How to Avoid Problems with Threaded Plastic Fittings

By Larry Workman

here are millions of miles of plastic piping systems with threaded fittings in use today, providing reliable, leak-free service.

At the same time, a tiny percentage of those threaded plastic systems is causing problems to their owners and major headaches to the installers, who are called back to repair leaking or broken joints. Most of the problems arise from one single source: *improper assembly of threaded joints*.

Installers who have solved the problem of leaking plastic systems have learned the four *wrongs* of PVC joint assembly.

 It is wrong to over-tighten joints by giving them "one more turn to be sure."

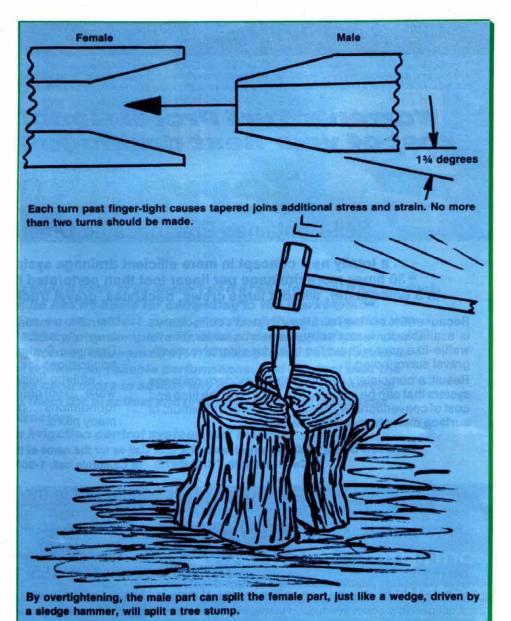
It is wrong to add excess bulk to a threaded joint by wrapping male threads in Teflon tape.
It is wrong to make over-tightening easier by using Teflon tape or Teflon paste or pipe dope.

 It is wrong to use "stronger" Schedule 80 threaded fittings on the assumption that they will solve the problem of splitting through over-tightening.

These statements are backed by the evidence of hundreds of "failure reports"—each of them carefully investigated in quality assurance laboratories—and by basic engineering data concerning standard pipe thread design. An understanding of the physical characteristics of plastic pipe fittings confirms the four vital lessons.

A failure case recently investigated serves as a good example. A golf course irrigation system using PVC pipe and fittings, had roughly 1,500 sprinkler heads mounted on field-assembled swing joints, made with threaded street elbows. Every threaded assembly was replaced because of leaks.

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The field investigation confirmed that the majority of the threaded joints had been overtightened to the point that the elbows had split. Laboratory tests indicated that the fittings themselves were sound, properly molded and well within the requirements of ASTM Standards.

Furthermore, the inspection revealed that male threads had been wrapped with multiple thicknesses of Teflon tape—an average of seven turns on most male ends and as many as ten turns on some!

The installation foreman on the job could not see, at first, what his crew had done wrong. "If the joints weren't made tight enough, they'd drip and cause flooding," he said. "Of course I told the crew to get those fittings down tight; otherwise, if a joint started dripping, we'd have to disassemble back to that dripping joint."

His conclusion was the PVC fittings were at fault; they were "too weak" to take the pressure of good and tight threading. And, besides, the Teflon tape wrapping was just an added way of making sure that the joints were sealed.

It's easier to split smaller diameter threaded joints than larger ones since the stress and strain are greater.

What the job foreman-and many others-failed to understand was that standard pipe threads are *tapered*, like a wedge. If plastic threaded fittings are over-tightened, the male part can split the female part, just as a wedge, driven by a sledge hammer, will split a tree stump. Put a threaded fitting into a brawny installer's hand and tell him to get it "hand tight"-and you'll wind up with an excellent chance that the joint will split when the system is pressurized... if not immediately, then not too far down the road.

Engineers explain this phenomenon in terms of "strain and stress." You may not be able to tell by looking at a joint, but each successive thread is slightly larger in diameter than the one before it and female threads get successively smaller. This is called taper and the amount of taper is specified (1³/₄ degrees) in the American National Standard B2.1. All pipe manufacturers voluntarily follow these standards to assure their customers they are receiving quality materials.

Because the threads are tapered, once the male and female threads are engaged

Size (IPS)	Strain/turn (in/in)	Stress/turn (psi)	Finger-tight + 2 turns + maximum allowable hydrostatic stress (psi)
1/2	.00588	2352	6704
3/4	.00461	1844	5688
1	.00447	1788	5576
11/4	.00349	1396	4792
11/2	.00302	1208	4416
2	.00239	956	3912
21/2	.00287	1148	4296
3	.00234	936	3872
4	.00180	720	3440

TABLE 1-Strain and Tensile Stress Levels of PVC Threaded Joints

Size (IPS)	Schedule 40 Solvent Weld	Schedule 80 Solvent Weld	THREADED Schedule 8 Joint
1/2	600	850	425
3/4	480	690	345
1	450	630	315
11/4	370	520	260
11/2	330	470	235
2	280	400	200
21/2	300	420	210
3	260	270	185
4	220	320	160

(finger tight – not even hand tight) additional turns cause the female part to stretch or undergo "strain." The amount of strain decreases as the size of the pipe increases.

"Stress" (tensile stress) is the force exerted by the strain of the male thread multiplied by the resistance of the PVC. The resistance of PVC is 400,000 pounds per square inch (psi). The strain per turn past finger tight for one-inch PVC pipe is .00447, so the stress per turn is 1,788 psi.

Thus, a one-inch threaded PVC joint that is tightened four turns past finger tight will develop a tensile stress of 7,152 psi. The joint is bound to fail since the stress exceeds the 7,000 psi tensile strength of PVC, without even adding the tensile stress caused by the pressure inside the irrigation system (up to a maximum of 2,000 psi).

You can see that four turns past finger tight with one-inch PVC pipe will result in a split joint. On the other hand, two turns past finger tight plus the stress of the system pressure is within the tensile strength of one-inch PVC. (1,788 psi x 2 plus 2,000 psi # 5,576 psi).

It's easier to split smaller diameter threaded joints than larger ones since the stress and strain are greater. It is also easier to overtorque smaller diameter fittings because their resistance to torquing is less.

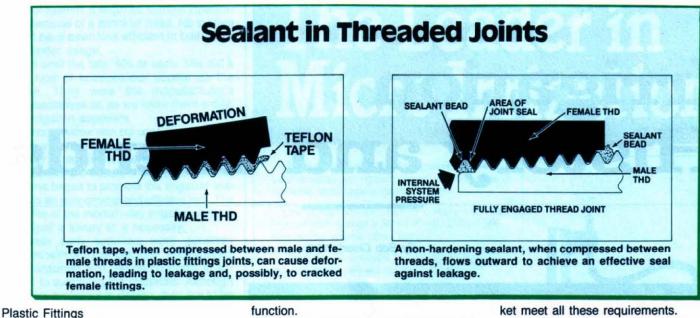
Recommended good practice is to use a thread sealant (not a thread lubricant) and to assemble the joint to finger tight plus one turn, two turns at the most.

When Teflon tape is wrapped around the male threads, it adds to the strain and tensile stress. The tendency of most installers is to wrap several thicknesses of tape around the male threads, increasing stain and stress further. The tape also makes the threads more slippery inviting over-tightening. The joint goes together so easily that two turns doesn't feel tight enough

Teflon tape and pipe dope, just like Teflon tape, make threaded joints slippery. Their use on PVC fittings can be an invitation to disaster.

Metal to metal fitting joints are more difficult to tighten; the surfaces tend to gall without the aid of such lubricants as Teflon or pipe dope. Plastic fittings do not need this lubrication.

This does not mean, however, that *seal-ing* compounds should be avoided. Rather, it means that PVC threaded joints require a sealing compound that meets certain



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criteria.

The sealing compound should be nonhardening. Tapes and hardening pastes permit a leak path to develop when a joint is backed off, mechanically flexed, or expands with rising temperatures. A non-hardening compound, on the other hand, is forced by water pressure into potential points of leakage, thereby performing a true sealing A sealing compound must be compatible to plastics. Many brands of pipe sealants contain oils, solvents or carriers that can damage plastic. A proper sealant must be certified by the manufacturer to be harmless to the fitting material and to not contaminate fluid in the pipe.

Finally, a sealing compound must not lubricate the joint to the point that over-tightening is encouraged. Several sealants on the marMany plastic piping system installers who encounter problems with splitting assume Schedule 40 fittings are weak. They conclude that the problem can be solved by switching to "stronger" Schedule 80 fittings.

There are several fallacies in this reasoning. First, all the problems inherent in overtightening apply as much to Schedule 80 systems as they do Schedule 40. While the walls continued on page 79

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of female Schedule 80 threaded fittings are thicker, wall thickness does not change stress and strain levels.

One advantage in using a Schedule 80 threaded joint arises from its greater stiffness produced by its extra wall thickness. The installer senses this stiffness as tightness, so there is less of a tendency to overtighten the joint. It feels snug with less turns than Schedule 40 fittings.

Installers believe Schedule 80 systems are stronger because they have higher pressure ratings than Schedule 40 systems. This is true *only* when comparing systems with components that have been cemented together with solvent. Introduce even one PVC *threaded* pipe or nipple, and the rating of the entire system must be reduced by 50 percent.

The presence of even one threaded fitting in a system requires a 50 percent cut in pressure rating.

Bear in mind that thread grooves in a fitting result in a reduction of the fitting's wall thickness. In addition, most plastics, including PVC, are "notch sensitive." When the smooth wall of a plastic part is notched, the part loses a significant portion of its original strength, just as a thick sheet of glass will break along a scribed line on its surface. This is why the presence of even one threaded fitting in a system requires a 50 percent de-rating.

Installers of plastic piping systems which involve threaded parts need to keep in mind these two "rights:"

 The right way to assemble a threaded PVC joint—Schedule 40 or 80—is finger tight plus one to two turns—no more.

• The right sealant for threaded joints is nonhardening, compatible with plastic and doesn't add slipperyness to encourage overtorquing.

With these two important facts in mind, many of the unnecessary headaches and costs of improperly installed systems can be avoided.

EDITOR'S NOTE: Larry Workman chairs the Molded Fittings Manufacturers Task Group of the Irrigation Association. He is an applications engineer for Lasco Fittings, Philips Industries, Inc., Anaheim, CA. Landscape & Irrigation VOLUME 10, NUMBER 8 AUGUST 1986

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