Saving Water with Pressure Regulation and Check Valves – Introduction to Hydraulics

Greg Palumbo
Product Manager – Commercial Sprays
gpalumbo@rainbird.com

David Perl
Product Manager – Commercial Rotors
dperl@rainbird.com

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The Intelligent Use of Water.™
TOPICS WE WILL COVER

- **Introduction to hydraulics**
  - A basis for understanding what factors lead to water waste

- **Check valves**
  - When to use them
  - Benefits of their use

- **Pressure regulation devices**
  - Types of pressure regulation devices
  - When to use them
  - Benefits of their use

- **Water saving resources**
Who’s ready for some science?
INTRODUCTION TO HYDRAULICS

- Review of key terms…
- **Hydraulics** = A topic in applied science and engineering that deals with the mechanical properties of liquid
- In the next slides we will review these key concepts
  - Pressure
  - Flow
  - Water Velocity
  - Friction Loss
PRESSURE = FORCE / AREA

- Pressure – In irrigation we measure pressure in a closed system where fluids are either “static” or “dynamic” in pounds per square inch (PSI)
INTRODUCTION TO HYDRAULICS

TOTAL FLOW = SUM OF ALL IRRIGATION DISTRIBUTION DEVICES

- Flow – In irrigation our net flow is determined by the type and quantity of water distribution components we select for each lateral line in an irrigation design. This is measured in gallons per minute (GPM)
WATER VELOCITY = \( \frac{0.408 \times \text{FLOW RATE}}{(\text{DIAMETER OF PIPE})^2} \)

- **Water velocity** – Water velocity in a pipe is calculated from two variables (below) and is measured in feet per second (fps or f/s)
  1. Pipe diameter
  2. Flow rate
INTRODUCTION TO HYDRAULICS

FRICTION LOSS PER 100’ OF PIPE =
0.0902 \times (\frac{100}{C})^{1.852} \times \left(\frac{q^{1.852}}{d_h^{4.8655}}\right)

C = Hazen-Williams roughness constant

q = GPM

d_h = Inside hydraulic diameter

- Friction Loss – The amount of pressure lost due to friction between water and container in a closed dynamic state – in irrigation this is friction between water and pipe
Key points and debunking myths…

- Water pressure and water velocity are not the same. For example, it is not correct to say that decreasing the diameter of a pipe will increase pressure. It may appear that this is occurring with an open pipe, but actually you are only increasing the velocity of the water and contributing to increased pressure loss.
- The larger the diameter of a pipe the less pressure loss will occur if flow remains constant.
- The greater the velocity of water, the more pressure loss will occur if pipe size remains constant.
- Air compresses, fluids do not. This is why hydraulic principals have been used to power large equipment. When no compression occurs we can efficiently transfer energy. This principle will be important later.
- You don’t need to memorize this information to design and install water efficient irrigation systems – Rain Bird eliminates variables for you!
CHECK VALVES

- **Location of check valves in an irrigation system**
  - Today, check valves are commonly integrated into irrigation spray heads and rotors
  - Check valves are also available for:
    - Installation directly underneath a spray or rotor (less common)
    - Installation in-line on a lateral or main line (less common)
    - Drip irrigation – integrated into dripline (increasingly common)

- **Why check valves are used in irrigation**
  - Check valves are typically used in an irrigation system to prevent low head drainage when irrigating slopes with spray heads, rotors, or drip
  - There are a number of benefits for the use of check valves...
# CHECK VALVES

## BENEFITS OF CHECK VALVES

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>BENEFIT OF C.V.</th>
<th>VALUE</th>
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</thead>
<tbody>
<tr>
<td>Low Head Drainage</td>
<td>Prevent low head drainage by trapping water in lateral up to a 14’ increase in elevation (equivalent of 6 psi)</td>
<td>Reduces run-off and erosion</td>
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<td></td>
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<td>Reduces growth of algae on walking surfaces decreasing liability: water + fertilizers + lawn clippings = breeding ground for algae</td>
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<td>Prevents slow drainage of water from irrigation, even on gentle slopes, that results in call backs - especially with new homeowner installations</td>
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<td>Saves water</td>
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<tr>
<td>Water Hammer</td>
<td>Check valves trap water in laterals instead of allowing the water to be replaced by air</td>
<td>Air will leave a nozzle up to <strong>five</strong> times faster than water</td>
</tr>
</tbody>
</table>
To fully recognize the benefit of check valves, they must be used on all heads on a slope.

- Placing a spray or rotor with a check valve at the bottom of a slope only does not eliminate drainage.
- This also prevents dirt, sand, and other materials to be “sucked” into the body of the spray upstream from the vacuum created by low head drainage.

Low head without SAM wastes water.
CHECK VALVES

- **Water Hammer** – The energy wave that is transmitted at sonic speed throughout the pipeline as a result of a sudden change in the velocity of the fluids
  - When air replaces water in a later line it creates a condition where water hammer can have a significant impact on the longevity of an irrigation system
  - Even if a system has been design properly for velocity of flow to not exceed the 5 feet per second rule, compressed air from the volume of water rapidly filling the lateral leaves a nozzle up to 5 times faster than water
    - This means that water designed to travel only 5ft/s will travel up to 25ft/s. When the wall of water traveling 25ft/s makes it to the end of the lateral line, the velocity suddenly changes to 5ft/s
    - The sudden change in velocity is converted to an energy wave that is transmitted throughout the pipeline and the irrigation head
    - How many of you have noticed damage to irrigation heads and fittings at the end of lateral lines and the bottoms of slopes?
CHECK VALVES

- Rain Bird Seal-A-Matic™ Check Valves:
  - Check valves are commonly integrated into spray heads and rotors
  - Rain Bird offers these products with a pre-installed check valve
    - **SPRAYS**
      - 1800 Series Sprays
      - 45 psi 1800 Series Sprays
    - **ROTORS**
      - 3500 Series Rotors
      - 5000 Series Rotors
      - 5000+ Series Rotors
      - 5500 Series Rotors
      - 6500 (Falcon) Series Rotors
      - 7005 Series Rotors
      - 8005 Series Rotors
CHECK VALVES

- How check valves save water
  - Prevent damage to the system that could otherwise result in equipment failure and lateral line breaks. When unnoticed, these failures result in significant water waste.
  - Elimination of drainage saves water (residential example)
    - Residential Example
    - ½ acre with 5 zones
    - 4 rotors in each zone running down a slope
    - 30 feet between rotors
    - 1 inch pipe
    - 600 feet of pipe x .041 Gallons per foot of pipe = 24 gallons
    - 24 Gallons * 156 cycles per year = 3,819 gallons of waste per year
    - Imagine the impact in a large commercial system.
PRESSURE REGULATION
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PRESSURE REGULATION
In irrigation systems, pressure is mainly regulated for the following reasons:

1. To reduce supply line pressure to be within manufacturers recommended operating pressure for downstream components
2. To reduce water waste caused by high pressure operation and ensure nozzles operate at maximum efficiency
3. To make certain that calculated design hydraulics are being achieved in the field and irrigation devices are operating to manufacturer provided radius, flow, and precipitation rates
4. Accommodate pressure fluctuations of water supply
PRESSURE REGULATION

1. To reduce supply line pressure to be within manufacturers recommended operating pressure for downstream components
   - Supply line regulation typically occurs at one of two locations (sometimes both):
     ▪ At the point of connection (POC) or near backflow device
     ▪ At the valve
   - Pressure regulation at the POC or near backflow device will use in-line regulation devices
   - Pressure regulation at the valve use add on devices like PRS Dial to regulate pressure

Why not just use PRS? – Supply line pressures can easily exceed recommended operating pressure of components downstream of irrigation valves

What should be considered when choosing where to place pressure regulating devices?
PRESSURE REGULATION

2. To reduce water waste caused by high pressure operation and ensure nozzles operate at maximum efficiency
   - More pressure ≠ Better performance
   - Optimal pressure = Optimal performance
     - Spray nozzles = 30 psi
     - ¾” inlet rotors and Rotary Nozzles = 45 psi
     - 1” inlet rotors = 70 psi
   - Water savings in a high pressure system can be +50% if a 70 psi spray zone is reduced to the optimal 30 psi operating pressure
   - Why?
     - Increased pressure leads to – excessive flow, increased velocity, overthrow, misting and fogging, vaporization, wind drift, smaller droplets of water
     - The greater the pressure above optimal, the less water that is beneficially used
     - Every 5 psi reduction in pressure reduces water usage by 6-8%
3. To make certain that calculated design hydraulics are being achieved in the field and irrigation devices are operating to manufacturer provided radius, flow, and precipitation rates
   - U12H at 30psi uses 1.30gpm
   - U12H at 70psi can use up to 2.3gpm
   - Imagine the impact to your system hydraulics if each nozzle used 1gpm more than anticipated!
   - Without pressure regulation at the spray a system could experience excessive pressure loss due to increased flow leading to greater water velocity in pipes
3. Continued…

– The same is true for rotors

– Pressure regulation at the irrigation head…
  - Eliminates head-to-head pressure variation and equalizes performance – upgrading to pressure regulating heads makes a big difference if you notice a decrease in performance the further downstream of the valve you get
  - Eliminates misting and fogging contributing to water waste
  - Results in bigger water droplets
  - Improves distribution uniformity and scheduling coefficient
4. Accommodate pressure fluctuations of water supply

- Even when great care is taken to calculate system hydraulics, you may still experience unexpected performance of your irrigation system due to fluctuations in your water supply. Always take the following supply and demand factors into consideration:
  
  - **Short Term Variation**
    - Hours of peak usage – you are not on site to observe performance 24 hours a day
    - Maintenance
    - Season
    - Restrictions
  
  - **Long Term Variation**
    - Community development – Who here has had trouble passing inspecting at the wrong time of day?
    - Changing regulations
    - Water source
PRESSURE REGULATION
# PRESSURE REGULATION

## BENEFITS OF PRESSURE REGULATION

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<tr>
<td>Supply line pressure exceeds operating pressure specifications of irrigation equipment</td>
<td>Regulation on main line or at valve can reduce operating pressure for downstream components</td>
<td>Decreases wear on irrigation system components and achieves desired performance</td>
</tr>
<tr>
<td>Misting and fogging leading to water waste</td>
<td>Regulation at the head results in optimal nozzle performance</td>
<td>Reduces water waste and run times. Increases uniformity and efficiency</td>
</tr>
<tr>
<td>High pressure causes excessive flow from nozzles resulting in unexpected pressure loss</td>
<td>Regulation equalizes system performance at manufacturer recommended pressures</td>
<td>Simplifies hydraulic calculations and eliminates poor performance of heads furthest downstream of valve</td>
</tr>
<tr>
<td>Water supply pressure fluctuates</td>
<td>Regulation eliminates the impact of fluctuating supply line pressure</td>
<td>Preserves system performance and ensures intended operation</td>
</tr>
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</table>
PRESSURE REGULATION

- Rain Bird pressure regulating solutions:
  - At the valve pressure regulation = PRS Dial
  - The PRS-Dial is an excellent means of regulating outlet pressure from 15 to 100psi at the valve regardless of incoming pressure fluctuations. The visible scale makes installation quick and easy
Rain Bird pressure regulating solutions:

- At the rotor pressure regulation = Pressure regulating swing joints
- The Rain Bird Turf Swing Joint with Pressure Regulating System (TSJ-PRS) controls and maintains a preset inlet pressure for rotors with 3/4" (45 psi) and 1" (70 psi) inlets
PRESSURE REGULATION

- **Rain Bird pressure regulating solutions:**
  - **In-stem pressure regulation** = Pre-installed pressure regulating devices
  - Rain Bird offers these products with pre-installed in-stem pressure regulation
    - 1800 Series Sprays (30 psi for spray nozzles – MPR, VAN, and U-Series)
    - 45 psi 1800 Series Sprays (45 psi for Rotary Nozzles)
    - 5000 PRS Series Rotors – The **ONLY** rotor that provides 45 psi pressure regulation in-stem
QUESTIONS?
RESOURCES

- “Don’t Get Hammered” – Article on water hammer and how it impacts an irrigation system – this is a must read!
  - http://landscapeandirrigation.com/Irrigation/pageHammered.htm

- The Intelligent Use of Water™
  - Learn more about Rain Bird and our commitment to the Intelligent Use of Water™

- Rain Bird water saving calculators
  - These calculators help estimate water savings, cost savings, and payback of installing PRS devices

- Rain Bird catalog reference section
  - This is a link to the reference section of our catalog with pipe sizing reference charts, technical support information, and warranty information

- Rain Bird para los hispano hablantes
  - Tenemos un catálogo en español en Internet