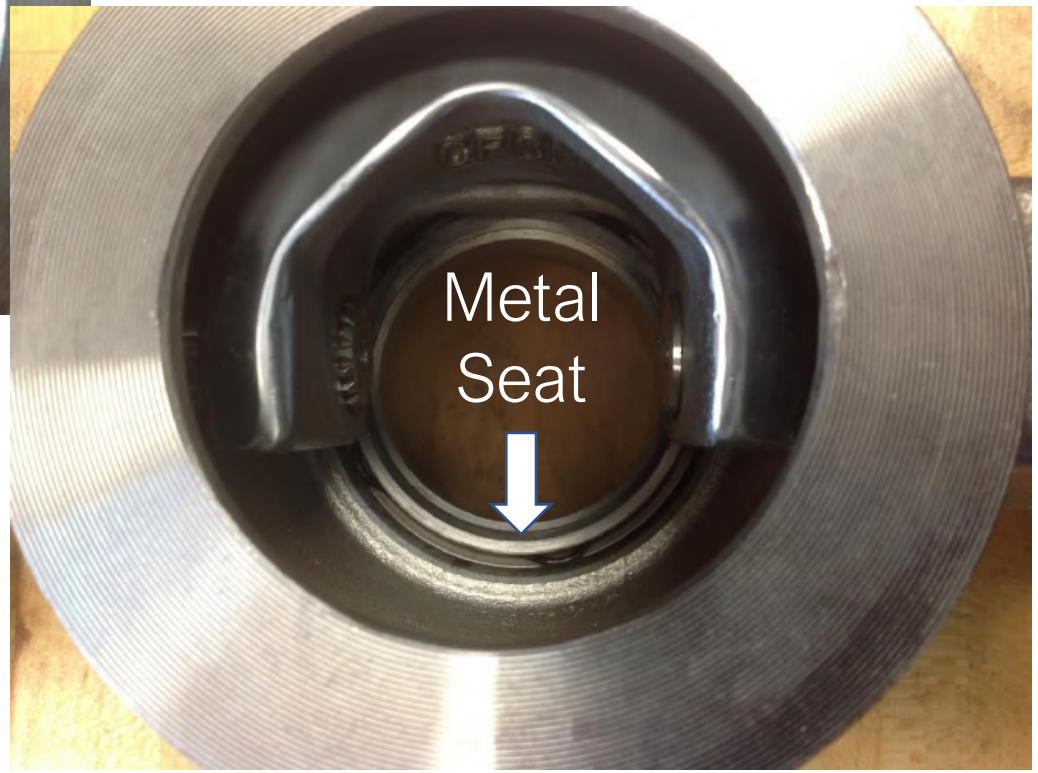


Preferred Flow Direction



Segmented Ball Valve





Segmented Ball Valve

Features:

- High rangeability
- Splined segment-stem connection
- One-piece design
- Self-aligning seat
- Maintenance free bearings

Come back Friday June5 morning same time for Part 2

Control Valve Sizing Theory, Cavitation and Flashing

Thank you for your time.
Questions/feedback please.