Valve Solutions for Best Performance and Longest Life in Pumping Systems

Presented by John Skalla – DeZURIK, Inc.
True Cost of Ownership

- Purchase Price is Usually the Least Expensive Part
- What Really Matters:
  - Energy costs – Pump efficiency
  - Maintenance Costs
  - Reliability – Unexpected Downtime
  - Anticipated Service Life
  - Protecting the System from Surges
Surge Pressure Cause and Effect

- Rapid changes in fluid velocity
- Surge intensity depends on the rate of velocity change
- Common causes of damaging surge pressure:
  - Rapid operation of valves or hydrants
  - Normal starting and stopping of pumps
  - Electrical power failure to the pumps
  - Rapid initial line filling
Magnitude and Critical Period

- **Magnitude** of the first surge wave depends on how fast the flow velocity is changed and the type of pipe.

- Every successive surge wave reduces about 50% until the system comes to rest.

- **Critical Period** is the time it takes a surge wave to travel down the pipe and back. It depends on length and type of pipe.

- Stopping flow over 10 or more critical periods usually result in acceptable surge magnitudes.
Check Valve Slam

Applications which create quick flow reversals may cause check valve slam

- Severe or repetitive slamming of check valve:
  - Will probably scare people
  - Can shorten check valve life
  - Might fatigue pipe supports
  - May cause pressure surges
  - Surge magnitude due to a slamming check valve depends on the initial reverse velocity

- Beware of these SLAM producers:
  - High static heads
  - Surge tanks
  - Vertical pipe runs following the check valve
Slam versus Surge

- Check Valve Slam is the noise produced when the disc of a check valve is violently thrown to its body seat by the reversing fluid column following a pump shut down.

- Surge is a change in pressure resulting from a change in fluid velocity.
Which Valve Type is Best?

Does Normal Pump Start-up and Normal Shutdown operation produce unacceptable surge pressure?

- **Yes**
  - Select a Pump Control Valve
    - (Commonly used with Constant Speed Pumps)

- **No**
  - Select a Mechanical Check Valve
    - (Commonly used with VFD Pumps)
Mechanical Check Valve Considerations

- Media type – clean, dirty, corrosive, abrasive
- Pressure
- Check valve slam potential
- Materials of construction
- Position indication
- Headloss
**Air Cushioned Swing Check**

- External lever and weight accelerates closure to close valve quickly on pump shutdown (before fluid reverses) to minimize slam
- Fully enclosed air cushion protects valve
- Provides longer seat life
**Bottom Mounted Oil Control Check Valve**

- Control Option for high velocity reverse flow applications where there is a high slam potential
- Excellent for use with surge tanks and for vertical flow up installations
- Directly controls last ten percent of disc movement
- Eliminates torsional shaft stress
- Allows full pressure rating for all sizes
- Adjustable speed controls
Body Shape

Enlarged Body Means Less Disc Travel – Resists Slamming

High Slam Potential!
Disc Connections

**Double Clevis Connection**
- Self aligning disc closes evenly to reduce wear
- Rugged connection, force distributed over four points

**Single Bolt Connection**
- Disc connected at one point
- Does not always seat in the same position
Single Bolt Connection Failure

Single bolt wear caused by disc vibration. The check valve was installed too close to the pump discharge.
VFD and Soft Start Pumps

• Most Variable Frequency Drives are not designed specifically for surge prevention service and do not include that functionality.

• Commonly available ramp up and ramp down times may not be slow enough to prevent surge in Municipal systems.

• Many VFDs cannot control pumps below a certain RPM (flow rate).

• Soft Start/Stops are designed to prevent excessive voltage spikes. They have only limited use for controlling surges.

• VFDs and Soft Starts/ Stops are not supported by a staff who may not be knowledgeable on surge control.

• Check Valves are still required.

• A Surge Relief Valve is needed for protection on a power failure.
Which Valve Type is Best?

Does Normal Pump Start-up and Normal Shutdown operation produce unacceptable surge pressure?

**✓ No**

Select a Mechanical Check Valve

(Commonly used with VFD Pumps)

**✓ Yes**

Select a Pump Control Valve

(Commonly used with Constant Speed Pumps)
Pump Control Valves

• Perform the same functions as a mechanical check valve
• Plus controls surge pressures associated with pump operation by controlled opening and closing over multiple surge periods
• Commonly used on applications with constant speed pumps, longer pipelines, higher heads, or higher velocities
• Higher initial cost than a mechanical check valve
• Powered actuation is required
• Many types and sizes available
Pump Control System

Diagram showing the components of a pump control system, including:
- Pump Control Valve Interface
- Air Valve for Vertical Turbine Pump
- Electrical Connections
  - Supply
  - Exhaust
  - 2-Way Solenoid Valve (Emergency)
  - 4-Way Solenoid Valve (Normal)
  - Speed Control Valve
- Pressure Switch
- Limit Switch
- Pump Control Valve with Cylinder Actuator
- Shut-Off Valve
- Flow direction

Diagram illustrates the integration of electrical and mechanical components in a pump control system.
Pump Control Valve Types

- Eccentric Plug Pump Check Valve
- AWWA Metal Seated Ball Valve
- AWWA Rubber Seated Ball Valve
- Cone Valve
- SmartCHECK Pump Control Valve
- Motor Operated Pump Control Valve
SmartCHECK
Pump Control Valve

- Electric Motor Operated with Adjustable Speed
- Fail-safe Emergency Closure On Loss Of Power
- Very Low Head Loss For Reduced Pumping Cost
- Lever & Weight With Air Cushion Eliminates Slam
- Optional Hold Open Feature
- Sizes 4" – 20"
Surge Protection

- Surge Relief Valve Opens quickly on upsurge
- Limits pressure rise by opening to atmosphere
- Normally set to open at 10% above normal pumping pressure (adjustable)
- Installed downstream of the check or pump control valves on discharge header
- Closes slowly after surge pressure subsides
Surge Relief Valve Operation

Open on upsurge to limit pressure rise by 10%
Air in Pipelines

- Air is present in all pipelines
- Three primary sources:
  - Water contains up to **2% by volume** of entrained air
  - Pump Startup – Air must be exhausted during filling
  - Air can enter into the pipeline through equipment (pumps, gaskets, fittings, valves, etc.) when vacuum condition occurs
Traditional Styles

- Air/Vac
- Air Release
- Combination
- Sewage
When Things Go Wrong...
When Things go Wrong...
High Performance
Sewage Combination Air Valves

- High performance on dirty, greasy sewage
- Simplicity in design of the body, cover, float and float linkage means minimal or no maintenance is required
- If maintenance is required, features such as bolted top cover and lifting lugs make the job easy
The cost of pumping through a valve is given by the formula:

\[
\text{$/hour} = \frac{0.746(Q)(HL)(Sg)($/kWh)}{3,960(P_{eff})(M_{eff})}
\]

Where,
- \( Q \) = flow rate, GPM
- \( Sg \) = specific gravity (water = 1)
- \( HL \) = head loss, ft H₂O
- \( kWh \) = kilowatt-hours
- \( P_{eff} \) = pump efficiency %
- \( M_{eff} \) = motor efficiency %

All things equal, pumping cost is directly proportional to head loss (HL).
Globe Style Pump Control Valve versus AWWA C508 Ball Valve

24” $C_v = 7,655$

24” $C_v = 83,872$
Valve Experts Can Help You
Energy Cost Comparison

**System Information**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Flow Rate</td>
<td>10,000 gpm</td>
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<tr>
<td>% Increase in Flow Rate Demand / Yr</td>
<td>2.0 %</td>
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<tr>
<td>Power Cost ($ / KW-Hr)</td>
<td>$0.08</td>
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<tr>
<td>% Increase in Power Cost / Yr</td>
<td>1.0 %</td>
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<tr>
<td>Pump and Motor Efficiency</td>
<td>85.0 %</td>
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<tr>
<td>Schedule 40 Pipe Inside Diameter</td>
<td>23.25 inches</td>
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<tr>
<td>Pipe Area</td>
<td>2.95 square feet</td>
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<tr>
<td>Pipe Velocity</td>
<td>7.56 fps</td>
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**Valve Information**

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<tr>
<th>Size</th>
<th>Valve Description</th>
<th>Cv or K known?</th>
<th>Cv</th>
<th>K</th>
<th>ft</th>
<th>Series</th>
<th>Valve Description</th>
<th>K</th>
<th>ft</th>
<th>Cost to use valve at the end of 1st year</th>
<th>Cost to use valve at the end of 1st year</th>
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</thead>
<tbody>
<tr>
<td>24&quot;</td>
<td>Globe Diaphragm Pump Control Valve</td>
<td>Cv known</td>
<td>7,655</td>
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<td>$6,117.36</td>
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**Cost Savings Calculations**

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<tr>
<th>Calculation</th>
<th>Years</th>
<th>Savings</th>
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<tr>
<td>Yearly savings using the Willamette valve @ the end of</td>
<td>1</td>
<td>$6,068.28</td>
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<tr>
<td>Cumulative savings using the Willamette valve @ the end of</td>
<td>30</td>
<td>$592,332.68</td>
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Valve Experts Can Help You
Air Valve Recommendations

- Air valve type, size and locations
Valve Experts Can Help You Control Valve Sizing and Selection

• Control valves for flow or pressure control
Basic Surge Investigation and Valve Suggestions Report

• The Basic Surge Investigation and Valve Suggestion Report examines:
  – The technical parameters of your application
  – Total cost of ownership
  – Your experiences and preferences
• Provides surge calculations, valve suggestions and specifications
Questions?
Valve Solutions for Best Performance and Longest Life in Pumping Systems

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