Advantages of Quarter-turn Control Valves for Modulating Control

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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 programmed 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.
How are valves controlled?

Control Valve in FLOW CONTROL

Control valve in LEVEL CONTROL

Control valve in PRESSURE CONTROL

Pressurized vessel
Types of Control Valves

- Linear Control Valves
  
  ![Unbalanced Trim Globe Top Guided](image1)
  ![Balanced Trim](image2)
  ![Cage Guided Trim](image3)

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

V-Ball Valve

Eccentric Plug

Double Offset Butterfly

Segmented Ball Valve
Rotary Control Valve Solutions

Series 21
Series 31
Series 39
Series 40
Series 41
Series 19
Series F15
Tri Lok
Series 41
Cryogenic
Components of a Control Valve

Globe Valve

- Positioner
- Actuator
- Filter Regulator
- Valve Body

Ball Valve
How do control valves control flow?
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.
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%
  - $\Delta$ Stroke = 10%
  - Flow @ 50% = 1200 gpm
  - Flow @ 60% = 2040 gpm
  - $\Delta$ Flow = 840 gpm (70%)
- Valves goes from 60% to 70%
  - $\Delta$ Stroke = 10%
  - Flow @ 60% = 2040 gpm
  - Flow @ 70% = 3470 gpm
  - $\Delta$ Flow = 1430 gpm (70%)
- Low Flow for smaller valve openings and Higher Flow for bigger valve openings
Inherent Flow Characteristics

- Fast opening globe
- Linear globe
- Ball
- Butterfly
- Equal percentage globe
Linear Control Valve Trim Geometry Defines Characteristic

- Plug Guided
- Cage Guided
V-Ball Valve Trim defines Characteristic Curves.
Concentric Butterfly Valve Characteristic Curve

Butterfly Valve Cv/Kv Fraction vs Angle

Valve Angle, degrees

Cv & Kv Fraction

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0

0 10 20 30 40 50 60 70 80 90
Double Offset Butterfly Control Valve Curve
Application of Control Valve Characteristics

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
<table>
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<tr>
<th>Application</th>
<th>Preferred Characteristic</th>
<th>Globe</th>
<th>Butterfly</th>
<th>Double Offset</th>
<th>Segmented Ball</th>
<th>V-Ball</th>
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## LEAKAGE COMPARISON

**UNITS ARE IN DROPS OF LIQUID OR BUBBLES OF AIR**

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## 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 Rangeability
- 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

Series 20, 21, 3A, 30, 31, 32, 33, 35, 36

Rated Operating Temperature (°F)

- EPDM
- HTEPDM
- BUNA-N
- FKM
- Polyurethane
- Neoprene
Corrosive Service Resilient Seat Butterfly Control Valves
ASME Rated High Performance Butterfly Control Valves

Double-Offset Valve

Tri Lok Triple Offset Valve
CONTROL BALL VALVES

V-Ball Control Valve

Series 19 Segmented Ball Valve
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

- 15°
- 30°
- 60°
- 90°
- Custom
- Slotted
Ball Valves Offer a Reduced Bore Option

Port/Bore/ID

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

- Tek-Fil Seat
- Metal Seat
Segmented Ball Valve

Features:
- High rangeability
- Splined segment-stem connection
- One-piece design
- Self-aligning seat
- Maintenance free bearings
Come back Friday June 5 morning same time for Part 2

Control Valve Sizing Theory, Cavitation and Flashing
Thank you for your time. Questions/feedback please.