Air Valve Basic Training

OWEA Collection System Specialty Conference

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Burgess & Niple, Inc.
Overview

• Why Air Valves?
• Types of Valves
• Valve Locations
• Sizing Valves
• Valve Specifications
• Installations
• Questions
Overview

• Information based on:
  – Manufacturers' published information
  – Our experience in design and the field
Why Air Valves?
Why Air Valves?

Effects of Air and Vacuum Pockets in Pipelines

• Higher Headloss and Binding
• Pipe Breaks
• Erratic operation of pumps, meters, and control valves
• Collapsed pipes
Sources of Air Entry in Pipelines

- Dissolved Air or Gas (2% at 1 atm)
- Air Valves
- Pumps
- Filling Empty Pipelines
Why Air Valves?

Sources of Vacuums in Pipelines

- Draining Pipelines
- Water Hammer
Types of Air Valves
<table>
<thead>
<tr>
<th>Sewage Air Valves</th>
<th>Air and Vacuum Valve</th>
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<tr>
<td>Super High Capacity Compound Lever Air Release Valve</td>
<td>Air and Vacuum Valve</td>
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<tr>
<td>Dual Body Wastewater Combination Air Valve w/ High Capacity Air Release</td>
<td>Stainless Steel Air &amp; Vacuum Valve</td>
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<td>Wastewater Combination Air Valve</td>
<td>Universal Air Release Valve</td>
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<td>Pressure Sewer Air Release Valve</td>
<td>Wastewater Air/Vacuum Valve</td>
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<td>“Minimatic” Air Release Valve</td>
<td>KINETIC Air &amp; Vacuum Valve to 4”</td>
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<td>Foot Valve</td>
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<td>Single Body Wastewater Combination Air Valve</td>
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<td>Air Valves for Vertical Turbine Pumps</td>
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<td>High Capacity Wastewater Air Release Valve</td>
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<td>Combination Vacuum Breaking and Air Release Valve for Wastewater</td>
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</table>
Types of Air Valves

Three Basic Types

• Air Release Valves
• Air / Vacuum Valves
• Combination Air Valves
Air Release Valves

- Automatically releases *small* pockets of accumulated air while the pipeline operates *under pressure*. 
Air Release Valve Operation

- Pipeline Flowing
- Air Trapped
- Air Released
- Repeat Cycle
Air / Vacuum Valves

• Designed to automatically:
  – Exhaust *large* quantities of air during pipeline filling.
  – Admit *large* amounts of air when the internal pressure drops below atmospheric.
Air / Vacuum Valve Operation

- Pipe Empty
- Valve Opens
Air / Vacuum Valve Operation

- Pipe Drains
- Air Intake
Air / Vacuum Valve Cycle

- Pipe Drains
- Valve Closes
• Perform both as air release and air/vacuum valves.
Combination Air Valve Operation
Locating Air Valves Along a Pipeline

(Or Thinking like an Air Bubble)
Locating Air Valves

Install valves where air will be trapped or vacuum pockets will form!
Locating Air Valves Along a Force Main

Pumps Operating and Line is Full
Locating Air Valves Along a Force Main

Lift Station

Manhole

Pumps Operating and Line is Full
Locating Air Valves Along a Force Main

- Lift Station
- Air Release
- Manhole

Pumps Operating and Line is Full
High Points

Potential Vacuum

Lift Station

Manhole

Pumps Stopped and Line is Draining
High Points

Lift Station

Manhole

Pumps Start and Vacuum Pockets Close with Pressure Spikes
High Points

Pumps Stopped, Line is Drained, and High Points are Full of Air
High Points

Lift Station

Any Air Valves?

Manhole
High Points

No Vacuum Points!
• Carefully review deep pump installations when over 20 feet deep.
• May need Air/Vac valve
• Examples include: vertical turbines and deep submersibles.
Pumps

- Line Full
- Pump On
• Pump Off
• Vacuum Develops
• Pump Turns On
• Pumps Against Vacuum
• Slams Check Valve
• Add Air/Vac Valve
• Air Enters System to Eliminate Vacuum
Pumps

- Add Air/Vac Valve
- Air Enters System to Eliminate Vacuum
- Air Released at Controlled Rate
Sizing Valves
Air Release

- Convert pipeline flow rate to Cubic Feet per Minute (CFM).
- Multiply CFM by 0.02 to estimate dissolved air in water.
- Determine the working pressure at the valve.
- Refer to Orifice Air Capacity Table in AWWA manual or manufacturer tables.
# Air Release

## Table 4-1  Air capacity table of air-release valve orifices ($C_d = 0.7$)

<table>
<thead>
<tr>
<th>Pressure (psi)</th>
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<th>$\frac{3}{32}$</th>
<th>$\frac{1}{8}$</th>
<th>$\frac{3}{16}$</th>
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<td>88.9</td>
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<td>228</td>
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<td>18.2</td>
<td>40.9</td>
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<td>164</td>
<td>223</td>
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<td>163</td>
<td>235</td>
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</tbody>
</table>

**Note:** Metric conversions—in. $\times 25.4 = \text{mm}$, cfm $\times 0.4719 = \text{L/sec}$, psi $\times 6.89476 = \text{kPa}$. 
• Determine required valve size for both filling and draining independently
• Use the larger diameter for air/vac valve sizing
Pipeline Filling

• Calculate the venting flow rate in CFM.

Venting Flow Rate = Fill Rate (CFM) * [(Pressure Differential across valve + 14.7 psi)/14.7 psi]

• Refer to sizing tables to select Air/Vac valve diameter.

• Use a 2 psi differential generally.
Pipeline Filling

Table 4-2  Air discharge table of large orifices ($C_d = 0.7$, $T = 60^\circ$F, sea level)

<table>
<thead>
<tr>
<th>Differential Pressure (psig)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
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<tbody>
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<td>56,400</td>
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</table>

Note: Metric conversions—1 in. = 25.4 mm, 1 cfm = 0.4719 slpm, psi = 6.89476 kPa.

Figure 4-2  Air discharge graph of large orifices ($C_d = 0.7$).
Pipeline Draining or Vacuum Prevention

- Determine the allowable negative pressure for the pipeline with a safety factor. Assume 5.0 psi for a max.
- Calculate the slope of the pipeline in ft/ft.
- Use following figure to determine the required CFM.
- Refer to table to select the required air/vac valve diameter.
Pipeline Draining or Vacuum Prevention

Table for Determining Air Flow when Draining Pipelines
### Table 4-3  Air inflow table of large orifices ($C_d = 0.7$)

<table>
<thead>
<tr>
<th>Differential Pressure (psig)</th>
<th>1</th>
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<th>4</th>
<th>6</th>
<th>8</th>
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<td>56,500</td>
</tr>
</tbody>
</table>

**NOTE:** Metric conversions—\(\text{in.} \times 25.4 = \text{mm}\), \(\text{cfm} \times 0.4719 = \text{L/sec}\), \(\text{psi} \times 6.89476 = \text{kPa}\).
Air Release Valves

- Orifice Size (1/16” to 1”)
- NPT Inlet size (1/2” to 3”)
- Maximum Working Pressure (75 psi and up)
- **Minimum Sealing Pressure** (softer seats needed when under 25 psi)
- Valve Materials (Ductile or Cast Iron, St. Stl)
- Accessories (check valve, back flush, flow regulators, etc.)
- **Service** (Wastewater or Clean Water)
Air/Vac Valves

- Similar to Air Release Valves
- Inlet/Outlet sizes (1” to 20”)
- Type of Connections (NPT and Flanged)
- Maximum Working Pressure (150 to 300 psi)
Combination Air Valves

• All of the above
• Body Configuration (Single versus Dual)

Dual Body

Single Body
Installation and O&M
Installation

- Connections
  - Inlet piping and isolation valve should be same size as valve inlet
  - Short Inlet Piping and Vent Lines
Installation

• Location
  – Need protection from freezing, contamination, flooding, and vandalism
  – Needs access
  – Watch valve clearances
• Inspections and Flushing
  – At least annually
  – More often for valves that operate continuously
  – Watch for external leakage