Irrigation Design Information

Pressure Surges in the Irrigation System

The typical turf irrigation system can be subjected to surges in the pipe line that can eventually rupture the pipe and/or blow out the fittings.

Surges occur when the valve closes and the water is stopped. The control of the intensity of the surge should be of concern to the designer. Surge intensity is determined by three variable factors; (1) the velocity of flow in the pipe (2) the straight line length of the pipe, and (3) the closing time of the valve in seconds.

The formula for calculating pressure rise is: $$P_r = \frac{VxLx0.07}{t}$$

Where:

P_r = Pressure rise
V = Velocity of Flow in Feet per Second (fps)
L = Length of pipe in feet
t = Closing time of valve in seconds

Example: Water flowing through 200' of 1" PVC Class 200 pipe with an operating pressure of 65 psi at a velocity of 5 fps with a valve closing time of 1 second.

$$P_r = \frac{5x200x0.07}{1} = \qquad P_r = \frac{70}{1} = 70 \text{ psi pressure rise}$$

The total pressure surge is Pressure rise plus the operating pressure or 70 + 65 = 135 psi surge.

Your pipe is rated at 200 psi so the surge will do little or no immediate damage unless your fittings were improperly cemented to the pipe.

As the system ages there is a tendency for the nozzle orifices to become larger due to the water flowing through them, just like rocks in a river bed erode with the flowing water. In time your orifice size might be large enough to pass 25% more water, if your nozzle was flowing 5.4 g.p.m. and the orifice size increased 1/64" your flow would be approximately 6.5 g.p.m. 10 heads flowing 5.4 g.p.m. = 54 g.p.m. 2" PVC pipe will have a velocity of 5 fps at 54 g.p.m. but when the flow increases to 65 g.p.m. the velocity increases to approximately 6 fps. Using the above example we would have a pressure rise of 84 psi plus 65 psi operating pressure or 149 psi surge. It doesn't seem like much but this will increase yearly especially if you are using water from a pond, lake, river or well, these have more solids in them and will act more like sandpaper in the nozzle.

Another factor to consider is the closing time of the valve. When the valve is 75% closed you will have up to 85% of the water still flowing across the seat. Because of the narrower space for the water to pass through the velocity across the seat will increase and as the speed increases the last 25% closing of the valve will be faster. So the actual closing time may be in the fractions of a second. In the above example using a closing tine of ¾ of a second we will have a pressure rise of 93 psi plus 65 psi operating pressure or 158 psi surge and with increased velocity of 6 fps you would have a pressure rise of 112 psi plus 65 or 177 psi surge.

These factors should be considered when designing. Do not go to the maximum flow velocity on the size pipe you are using, especially if your main line is long always do some anticipated surge calculations when sizing your pipe. By using 1 size larger pipe the life expectancy of your system might be extended by many years.

Another thing to do would be to replace the nozzles in your system periodically.