Pipe Fitting Choices for Golf Course Irrigation Systems

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Introduction: Pipe fittings are an integral part of golf course irrigation systems. Fittings provide the means of connecting sprinkler heads to the pipe mains delivering water and provide for changes of size and direction of the mains. Once installed, pipe fittings should not require maintenance or served for the life of the system. Unfortunately for many golf courses, pipe fitting failures and breakage are a major source of expense and irritation. With proper selection, breakage and repairs can be eliminated.

History of Golf Course Irrigation Systems. PVC pipe is the standard material for golf course irrigation systems. Prior to PVC pipe, systems were constructed of waterworks types of materials, cast iron and asbestos cement mains and cast iron fittings. These materials possessed good strength and good corrosion resistance, but were prohibitively expensive and only used in a small number of clubs throughout the nation. Galvanized pipe was used on smaller sized mains and laterals, but was also expensive and prone to long term corrosion problems. PVC pipe was developed after World War II. PVC pipe possesses a good balance of strength, corrosion resistance and acceptable price that has made irrigation systems affordable to the majority of golf courses in the USA. As technology has increased the capabilities of sprinkler heads, the physical demands on the pipe and fittings has increased. At the same time, systems continue to increase in size, capacity and complexity.

Pipe fittings for golf courses have been "borrowed" from other industries because of the relatively small size of the golf market. Only in the last 15 years, as the market has grown, have manufacturers begun to focus design and manufacturing to address the specific needs of golf course irrigation systems.

Requirements of Pipe Fittings. Pipe fittings should be selected to withstand short-term pressure loads, long-term pressure loads, pressure surges, mechanical loads and potential corrosion present in a golf course irrigation system. Pipe fittings should be selected to function without failure for the life of the pipe. Well-designed and properly operated systems are capable of lasting 30 years of longer. Fittings should be selected to minimize total cost over the life of the system, and to eliminate future maintenance cost and aggravation to the superintendent.

The term cost is defined by Webster's dictionary as: "...the amount of money, time, effort, etc. required to achieve an end..." and also defined as "...loss, sacrifice; detriment...." The pipe fitting selection should be made to reduce the combined aggregate cost of "money, time, effort...loss, sacrifice..." to the course over the long term.

Golf Course Irrigation Systems Generate Unique operating loads. Golf course irrigation systems possess unique properties, found in few other industries. The compact and finite size of the system, the large number of sprinklers, the large volumes of water and the intermittent operations of the system combine to create high velocities and large numbers and magnitudes of pressure surges of shock waves.

Sprinkler valves are designed to close in a reasonably short period of time to minimize drool and puddling. The faster a valve closes, the greater is the shock wave that is created. Ron Bliesner in *Designing, Operating and Main-*

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taining Piping Systems Using PVC Fittings states that modern golf course systems with computer controllers may experience 40,000 to 100,000 cycles per year of magnitudes from 10 to 80 psi (1). In test performed at Cal Poly in Pomona California, pressure surges measuring 105 psi were recorded when an electric operated solenoid valve was closed. The system had a 150 psi static pressure and recorded a low pressure 16 psi during full flow open valve condition. The total range of pressure was 239 psi. (2) Pipe fittings selected for new or repair work must be selected to withstand pressure surges of these ranges and magnitudes present in a golf course.

Of all the forces that fittings are subjected to, pressure surges are the most critical and damaging. Pipe fittings should be carefully selected to withstand the repetitive pressure surges that are so unique to golf course irrigation systems.

Pipe Fitting Choices Available. There are four types of fittings that directly connect with PVC pipe used on golf course irrigation systems. PVC solvent cement joint fittings, PVC gasketed joint fittings, epoxy coated steel fittings and ductile iron push on joint fittings.

PVC solvent cement joint schedule 40 and schedule 80 fittings were the first fittings to be used on PVC irrigation systems. They were readily available, inexpensive and widely used on commercial and residential irrigation systems and industrial applications. The use of glued fittings on sizes above 2" on golf course systems has declined after gasketed fittings became available. Gasketed joints solved the problems of installation errors in gluing and solvent welded fittings' inability to allow for expansion and contraction. Additionally, schedule 40 fittings are unable to withstand numerous cyclical loadings that are present on many golf irrigation systems.

PVC gasketed joint fittings were developed in early 70s to provide means for expansion and contraction. These fittings have the same desirable features of corrosion resistance and low cost as the PVC pipe. The major limitation of PVC gasketed fittings is its inability to withstand numerous cyclical loadings present on many golf irrigation systems. PVC fittings, gasketed and glue type,

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are unable to withstand the cyclical loading due to a combination of internal flexing and the mechanical properties of PVC. The fittings wear out in the inside crotch of the fittings and split from the inside to the outside. This problem is most pronounced in full-size and 90-degree bends.

Epoxy-coated steel fittings are widely used in the agricultural irrigation market. Epoxy-coated steel fittings began being used widely in the golf market in the late 70s. Designers and contractors turned to epoxy-coated steel fittings after experiencing numerous failures of PVC fittings. In the last few years, a growing number of golf courses throughout the nation have experienced numerous failures from corrosion in these fittings. Most golf irrigation consultants have discontinued using epoxy-coated steel fittings.

Ductile iron fittings have been used in the waterworks industry in the United States for centuries. In Versailles, France, a cast-iron water main 17 miles long was installed in 1664 and is still in use providing water to the fountains at Versailles. Cast and ductile iron possess excellent resistance to corrosion. Initial corrosion forms a layer of insoluble graphite that protects the fitting from further corrosion. Many new golf irrigation systems are now using push-on joint ductile iron fittings.

Please see attached *Chart of Characteristics of Pipe Fittings* for a list of features of each kind of fitting. Attached also is *Chart of Advantages and Disadvantages.*

Summary: The golf course superintendent has several options when choosing pipe fittings for repair work or new installations. The superintendent should understand his system and choose pipe fittings that will provide service for the life of the system at the lowest cost.

References

1. R.D. Bliesner, "Designing, Operating and Maintaining Piping systems Using PVC Fittings," Keller-Pliesner Engineering, Logan Utah, (1987)
2. R. Kumar, E. Vis, J. Hung, "Electric Remote Control Valve Closing Time," Agricultural Engineering Department, Cal Poly Pomona, Pomona, California, (1987)
3. M.B. Harrington, "PVC Fittings Failures on Golf Course Irrigation Systems," Harrington Corporation, Lynchburg, Virginia, (1992)

Characteristics of Pipe Fittings For Golf Course Irrigation Systems

Type of Fitting	Size Range	Material tensile strength KSI	Quick Burst (psi) Approx.	Resistance to Cylical loading	Inherently Corrosion Resistant?	Type of joint	All weather Installation?	Provides underground expansion & contraction?	List Price 8" Tee	List Price 2-1.2" Tee
PVC Sch 40	1/2"-8"	7	900	Low	Yes	Solvent Cement	No	No	$94 (1)	#7 (1)
PVC SDR 21	1-1/2-8"	7	900	Low	Yes	Gasketed	Yes	Yes	$102	$36
Epoxy-Coated Steel	2"-12"	49	1400	High	No	Gasketed	Yes	Yes	$142	$55
Ductile Iron PJ	2"-12"	65	3000+	High	Yes	Gasketed	Yes	Yes	$200	$42

Advantages & Disadvantages of Pipe Fittings for Golf Course Irrigation Systems

	PVC SCH 40	PVC Gasketed Joint	Epoxy-Coated Steel	Ductile Iron
Advantages	Corrosion Low Price	Corrosion resis-tent Flexible Low Price	High Strength Flexible Joint Many Confiturations	High strength Corrosion resistent Flexible Joint Many configurations
Disadvantages	Low strength Will not withstand repetitive cyclical pressure surges	Low Strength Will not withstand repetitive cyclical pressure surges	Corrosion problems Higher price	Higher price