A Look Inside Tubing: Avoiding Leaks and the Hassles That Follow Them

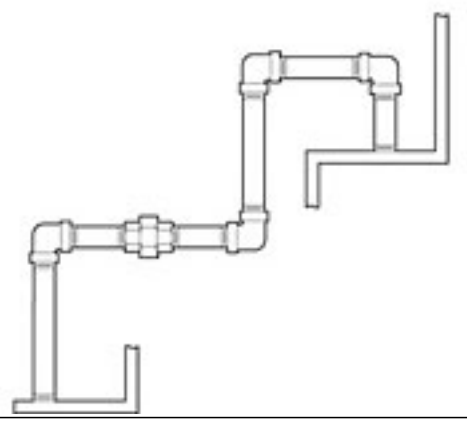
Leaks can lead to costly repairs and even shutdowns. The cost of fines, suspended operations, and cleanup can far outweigh the price of a leak-tight tubing system. Here's a provocative comparison of today's tubing and piping systems

By Ron Holt

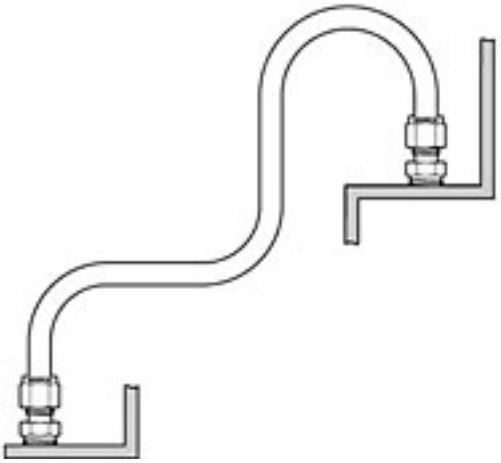
Plant engineers and maintenance personnel are facing tougher demands in the construction, maintenance, and upgrade of processing systems. The performance expectations for these systems are much higher than they were just 10 years ago, in part due to stricter industry standards and stronger competitive forces that are prompting companies to examine how they can enhance cost effectiveness while achieving peak operating efficiencies. System leaks that were once considered nuisances can be classified now as fugitive emissions and hazardous spills, which can result in costly shutdowns and repairs. In addition, technological advancements are pushing pressures, flows, and temperatures to new heights and putting even more stress on fluid systems.

Although the operational landscape has changed and continues to evolve, the basic concepts of assembling and maintaining these systems have remained the same. Pipe has been the material of choice in many plant applications with flanges, fittings, and welds making the connections in much the same manner as they have for decades. In fact, the integrity of most piping systems depends upon sealing and fastening methods that were developed nearly a century ago. In today's environment, there is a real question as to whether traditional piping methods are keeping pace with industry requirements. Tubing is a viable alternative to small bore piping because it provides performance advantages that can help companies meet tougher standards and increasing demands. In short, tubing is economical and less prone to leaks.

Tube vs. Pipe



Pipe typically relies on 45- and 90-degree elbows to route a system. Eliminating these fittings can speed assembly, reduce potential leak points, and improve flow characteristics.



Tubing provides a more compact system and fewer leak points than an equivalent run in pipe.

From a historical perspective, tube and pipe have had their place in plants. Tubing has been used extensively and has performed reliably in small-size instrumentation systems &#151 primarily 1/2-inch diameter and less. Its popularity in instrumentation applications is tied to its ability to provide a more compact system with better flow rates. Energy losses caused by the sharp bends in piping systems are greatly reduced by the gradual bends and the smooth inside diameter of tubing systems. Because tubing can be bent, it results in fewer leak points than an equivalent run in pipe. Also, tubing can be bent in compound angles. Alternatively, piping tends to rely on 45- and 90-degree elbows to route a system, leading to a bulkier and larger footprint. It is a common misconception that tubing is weakened by bending; in fact, the bend will usually be stronger than a straight run, due to the work hardening that takes place as the tube is bent.

Piping has traditionally been used in applications where larger sizes have been required. However, tubing is readily available in larger diameters and in a variety of wall thicknesses and materials. Generally speaking, tubing can replace pipe in many process line applications up to two inches in diameter. Pipe, however, still should be used in diameters in excess of two inches.

The widespread availability of tubing, coupled with its myriad performance and cost advantages, makes it a growing choice for systems with a wide range of pressures and temperatures. Major factors that should be considered when deciding whether to use tube or pipe include installation, maintenance, cost, performance, and code requirements.

Labor and Installation

Just the Facts About Leaks and Regs

The reliability of tube fittings is key. Leaks can lead to costly repairs or, worse yet, to investigations, fines, or shutdowns by regulatory agencies charged with monitoring environmental hazards and safety practices. The cost of fines, suspended operations, or cleanup can far outweigh the cost of a

leak-tight tubing system.
Beyond the benefit of leak-tight fittings is the improvement in overall system performance. Tubing systems reduce entrapment areas and have better flow characteristics. Smoother internal surfaces and gentle curves of tube systems reduce flow losses, drag, and pressure drops. Tube systems also support higher pressures. Because there are no threads, the full wall thickness of the tubing is used to contain pressure, whereas the wall thickness of pipe is effectively reduced by the threads.
While there are many places within a plant where tubing can be used, the actual decision to use tubing must be consistent with applicable codes, standards, and regulations as well as the design practices and philosophy of the end user. The technical requirements of the application should be considered because not every piping system is a potential tubing application. For example, economics may dictate that pipe is the best choice in a system that is larger than two inches in diameter and is to be permanently installed with no future modifications.
Pipe also may be preferred in applications with erosion problems, such as process lines that carry a large amount of solids or abrasives, since pipe inherently has a thicker wall. A tubing system, however, offers bottom-line benefits in the form of increased efficiency, reduced maintenance downtime, improved performance, and greatly enhanced protection against environmental problems and consequences.

Tubing systems require less time to construct than pipe systems because they need less equipment and far less labor time per connection. Pipe is connected via welded, flanged, or threaded connections, while tubing is connected with weld or tube fittings. Welding pipe is a labor-intensive process requiring highly skilled workers. The pipe must be cut, prepped, aligned, and tack welded, and then finish welded on each joint to complete the system. Tube fittings can be installed with standard wrenches, but pipe fittings may require threading or welding. In addition to weld consumables, welded pipe installation may also require hot work, or "burn," permits as well as high-voltage electric power, additional personnel for OSHA compliance (fire watch), and other craft support.
Threaded connections can serve as an alternative to welded pipe, but they bring a different set of difficulties. Field threading can produce threads of varying quality and finish, which can impact installation time and contribute to higher scrap rates. Sealing compounds or PTFE tape is applied to reduce leakage. Unfortunately, a sealed pipe joint that is subject to vibration and temperature or pressure extremes can begin to leak over extended periods of time. In addition, the pipe thread sealant can be incompatible with chemical solutions that move through the process lines, which could contribute to leakage.
Tubing, by contrast, is cut to length and deburred. Fittings are installed simply by tightening a nut that swages ferrules onto the tubing. The fitting creates a mechanical metal-to-metal seal, resulting in a leak-tight connection. Some tube fittings also can be gauged to ensure proper tightening before the system is pressurized and started. Tubing provides a high degree of flexibility by enabling the system to be completely aligned before any fittings are tightened, making it easier to position or orient system components properly. For example, gauges can be aligned for easy reading.If welding is the only or preferred option, a tubing system can be installed with an orbital welding system that can still out-perform pipe. Orbital welding systems, particularly those that use microprocessor technology, are quicker and simpler than manual pipe welding. The weld fittings are designed specifically for tubing, and the microprocessor capability ensures repeatability of welds and minimizes operator errors.
The following comparison of installation times for one-inch connections illustrates the potential savings.

&#149 Welding of schedule 40 pipe requires an average of one hour &#151 from the cutting stage through alignment and weld. Screwed pipe connections require an average of 48 minutes to cut, thread, align, and seal.
&#149 Tube connections require 12 minutes for cutting, prep, and assembly. (Sizes greater than one inch require up to five additional minutes.)
In conclusion, tube connections can cut installation time by more than 50 percent. There are many resources available, both in print and online, to help estimate the cost for all types of pipe and tube systems. For more information, type "plumbing estimating" into your Web search engine. Although the relative cost savings achieved by using tube can be determined from any of the sources, regional labor rates must be considered to determine the most accurate total dollar cost.

Maintenance and Cost Efficiencies

Systems may need to be modified after initial installation. In a tube system, every fitting and connection can be quickly disassembled for replacement, retrofit, or redesign. If an installed tube system requires modification, maintenance personnel can complete the task using a hacksaw, wrenches, and a few parts. For instance, if a branch needs to be added to a line, a union or elbow literally can be replaced with a tee in a matter of minutes, reusing most of the existing hardware. Removing a component to ensure proper drainage of the system is also much easier in a tube system.
Disassembling a threaded pipe system is labor-intensive and unwieldy because each component must be handled individually and sequentially. Threads also can be extremely difficult to remake, leading to trial-and-error reassembly work. Welded pipe systems require costly and time-consuming cutting and re-welding. The issue of safety also comes into play because welding torches &#151 a leading cause of in-plant fires &#151 must be used. Prudent safety practices should limit the use of welding torches whenever possible.
From a cost standpoint, tubing is in nearly all cases less expensive to use than pipe, even though tube fittings &#151 highly engineered, quality products &#151 tend to carry a higher initial price than similarly configured pipe components. This initial material price difference can make a tubing system seem less attractive. But the true cost advantage lies in the savings on installation and maintenance time, the potential for reducing the total amount of materials, and the long-term performance advantages.
Any means of reducing the cost of installation and maintenance, while making the best use of skilled labor, can produce a competitive advantage. Material cost reductions can be achieved with tubing systems because there is ample opportunity to use fewer connections. Tubing can be bent into multiple angles and planes with a tube bender, thereby eliminating elbows that are commonplace in pipe systems. Additional cost efficiencies are realized in the long run.

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