Pressure Regulators: Tools for the DU (distribution uniformity) Conscious Designer

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What is a Pressure Regulator?

By name and definition, a pressure regulator is simply a valve designed to regulate system pressure downstream of its placement. Irrigation system designers use pressure regulators to control and tailor a system's hydraulics to meet specific design objectives.

Cutaway view of a pressure regulator

A pressure regulator maintains downstream pressure by automatically modulating the area of opening through the device. By changing the area of opening as upstream pressures vary, pressure loss through the valve changes proportionally to maintain the downstream pressure at a relative constant. Understanding that all pressure regulators are designed to accurately reduce system pressure, it is important to always design for an upstream pressure greater than the desired downstream pressure.

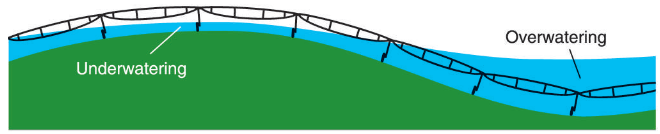
To allow a reasonable level of accuracy in pressure maintenance, there are various models of pressure regulators available to meet specific flow and pressure requirements. To ensure proper regulator function, the designer should always observe the operating parameters stated by the pressure regulator manufacturer. The manufacturer's parameters usually include a maximum and minimum upstream pressure, downstream pressure to be maintained and an acceptable flow range.

Why Regulate Pressure?

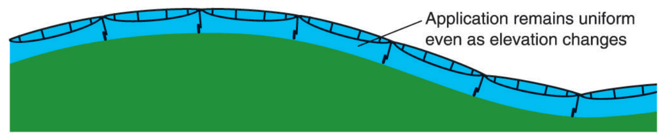
Pressure regulation is utilized in the design of solid set, mechanical move and low volume irrigation systems. The basic reasoning for controlling system pressure is similar in all types of system design.

Distribution Uniformity

System distribution uniformity is one of the primary reasons that regulators are used. A standard design objective is to take a predetermined amount of water and apply it uniformly over a predetermined area. Independent of the system or method of irrigation selected, pressures within a system effect the system flow rate. Consequently, it is important to keep system pressures somewhat constant in order to expect uniform distribution of water throughout an irrigation system.



WITHOUT PRESSURE REGULATORS



WITH PRESSURE REGULATORS

Mechanical move systems have the potential to experience elevation and pressure changes causing flow fluctuations on unregulated systems.

System pressures will vary throughout the system due to pressure loss through pipe and fittings as well as pressure fluctuations induced by elevation changes in undulating terrain. Once the system is installed, pipe diameters are constant and topography does not change. The predictability of these pressure variations makes it possible for a designer to adjust for them on stationary systems. Mechanical move systems have the potential to experience elevation and pressure changes as they operate. This scenario could easily cause flow fluctuations in excess of plus or minus 5%, in which case, pressure regulators are recommended.

More difficult to forecast and design for on all systems, are some of the factors that cause system pressures to change during operation. Classic examples of such factors are a center pivot system's end gun or corner arm valves turning on and off. These changes in system flow demand may also cause significant fluctuations in pressure. Solid set and low volume systems may have block or zone valves being turned on and off, creating the same concerns with system pressure.

Pressure variations may also be induced from the water source. Large projects with multiple wells supplying water for the system frequently turn wells on and off as system demand changes. The modifications made at the source are rarely proportional to the system demand, which result in an overall change in system pressure. Many parts of the world have wells that experience fluctuating water levels in the aquifer system. The result of a change in water level is a fluctuating pumping pressure.

Some drip or solid set installations call for pressure regulators to be installed below ground.

Pivot installations can employ pressure regulators used at the top of the drop pipe or near the spray nozzle.

Proper placement of pressure regulators will prevent any of the above-mentioned causes for system pressure variations from effecting the uniformity of water distribution. The designer need only provide adequate pressure up to the point of regulation.

System Component Performance

Some system components may fail or exhibit unacceptable performance characteristics if pressures exceed a specific point. Most low-volume tubing or tape products have a maximum pressure rating to prevent product damage or failure. Pressure compensating products have a pressure range which, if exceeded, will fall out of a tolerable flow variation.

Mechanical move system components have a range of pressures that provide optimal performance. For example, when pressures are allowed to exceed 15 to 20 psi, spray nozzles produce water droplets that are very susceptible to evaporation and wind drift. Product longevity can be enhanced for many other applicators by heeding the manufacturers maximum pressure recommendations.

The Pressure vs. Flow Relationship

One key formula to calculate the change in flow resulting from a change in pressure is:
New Flow Rate = Old Flow Rate x the square root of (New Pressure divided by Old Pressure)
A common design practice is to regulate any system that, any combination of variables would result in a flow fluctuation of plus or minus 5% on a specific area of the system *(10% maximum variation throughout the entire system).*

The increasing awareness of energy savings and pumping costs are resulting in more low-pressure system designs. The lower the system design pressure, the more critical it is to stabilize system pressures. If a system designed for 800 gpm at 70 psi experiences a 5 psi drop, the resulting flow rate drop is 30 gpm. If the same system were designed at 35 psi, the same pressure drop would equate to a flow drop of 60 gpm.

With current water availability and quality concerns, placing ever-increasing demand for greater efficiencies in irrigation systems, the use of pressure regulation is critical. Good distribution uniformity is dependent on proper system design. Proper system design hinges on a designer's ability to control the hydraulics of the system through pressure regulation.