A Guide to Tube and Pipe Fittings: Ten Types Examined

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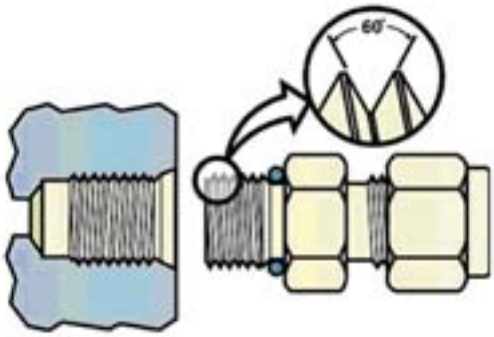

System leakage most often occurs at the connections. This is why selecting, installing and maintaining a system's fitting connections is an important component of plant operation. In energy costs alone, a few small leaks in a facility using air at 100 lbs. per sq. in., for example, with an electric-consumption cost of 6 cents/kilowatt-hour, can waste more than $22,000 annually.

Is there an ideal fitting connection, one that offers 100% leak-free operation under every system parameter requirement? No. Any type of tube or pipe fitting is prone to leakage under certain conditions, especially if mechanical vibration is present. However, certain fitting designs and technologies offer greater reliability than others. Properly installed, quality fittings can reduce leakage to less than 3%.

Considerations for leak prevention include the types of connecting devices used in joining process piping throughout the system, and the experience level of those installing and maintaining the application. Learning important design, installation and maintenance tips and warnings for different types of fittings can minimize potential fluid-handling system problems and enhance their overall performance.

Fittings for Tubes

*Compression fitting.*This was the first tube fitting to be developed. Its three components nut, body and gasket ring or ferrule use a friction grip on the tube. A benefit of this type is that no special tools are required in assembly, unlike pipe connections, which require thread chasers and dies to make up the threads. Furthermore, the seals are often line-type, which creates a dominant force in one small area, providing one of the most effective metal-to-metal seals available. However, this type of connection can only withstand minimal pressure as a result of the friction grip. It is available in only a few materials (mostly brass), and often does not function well in systems having vibration, thermal cycling and other dynamic forces.

Flare fitting. This is made up of a nut, sleeve and body with a flare or coned end. In

some instances, the sleeve is used as a self-flaring option, usually on thinner wall or softer tubing materials. Compared to the original compression fitting, the flare fitting can handle higher pressures and wider system parameters. It is also available in a larger variety of materials and has a larger seal area, which provides remake capabilities in maintenance applications. However, special flaring tools are required to prepare the tubing for installation. Additionally, flaring of the tubing can cause stress risers at the base of the flare or cause axial cracks on thin or brittle tubing. Uneven tube cuts will create an uneven sealing surface.

Bite-type fitting. This fitting needs no special tools for assembly and accommodates higher pressure ratings than those of the original compression design. The design is composed of a fitting with a nut, body and ferrule(s) having a sharp leading edge, which bites into the skin of the tubing to achieve holding ability. A second seal is made on the long, deep surface between the ferrule and internal body taper. Bite-type fittings are typically single ferrule in design. This requires the nose of the ferrule to perform two functions: to bite into the tube to hold it, and to provide a sealing element for the coupling body, an action that can easily compromise one or both functions. A two-ferrule separation of functions (the first to seal, the second to hold the tube) would solve this problem, as the separation would permit each of the elements to be designed specifically for the task.

Mechanical grip-type fitting. This is typically a two-ferrule design, which might also use a live-loaded seal characteristic. This pertains to the spring action of the ferrules during sealing. When the fitting is pulled up, the front ferrule is spring-loaded as it seals, thereby joining the surfaces of the tubing and coupling body. A radial colleting or holding action of the back ferrule grips the tube for a distance just outside the tube holding point of the ferrule nose to enhance vibration resistance. Break and remake of the fitting after installation can be accomplished successfully without damaging fitting or tubing. Some manufacturers offer a gauge to ensure proper and sufficient pull-up on initial installation. Under-tightening of tube fittings, especially in harder materials such as stainless steel, can be a major cause of leakage.

Fittings for Pipe

*Pipe butt weld.*This is the pipe fitting connection that is most resistant to both vibration and fatigue, but does have disadvantages. For example, the welding equipment and specialized training required to make the connection can be costly. Additionally, the amount of time required to install pipe butt weld fittings into a system is greater than that required for other fitting options. Also, training is essential to ensure quality weld connections are achieved. Finally, use of this type fitting limits accessibility for maintenance, unless maintenance people are prepared to carry a torch or hacksaw to cut into a system line.

NPT (National Pipe Thread) fitting. One of the most common types of connections found in process fluid-handling systems, NPT fittings have a tapered thread on both the male and female ends. The seal is actually a "crush seal" between the joining metal surfaces, and occurs on the flank, crest and root of the tapered thread. Because of the affinity metal has for itself, especially when mating carbon steel or

stainless steel, galling and tearing of the metal will take place during the installation procedure. When joining NPT threaded connections, it is imperative to apply lubricant or a sealant with a lubricating agent on the male threads to prevent damage. A popular thread sealant is polytetrafluoroethylene (PTFE) tape.

SAE (Society of Automotive Engineers) straight-thread fitting. Another thread-type gaining popularity, the SAE is a mechanical type, designed to hold only the fitting in place. SAE threads do not provide a seal. The sealing function is provided by an elastomer, typically located at the base of the male thread. The elastomer compresses against a boss or flat surface near the entrance to the female port. This type of threaded seal offers the advantages of an NPT connection in that maintenance, accessibility, and remake of the fitting are significantly easier for the installer.

ISO (International Standards Organization) parallel and tapered-thread fitting. This is similar to NPT tapered thread fittings (relying on threads to perform the sealing characteristics) and SAE straight-thread fittings, using either an elastomer, bonded metal washer or gasket as a backup seal.

NPTF (National Pipe Thread Fine) tapered dryseal fitting. Dryseal threads have roots that are more truncated than the crests, so an interference fit causes the roots to crush the crests of the mating threads. The theory behind this thread is that when the crest, root and flank of the threads are engaged, mating contact is always achieved, creating a seal without lubrication. Unfortunately, inherent properties of some metals such as carbon steel and stainless steel cause galling to occur in this type of seal without lubrication, making initial installation difficult and remake impossible.

37-degree AN (Army/Navy) flare fitting. This uses straight mechanical threads similar to the SAE and ISO straight- or parallel-thread design. It is used only for holding, while a 37-degree male flared end, machined on the end of the fitting, mates with a female flared surface at the base of the female threaded port. This connection is found predominantly in hydraulic applications.

By understanding the above characteristics of fitting designs, your maintenance team will be better prepared to correct system problems, keep it in shape, and reduce leakage-related costs.