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Characteristics of PVC Pipe

For years there was not much choice in irrigation pipe material – steel was the standard of the industry. Now there's PVC pipe with its major advantages, such as installation ease, weight, chemical resistance, and relative flexibility

Before deciding to use PVC in your irrigation system, there are some important points you should be aware of. They are: the differences between PVC and steel, PVC pipe rating, visco-elasticity issues, and water hammer.

Comparing PVC pipe with steel
The chart on page five compares PVC with steel. This helpful information is organized to help make your decision easier. Both PVC and steel have their definite advantages.

Rating PVC pipe
The industry uses two methods to rate PVC pipe. One is the Standard Dimension Ratio and the other is the Schedule System.

Standard Dimension Ratio
Standard Dimension Ratio (SDR) or Class System was developed by the plastic pipe industry. It is the ratio of the minimum wall thickness to the outside diameter of the pipe for an established stress or pressure level. for example, Class 200 pipe has a pressure rating of 200 psi.

It is the more commonly used method of rating pipe because it makes it easier to recognize the rating of the whole system. For example: a system using all Class 200 pipe and fittings will have the capability to handle 200 psi.

Schedule System
The Schedule System was developed long before the advent of plastic pipe. It has specific pressure ratings for each pipe size. These ratings range from 850 psi for 1/2 inch Schedule 80 pipe down to 180 psi for 6-inch Schedule 40 pipe. However, the fittings for Schedule 40 and Schedule 80 don't have pressure ratings because their shapes and irregularities have made standard pressure rating almost impossible to develop.

Years of field experience have lead to the concept that a fitting must have a wall thickness at least 25 percent heavier than its equivalent schedule and diameter pipe. This way the PVC fitting does not become the weak link in the piping system.

The PVC nipple is a unique component in the PVC piping system. Nipples should be made only from Schedule 80 pipe stock or the equivalent. Both nipples and Schedule 40 threaded fittings will have a wall thickness in the threaded portion that is equal to the minimum wall thickness of a Schedule 80 threaded pipe because of cuts in the wall thickness made by the threads. Recent studies show that molded threads are substantially stronger than machined or cut threads because of the natural flow of molten material around the thread profile during the molding process. This is similar to metallic fasteners that are stronger if they have rolled threads rather than machined threads.

Visco-elasticity issues
All plastics and specifically PVC are visco-elastic materials, A child's plaything called Silly Putty® is an example of a visco-elastic material. Visco-elasticity allows a material, like Silly Putty, to be stretched greatly if you pull it slowly. However, if you pull quickly, the material will break with a snap. Visco-elasticity has both advantages and disadvantages in piping systems. The ability of PVC pipe to deform or "creep" is a major benefit when you install a sprinkler system along a curved sidewalk or when you need to compensate for change in elevation or grades. Also, a visco-elastic material can more easily tolerate temperature- related expansion and contraction.

The two most common types of system failures related to visco-elasticity are catastrophic burst and long-term yield (stretch).

Catastrophic burst
Burst failures can be identified by the sharp, jagged breaks that almost always leave the system in pieces. It is not uncommon for the failure to spread away from the origin and travel into adjacent components, such as pipe or fittings. Pressure surges, especially those caused by water hammer, produce burst failures.

COMPARING PVC PIPE WITH STEEL

Characteristic	PVC	Steel
Solvent weld	Yes	No
Weight	81 lbs/ft3	455.5 lbs/ft3
Chemical resistance	Excellent	Poor
Flow coefficient	150	65 to 110
Modulus of elasticity	400,000 psi	29,000,000 psi
Maximum service temperature	140° F	1,000° F
Tensile strength	7,000 psi	60,000 psi
Maximum design stress	2,000 psi	20,000 psi
Relative impact resistance	1	6

Long-term yield
Long-term yield failures remain localized and often result in areas of plastic erosion around the point of origin. You can see in a close-up examination of these areas that the plastic has “stretch marks’ and a very glossy surface. These long-term failures usually will be located in the most highly stressed area of a fitting or component. In typical PVC tees and elbows, these areas can be the crotch or inner corner of the direction change.

Sometimes the failure of a female threaded socket seems to contradict this scenario. Here, the failure is almost always found to originate and follow the knitline, bondline, or weldline. The knitline can be the weakest link in the chain and with the high wedging loads induced by tapered pipe threads, the wall may fall. PVC pipe and water hammer The elastic or non-rigid nature of PVC greatly reduces the pressure wave or surge pressure that travels through the piping system. PVC’s ability to swell or grow slightly helps to dissipate some of the energy crated as the pressure wave travels through the system. The maximum surge pressure generated in a 2-inch Schedule 40 PVC system flowing at 5 feet per second is about a third as great as the surge pressure generated in a steel or copper system. However, the wave velocity is also very slow – about the same 3:1 ration. This can produce water hammer in a system with quick-closing valves.

Therefore, the valve closing times in a PVC system must be that much longer than the closing times in a metal system in order to prevent water hammer.

An air slug is a common cause of water hammer that is often overlooked. An air slug is nothing more than a bubble or air pocket within the system. When this bubble travels through the piping at the velocity of water, there is no real problem. But when the air slug gets to the sprinkler or opening, the air escapes through a sprinkler nozzle approximately five times faster than water, so the upstream water velocity suddenly increases. When the air slug is gone, the system velocity suddenly drops to the original value.

For example, if the normal velocity is 3 feet per second, the velocity can increase to 15 feet per second during air escape. After the air is gone, the velocity is instantly reduced by 12 feet per second to the original speed. That 12 feet per second will create an additional pressure of more than 200 psi in a 2-inch system. This 200 psi surge, added to the working pressure of 100 psi, exceeds the 280 psi rating of Schedule 40 pipe.

The 200 psi surge will only last about a third of a second, but remember: PVC pipe is visco-elastic and the pipe cannot tolerate sudden changes or forces. That size of surge, even for that brief time, may result in broken piping and components.

One of the most frequent causes of PVC system problems is failure to design the system to withstand the surges, shocks and other abnormalities that occur in all piping systems. The easy solution is to design the system so its normal operation pressure rating, including surges, is two-thirds the working pressure of the weakest component in the system. This will reduce the chance of failure due to shock. Today, you have a choice in irrigation piping. Knowing the difference between PVC and metal, PVC pipe rating, visco-elasticity problems and water hammer, can help you make the right one.

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