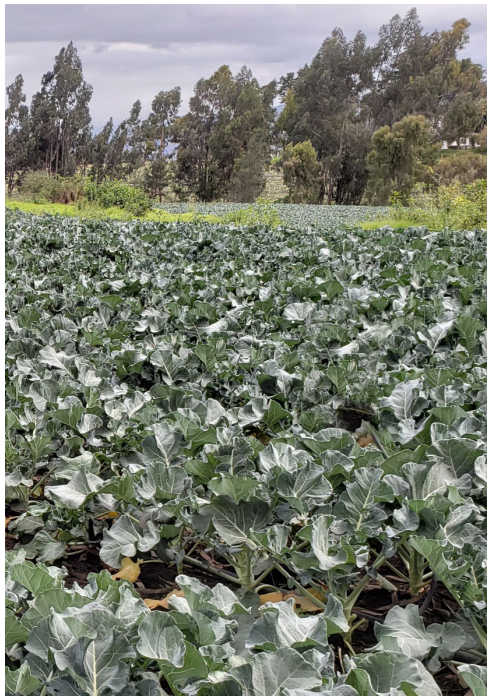
Understanding Pressure Regulation

Relationship Between Pressure and Flow

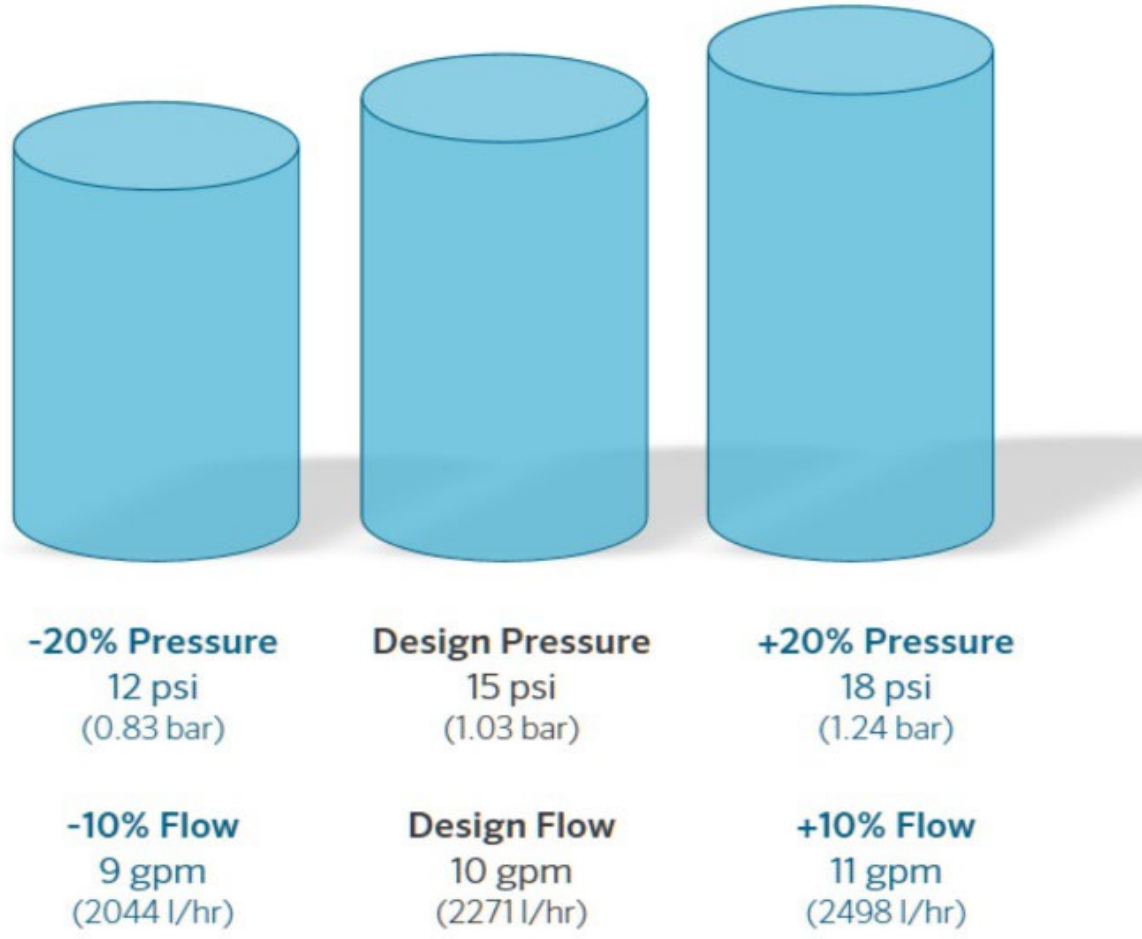
Irrigation systems are designed to apply a specific amount of water to achieve a prescribed application rate tailored for the soil and crop.





Relationship Between Pressure and Flow

- Q = KVP - The operating pressure of an irrigation system always affects the flow rate.
- A 20% pressure variation will result in a 10% flow variation



Relationship Between Pressure and Flow

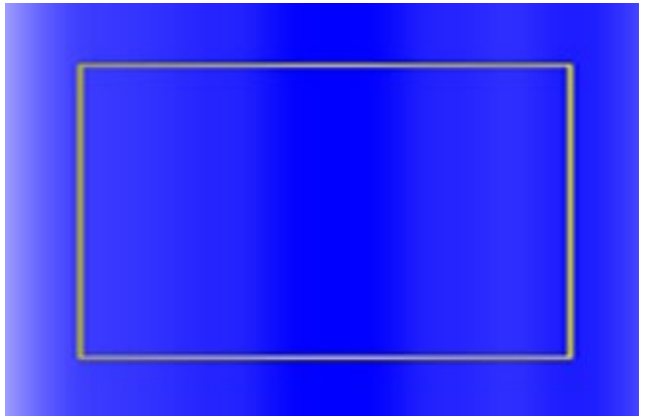
Pressure Variations				
DESIGN PRESSURE	1 PSI *0.07 BAR*	2 PSI *0.14 BAR*	3 PSI *0.21 BAR*	4 PSI *0.28 BAR*
10 PSI (0.69 BAR)	**5.0%**	**10.0%**	**15.0%**	**20.0%**
20 PSI (1.38 BAR)	**2.5%**	**5.0%**	**7.5%**	**10.0%**
30 PSI (2.06 BAR)	**1.7%**	**3.3%**	**5.0%**	**6.7%**
40 PSI (2.76 BAR)	**1.3%**	**2.5%**	**3.8%**	**5.0%**
% Flow Variation				

Pressure regulators are recommended if there is a 10-20% pressure and/or a 5-10% flow variation. The lower a system's design pressure, the more critical it is to accurately control its pressure.

Why Are Pressure Regulators Needed?

Without regulators, the radius of throw is reduced, application rates are not consistent, and uniformity numbers are drastically affected.

With Pressure Regulators



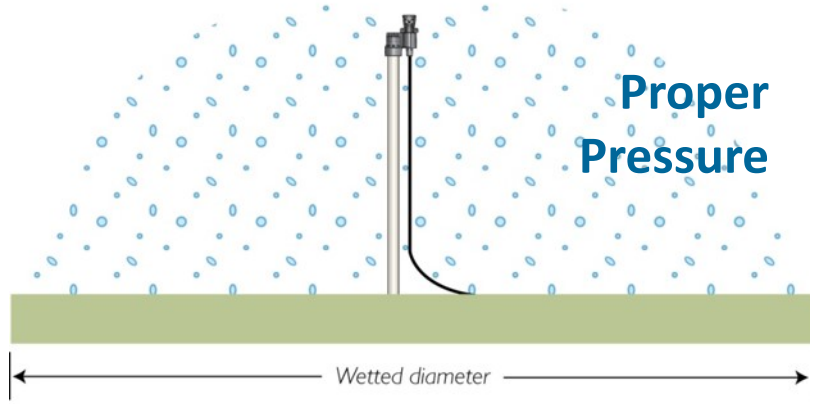
AREA	
CU	93.21%
DU	90.53%
SC 5%	1.15

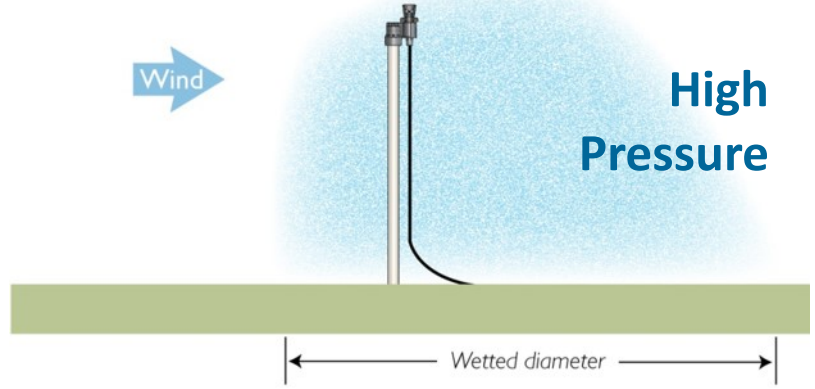
Without Pressure Regulators

AREA	
CU	70.80%
DU	58.31%
SC 5%	2.25

Why Are Pressure Regulators Needed

High pressures produce small droplets which are prone to wind-drift and evaporation



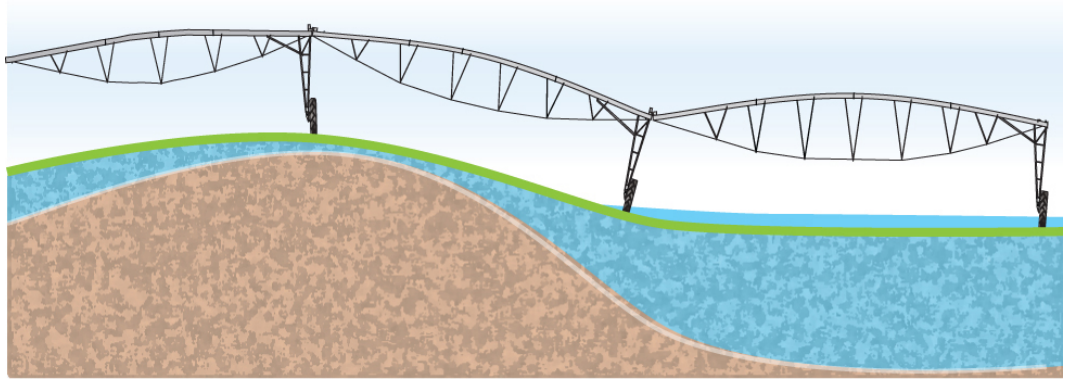


What Causes Pressure Variations?

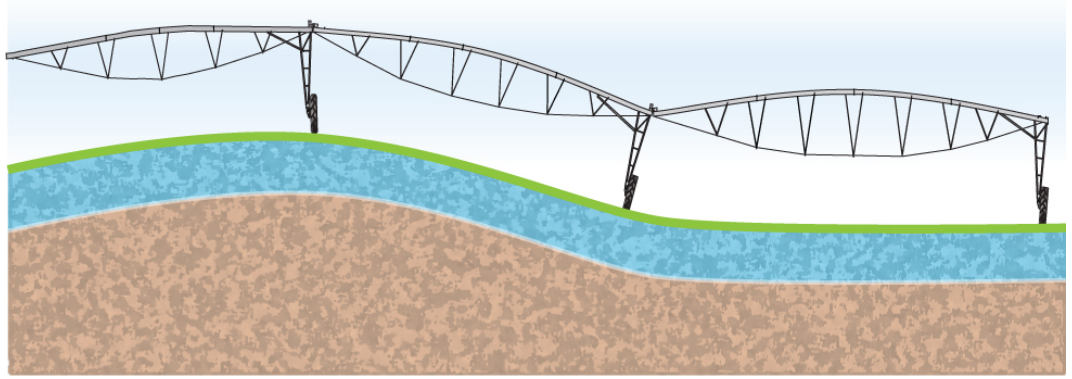
Elevation Changes

- Pressure is related to gravity. More pressure is needed to move water uphill. When water moves downhill, more pressure is available.
- Every 2.31 ft (0.7 m) of elevation change will result in 1 psi (0.07 bar) pressure change.

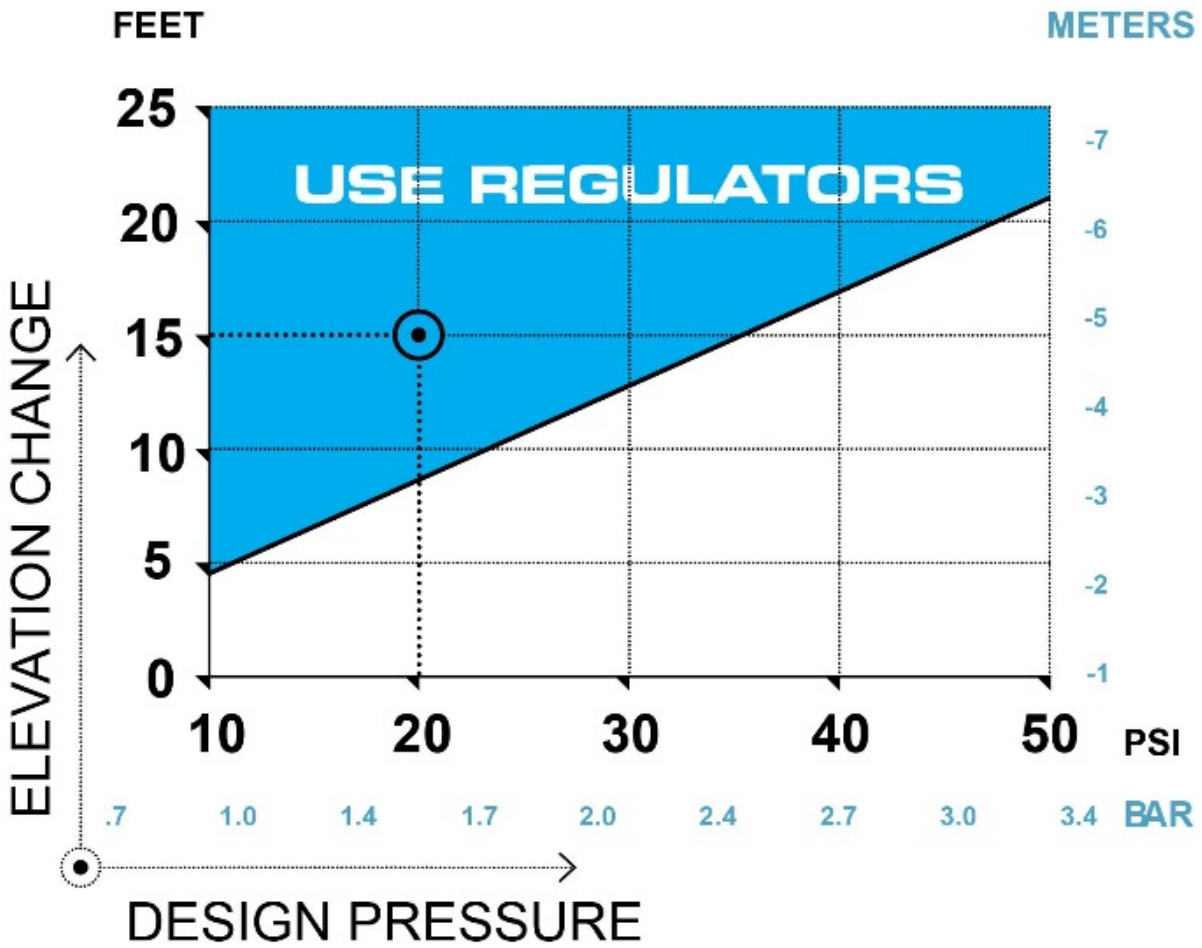
Water Application Without Pressure Regulators



Water Application With Pressure Regulators



What Causes Pressure Variations?



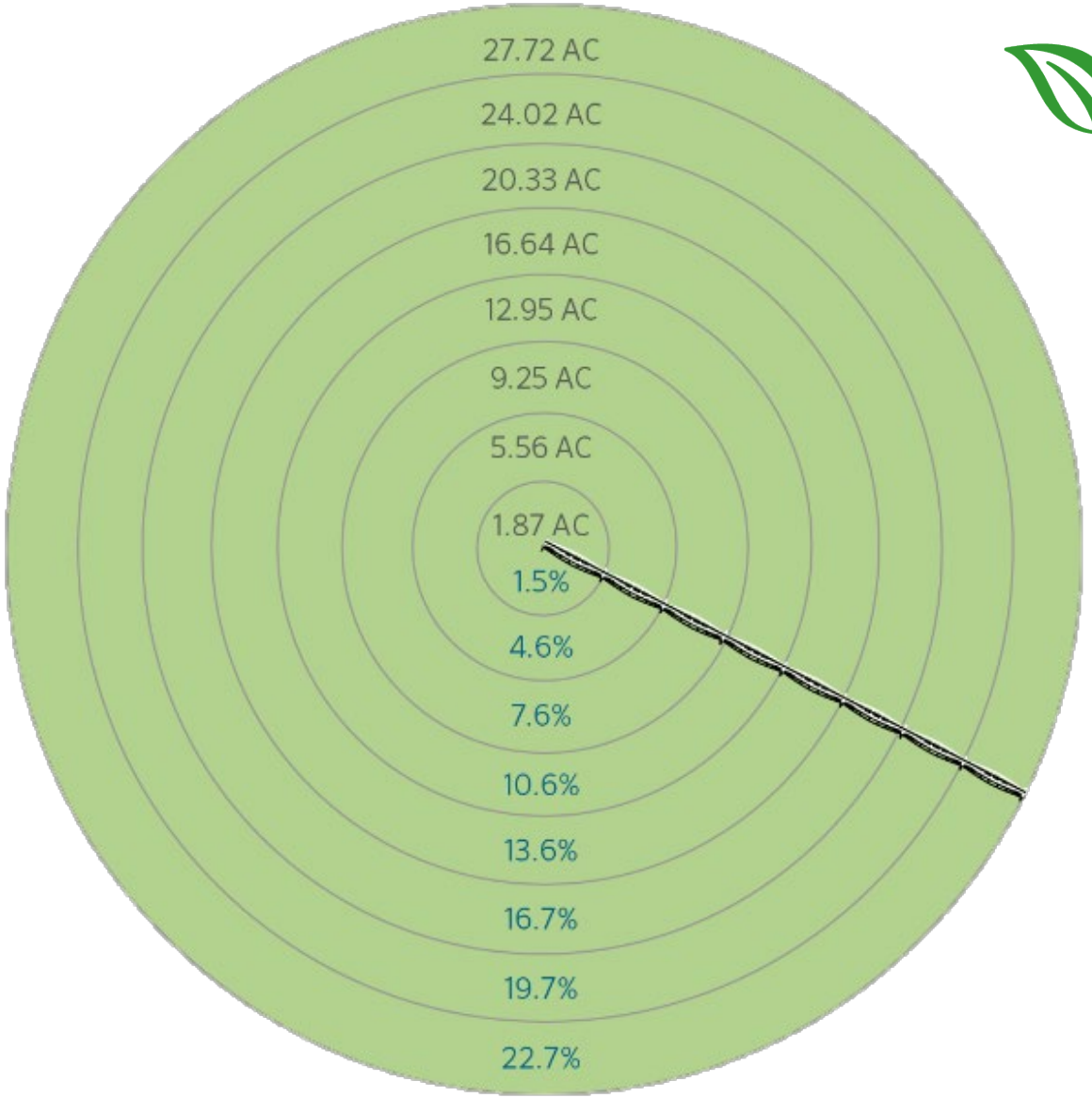
Elevation Changes

- If the elevation change from the lowest point is above the line, then a flow variation of more than ten percent will occur.
- Notice lower design pressures allow less elevation change before pressure regulators are recommended.

What Causes Pressure Variations?

Design Pressure

- Elevation difference on the outer spans involves a greater amount of water and a greater irrigated area than near the pivot point.



What Causes Pressure Variations?

Hydraulic Conditions
There is pressure loss through pipes and fittings when:

- End guns or corner arms cycle on and off
- Irrigation zones in non-mechanized systems cycle on and off

What Causes Pressure Variations?

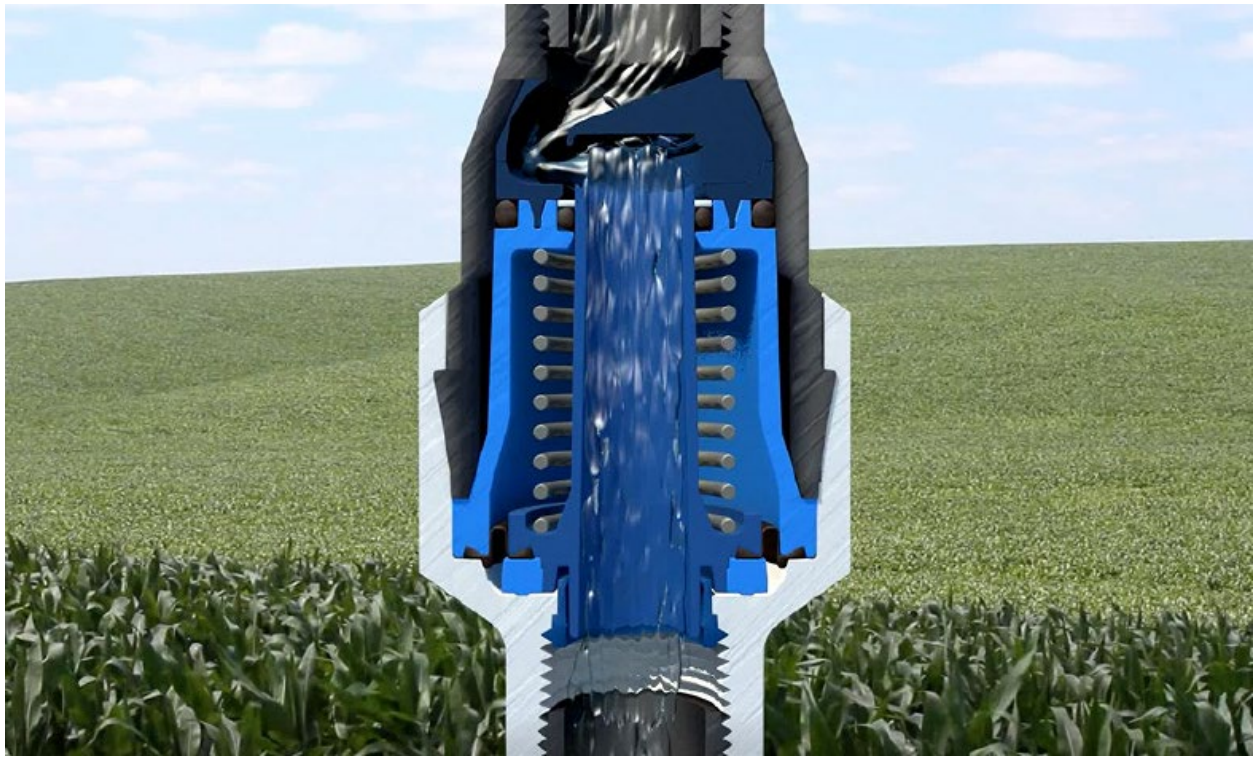
Pumping Scenarios

- System demands change with multiple water sources
- Additionally, pump efficiencies play a role

How do they work?

- Pressure regulators control excessive and varying inlet pressures to a constant outlet pressure.
- Pressure regulators do not produce or store energy, so the outlet pressure will never exceed the inlet pressure.

How Do They Work?

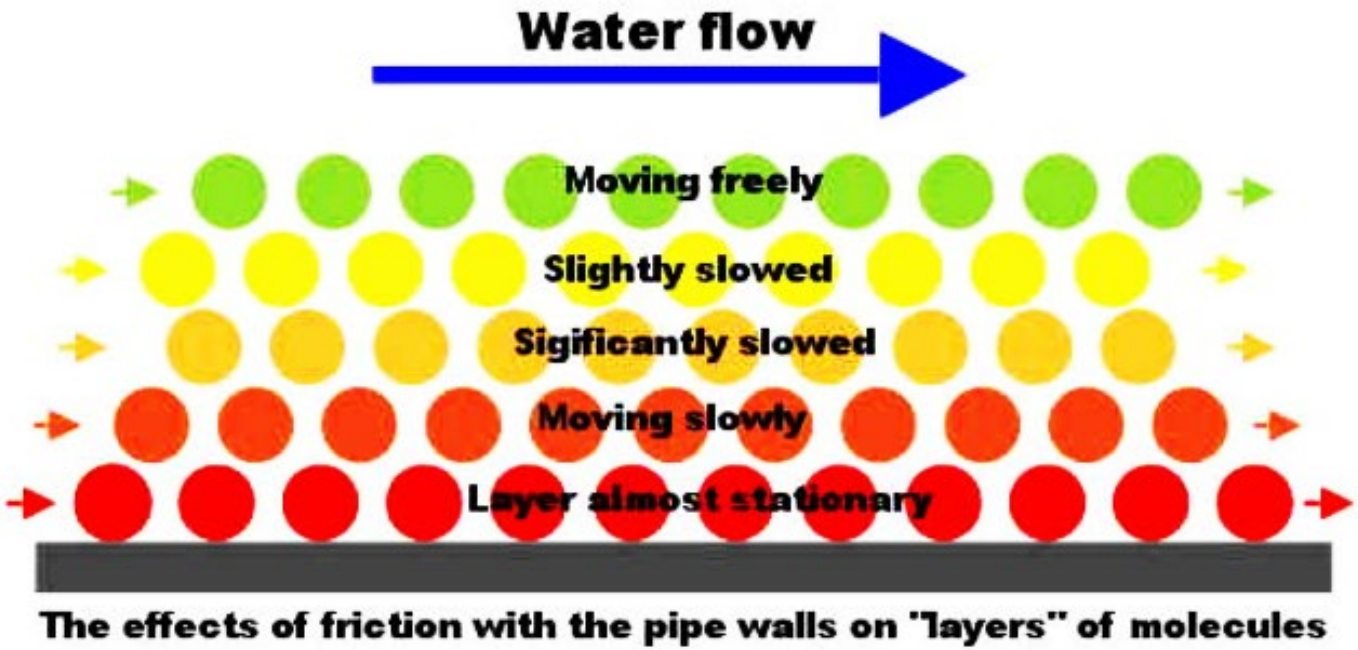


- Water travels through the inlet of the regulator across a fixed seat into the critical flow area
- Water then enters a hollow cylinder or throttling stem attached to a diaphragm
- Increasing inlet pressure causes valve to close. Decreasing inlet pressure allows valve to open
- The regulated outlet pressure is determined by the spring's compressive strength.

Why is Additional Inlet Pressure Needed?

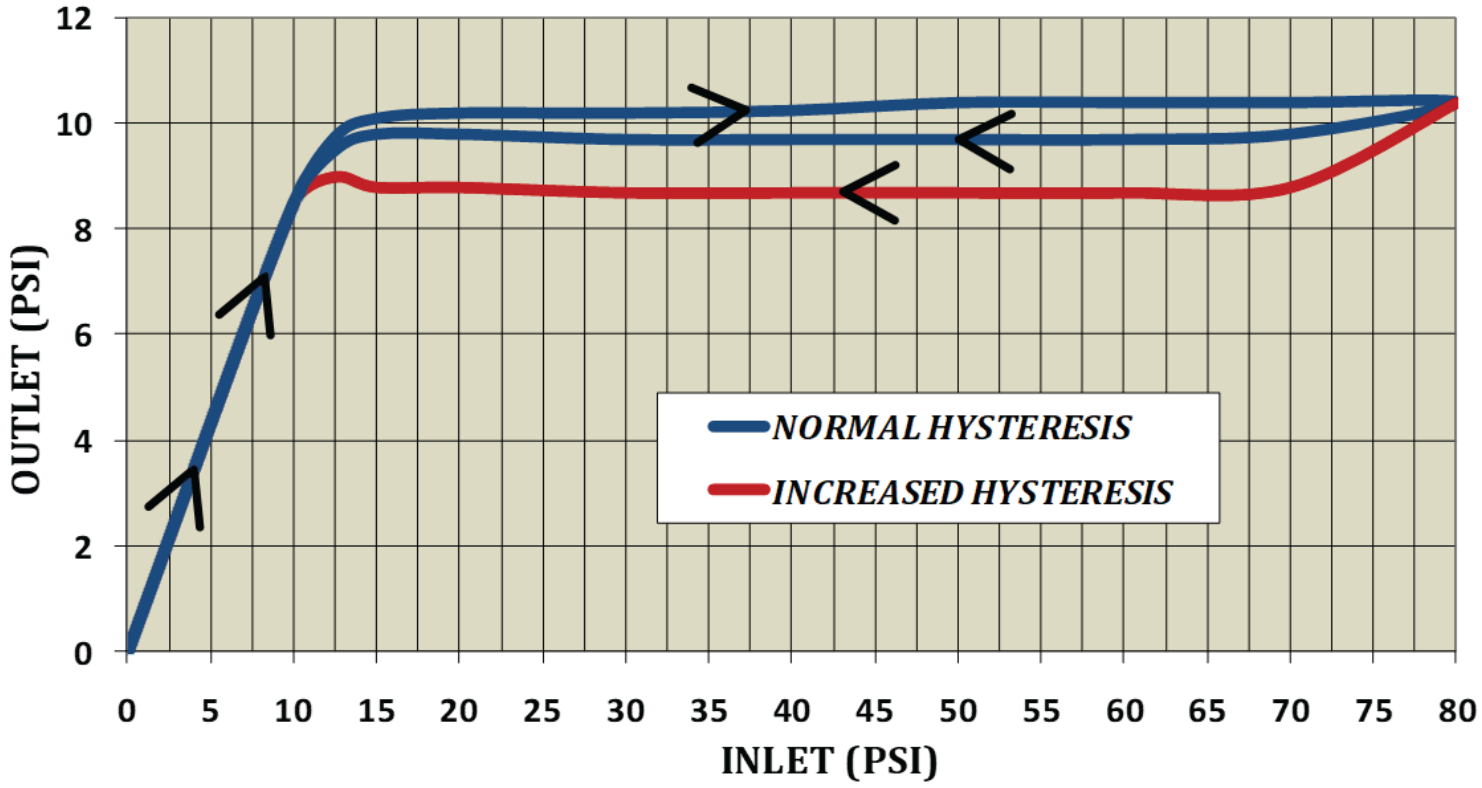
Friction Loss

- Hydraulic friction loss is what makes a pressure regulator work.
- To compensate for friction inside the device, the recommendation is to assure inlet pressure is 5 psi (0.34 bar) higher than expected outlet pressure.



The effects of friction with the pipe walls on "layers" of molecules

Why is Additional Inlet Pressure Needed?

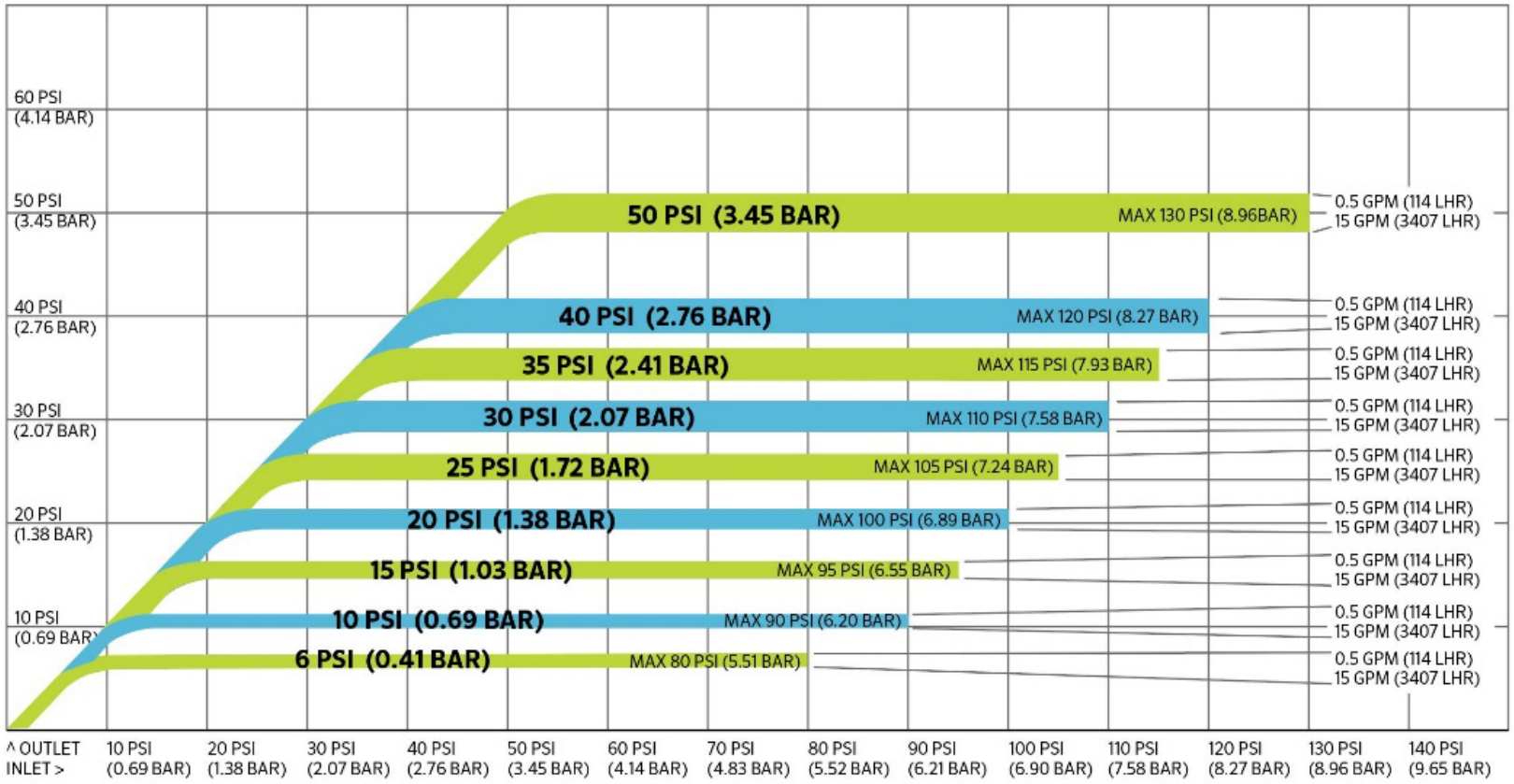


Hysteresis

- When a regulator has very low hysteresis is can maintain similar performance while the system pressure increases compared to decreasing pressure.

What is a Performance Curve?

A regulator performance curve illustrates how the pressure regulator will perform at a minimum and maximum inlet pressure and a predetermined flow range.



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How Do You Specify Regulators?

- Sprinklers designed for center pivots have a recommended pressure range that usually varies by only 5 to 10 psi (0.34 to 0.69 bar).
- Most center pivots have more pressure differential.

How Do You Specify Pressure Regulators?

- **Operating pressure range** – select the PSI model based on available system pressure, sprinkler type selected; desired application rate, and droplet size; assure inlet pressure is at least 5 psi above regulator model's preset outlet pressure
- **Flow requirements** – assure the flow matches the regulator model's recommendations
- **Material of internal components** – seals, springs, diaphragms are a consideration for possible chemical compatibility
- **Size and weight constraints**

PSI	BAR	GPM	M^3/HR
6	0.41	0.5-8	0.11-1.82
10	0.70	0.5-10	0.11-2.27
15	1.0	0.5-12	0.11-2.72
20	1.4	0.5-12	0.11-2.72
25	1.7	0.5-12	0.11-2.72
30	2.0	0.5-12	0.11-2.72
40	2.8	0.5-12	0.11-2.72
50	3.4	0.5-12	0.11-2.72

How Long Do Pressure Regulators Last?

- Like sprinklers, pressure regulators do not last forever.
- The conditions under which pressure regulators operate influence their lifespan.
- Irrigators are encouraged to check their pressure regulators at least every three to five years.

Factors the Contribute to Regulator Wear

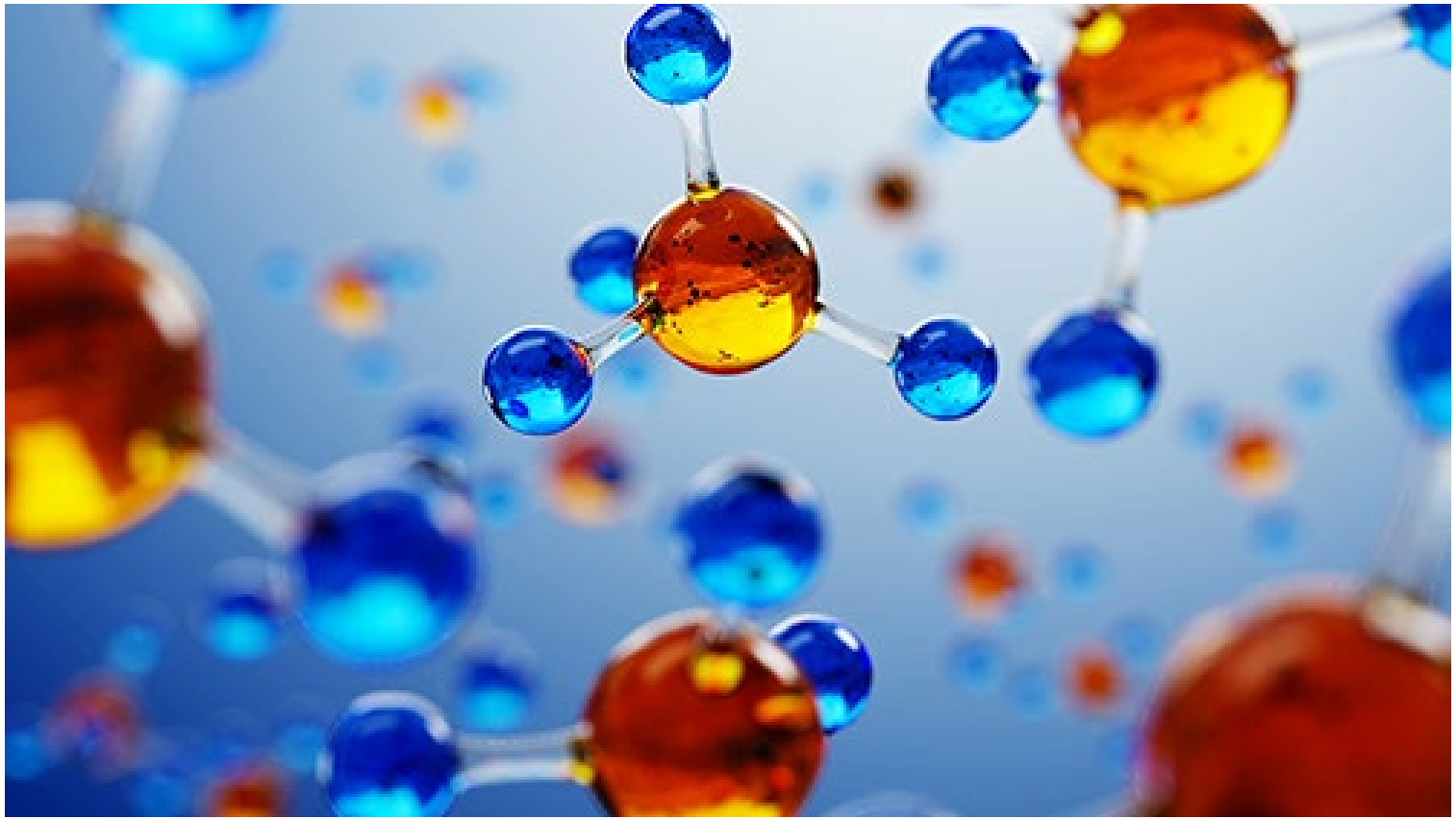
Poor water quality

- Grit and fibrous matter
- Chemicals
- Iron

(left) Inlet and outlet connections of regulators on a system with high iron content in the water

(right) Scarred throttling stem from a worn pressure regulator

How Long Do Pressure Regulators Last?



Unflushed chemicals

- Nitrogen
- Fertilizers
- Insecticides

Factors the Contribute to Regulator Wear

Extended Operating Hours

- Anything with moving parts wears out over time.

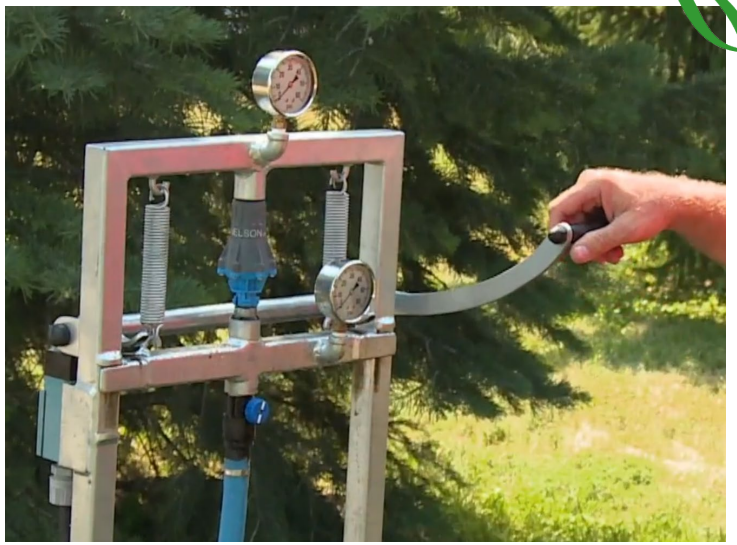
What are Signs of Wear of Problems?

- Leaking between the upper and lower housings
- High-pitched squealing
- Noticeable difference in sprinkler performance
- Over- or under-watered areas within the crop

Testing Pressure Regulators

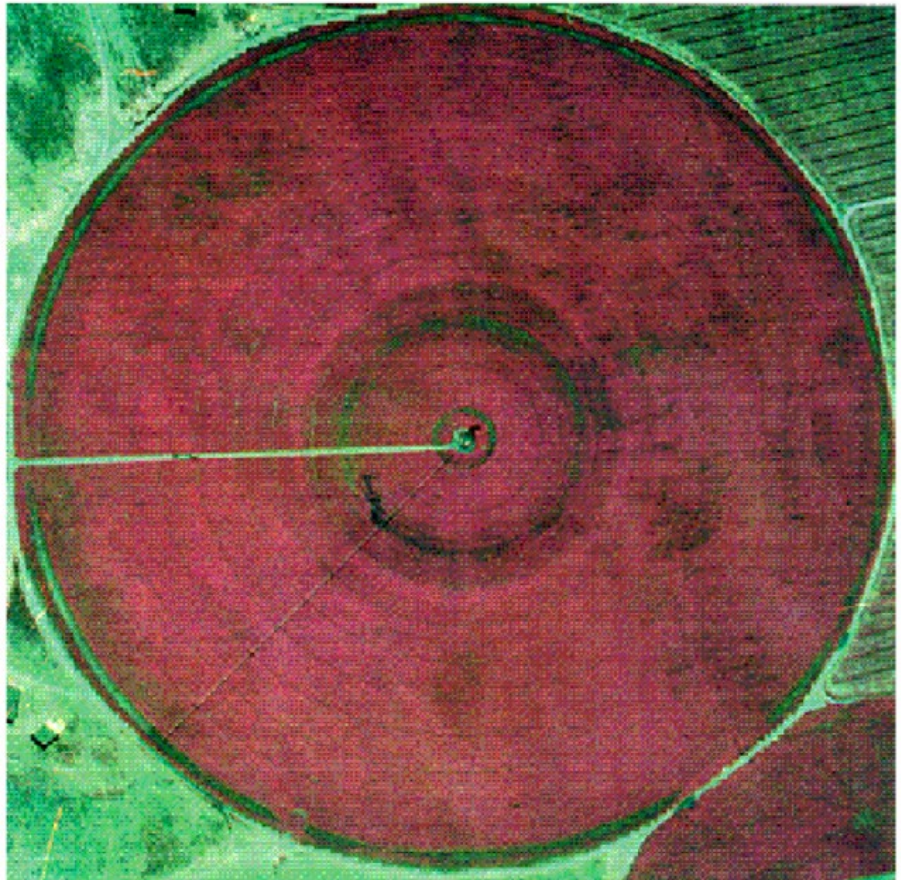
Pressure gauge before and after the regulator:

- Check the readings on a new pressure regulator matching the model you are testing as a "witness." If the new unit regulates in the apparatus 2% higher than the preset outlet pressure, then the unit being tested should also regulate 2% higher.
- Substantial variations are a concern



Testing Pressure Regulators

- Pitot tube to check the nozzle flow
- Flowmeter
- Yield map or overhead imaging



Installation Recommendations

Direction of the Flow

Pressure regulator installed incorrectly on the center drop which prevents proper sprinkler operation

Installation Recommendations

Flow Range

- Each regulator is designed to handle a specific flow range

Installation Recommendations

Maximum Pressure

- Each pressure regulator is designed with a maximum pressure rating.

Flow Range	Preset Operating Pressure	Maximum Inlet Pressure
0.5 - 15 GPM (114 - 3407 L/hr)	6 PSI (0.41 bar)	80 psi (5.51 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	10 PSI (0.69 bar)	90 psi (6.20 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	12 PSI (0.83 bar)	90 psi (6.20 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	15 PSI (1.03 bar)	95 psi (6.55 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	20 PSI (1.38 bar)	100 psi (6.89 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	25 PSI (1.72 bar)	105 psi (7.24 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	30 PSI (2.07 bar)	110 psi (7.58 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	35 PSI (2.41 bar)	115 psi (7.93 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	40 PSI (2.76 bar)	120 psi (8.27 bar)
0.5 - 15 GPM (114 - 3407 L/hr)	50 PSI (3.45 bar)	130 psi (8.96 bar)

Installation Recommendations

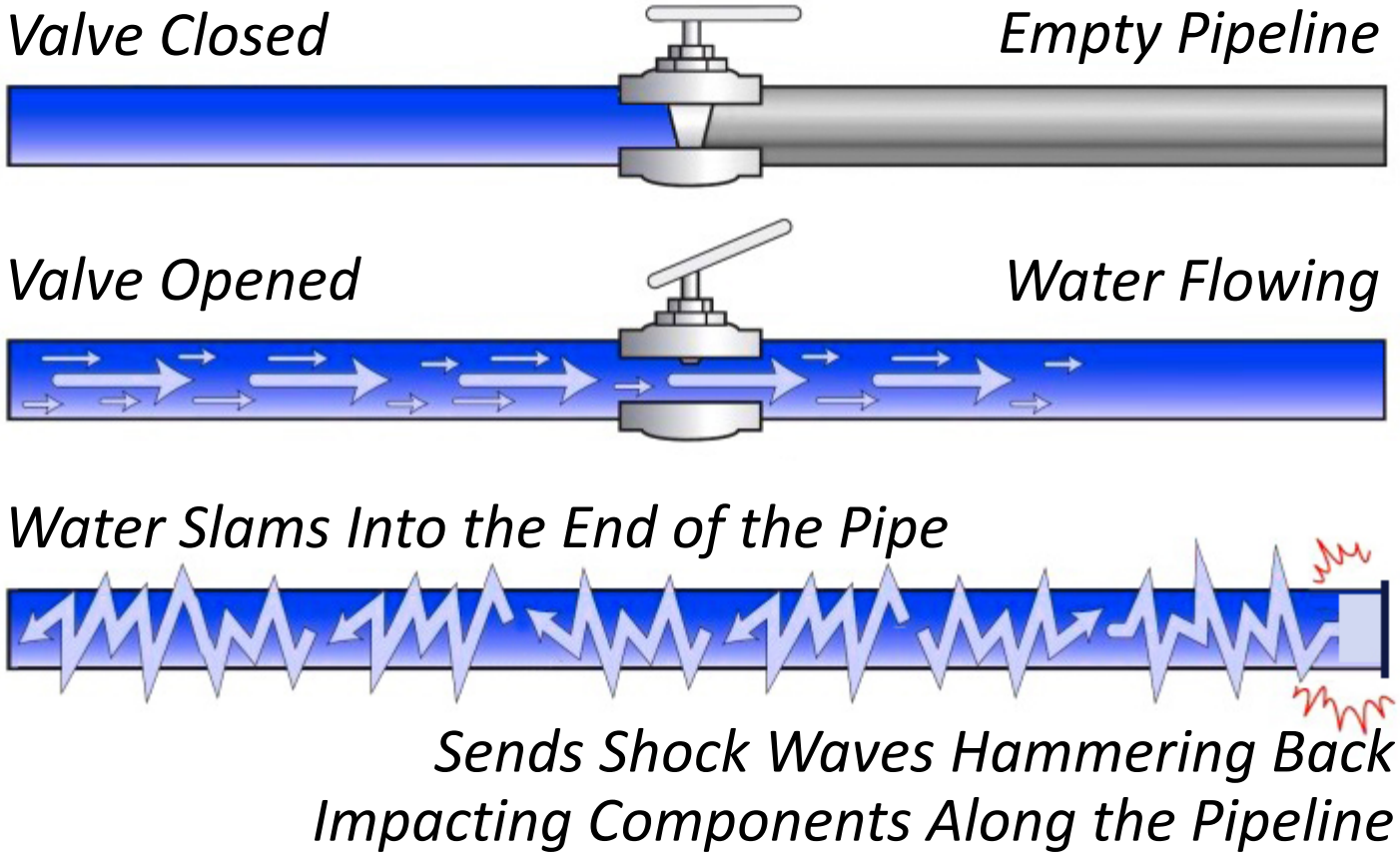
Shut Off Valves

- Pressure regulators should be installed after the shut-off valve to avoid damaging the regulator.

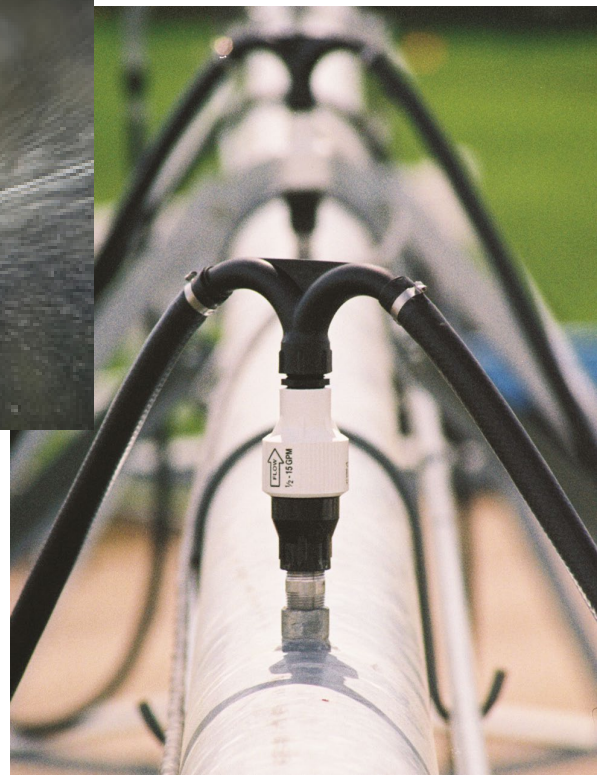
Installation Recommendations

Water Hammer

- If systems fill with water quickly at start-up, it can create high pressure shock waves or a “water hammer” which can damage system components.



Installation Recommendations



Mechanized Systems

- Pressure regulators are usually installed immediately preceding the applicator.
- Some prefer to install the pressure regulator on the outlet or inlet side of the gooseneck.

Installation Recommendations

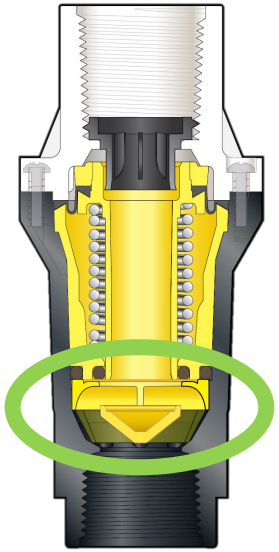
Solid Set Field Systems

- Regulators are usually installed at the beginning of the lateral.
- Certain installations may require a pressure regulator for each applicator.
- In high flow scenarios, a high flow model should be used.
- Timer-control installations employ regulators after the control valve

Pressure Regulators Versus Limit Valves

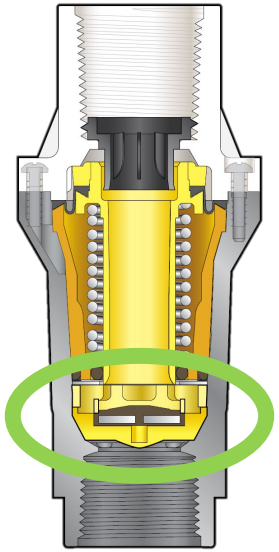
Pressure Regulator

- Maintains preset outlet pressure <u>with</u> water flow
- Installation <u>after</u> shut-off valve
- If a downstream shut-off valve were to close, the t-stem would be unable to completely seal against the rigid seat.
- The inlet pressure would equalize across the regulator and when the shut-off valve is opened, a high-pressure surge could damage downstream components.



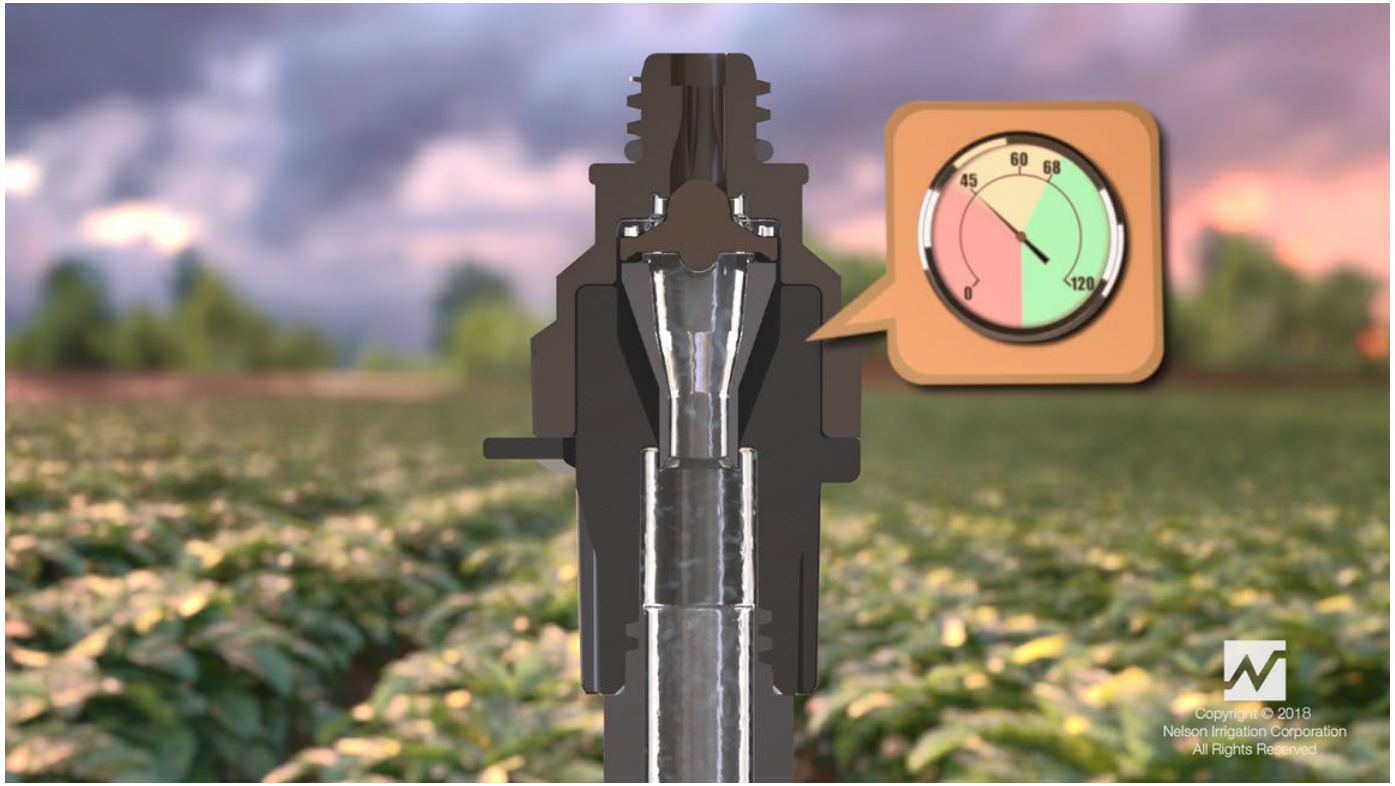
Pressure Regulating Limit Valve

- Designed to control pressure when there is <u>no</u> water flow
- Installation <u>before</u> shut-off valve
- When this shut-off valve is closed, the t-stem flow-passage closes and seals on the rubber washer in the seat.
- The limit valve limits outlet pressure to only 10 to 15 psi above its normal regulating pressure.

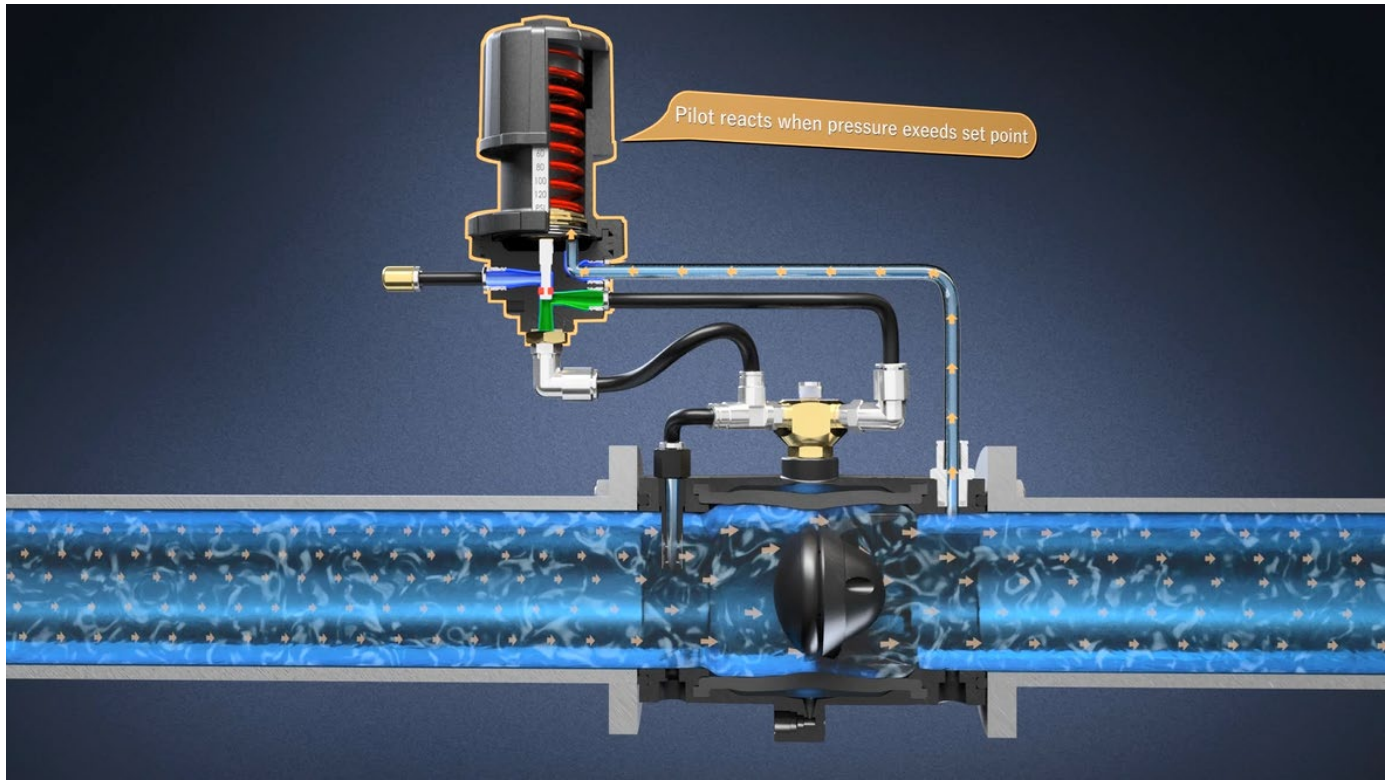


Pressure Regulators Versus Check Valves

- The drain check feature eliminates sprinkler drizzle during shut-down and start-up.
- A check valve helps eliminate wash-out and erosion damage caused by partially pressurized sprinklers.



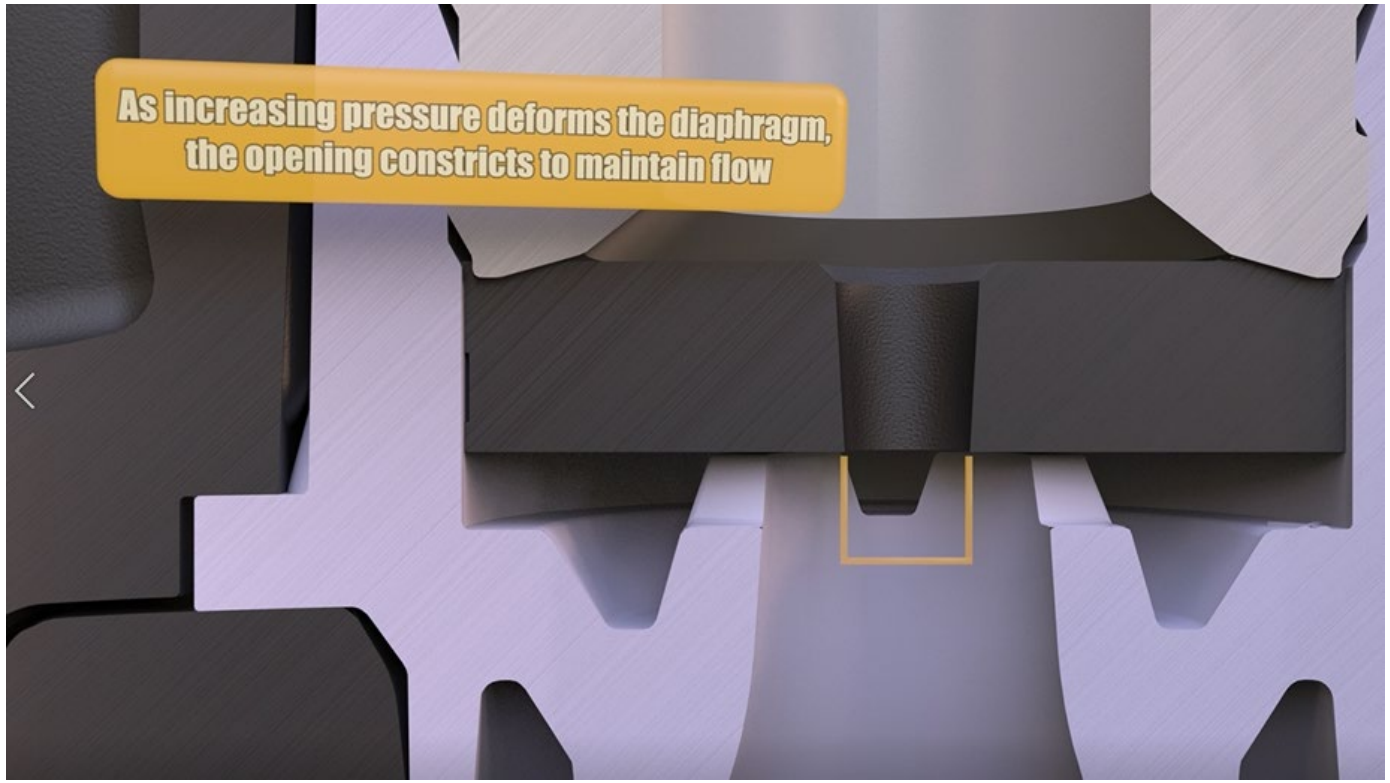
Regulators Versus Pressure Control Valve



- Valves are sized by flow rate to control pressure in large piping systems.
- Pressure control valves react through a pressure control regulator.
- Many models are available offering manual or electric closing control.

Regulators Versus Flow Control Nozzles

- Flow control nozzles can eliminate the need for pressure regulators.
- In some cases, they may pass debris more easily than conventional nozzles.
- Depending on device, high pressures will negatively affect their performance.



The Importance of Pressure Regulators

Investing in new pressure regulators is worth the investment when compared with the time and money lost in wasted input costs and potential yield loss. Pressure regulators help make the most of the water applied improving crop yield. They are an important tool to help provide food, fiber, and fuel for a growing population.

Any Questions About Pressure Regulation?