Compressed Air Efficiency: A Piping System Solution

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Maintaining the efficiency of a compressed air system is a constant battle, with leaks being a considerable source of the problem. Pipe joints and fittings are two of the most common areas for leaks to occur in a compressed air system. Detecting and repairing these leaks is an ongoing process that requires skill and patience. Particularly with older compressed air systems, especially threaded galvanized lines, it may be better to scrap the outdated system and start fresh.

An example of a pressed joint (right side). The left side illustrates an unpressed joint.

The Cost of Compressed Air

According to the Compressed Air Challenge (CAC), compressed air systems in the United States consume an estimated 90 billion kWh/year of electricity. Compressed air systems, even the small ones, are massive energy hogs, so it’s important to optimize that energy use and minimize leaks as much as possible. Unfortunately, leaks are all too common; an average facility that has not properly maintained its compressed air system can lose 30-35 percent of the compressor’s output to leaks. In addition, leaks can lead to fluctuating system pressure, decreasing the efficiency of tools and machinery. Equipment service life may suffer, and maintenance time and costs could increase. Corrosion of the steel piping system caused by moisture in the system may also result.

The piecemeal nature of many existing compressed air systems—a result of increased production, facility expansion and the addition of new equipment over the years—has brought together components new and old, perhaps incompatible. The interaction of these components combined with ongoing plant operations and a number of other factors leads to leaks in the system. Leaks can occur at any point within a compressed air system, but the most common locations are joints and connections, including pipe joints, valves, hoses, tubes, fittings, and the like.

Many older compressed air systems are constructed with threaded steel piping, but threading is the least reliable pipe-joining method when it comes to preventing leaks. Two considerable causes of leaks in threaded piping systems are improper initial installation and typical plant operations that weaken the threaded seal. System vibration, for example, can affect the thread tape or sealant, resulting in a leak. Poor thread cuts can also lead to leaks.

Attempting to fix leaks in threaded piping systems can create more headaches than the cost savings may seem worth, because tightening the joint by turning the pipe will loosen an adjacent joint. Basically, fixing one leak may create another one.

Often, the solution to fixing leaks in threaded compressed air piping systems is complete replacement of the piping. Given the age and the number of leaks elsewhere in many of these systems, it may be best to start anew: Create a system in which all components are compatible, using the latest technology available. The cost savings achieved through the elimination of leaks will cover the material costs of the new system within a reasonable timeframe.

Compressed Air Piping

There are several schools of thought regarding the best type of piping system to use for compressed air, and multiple options on the market within each category. In recent years, compressed air lines constructed with press-to-connect and grooved mechanical piping have become popular for their ability to dramatically reduce the pipe joint as a leak source. As relative “newcomers” on the market, let’s take a closer look at these joining methods.

Press-to-Connect Systems

Press-to-connect piping systems join stainless steel pipe via a flame-free joining process that creates permanent joints in a matter of seconds. Pipe is cut to size and deburred, marked for visual verification of full pipe-to-component engagement, then inserted into a lubricated coupling, fitting, or valve. A handheld pressing tool is used to press the component containing seals onto the pipe-ends, providing a positive mechanical interlock and creating a precisely compressed, rigid joint. Sealing is achieved by a combination of the mechanical interference between the component and pipe and the compression of the seal material. The mechanical strength of the joint is achieved through the crimping process.

When installed correctly, the elastomeric seals of a press-to-connect system significantly reduce the likelihood of leaks compared to threaded systems. In addition to minimizing potential leaks at the joints, thereby increasing energy efficiency and reducing operating costs, press-to-connect systems offer several other benefits advantageous to industrial operations: Installation that is up to five times faster than other joining systems and safer than welding, simple installation, and reduced total installed costs compared to other joining methods.

There are multiple factors to consider in specifying a press-to-connect system for a compressed air line, including steel type, pipe size, and gasket material. Press-to-connect systems are available for Type 304(L) and Type 316(L) stainless steel.

Press systems are available for IPS pipe sizes ½-2 inches in diameter. Selecting an IPS pipe-sized press system can simplify integration with larger systems, and the thicker-walled pipe is typically more suitable for industrial applications. Press systems are available for Schedule 5S tube and Schedule 10S pipe. The pipe-wall thickness of ANSI Schedule 10S pipe is up to double that of Schedule 5S tube, which creates a system with up to three times the end-load performance, twice the bend-load performance, a 52 percent increase in available flow, and a 23 percent reduction in pressure drop per 100 linear feet of pipe over tube-sized systems.

Most press systems offer several options for the seal material, including HNBR, nitrile, EPDM, fluoroelastomer and silicone, among others. For compressed air systems, the best option is HNBR or nitrile, both of which are resistant to oil vapors that may be present in the air. Some press systems can withstand pressures of up to 500 psi.

Grooved Mechanical Piping Systems

Although not as new as press systems (grooved mechanical piping has been around since the 1920s), the concept is still unknown to some. Like press systems, grooved systems employ a mechanical joint containing an elastomeric seal, known as a coupling, to join pipe.

A grooved joint comprises four elements: grooved pipe, coupling housings, a gasket, and nuts and bolts. The pipe groove is made by cold forming (roll grooving) or machining (cut grooving) a groove into the ends of a pipe. A gasket is positioned around the joint of two abutted pipe ends, then enclosed in the coupling housings. The key sections of the coupling housings engage the groove. The bolts and nuts, tightened with a socket wrench or impact wrench, hold the housings together. In the installed state, the coupling housings encase the gasket and engage the groove around the circumference of the pipe to create a leak-tight seal in a self-restrained pipe joint.

The unique gasket design provides a triple-seal effect, creating a leak-tight joint. Gaskets are molded to fit over the pipe ends and seal between the grooves. They are slightly compressed as the coupling housing is tightened, which enables low-pressure sealing. The internal cavity is also energized by internal forces applying pressure downward on the sealing lips. The net effect is a pressure-responsive gasket that seals equally well at low pressures and at maximum rated coupling pressures.

In addition to creating leak-tight seals, grooved systems offer a number of additional benefits: Installation that is up to 10 times faster than welding; safer installation through the elimination of flame and cutting; reduced total installed costs; ease of system maintenance and system expansion; accommodation of thermal expansion and contraction, deflection and seismic movement; and noise and vibration attenuation.

Grooved systems can be used on piping up to 60 inches in diameter, and pipe materials ranging from carbon, stainless and galvanized steel, to copper, aluminum and plastic.

In short, press-to-connect and grooved mechanical piping systems are an ideal choice for compressed air lines because both joining methods practically guarantee a reduction, if not elimination, of air leaks through pipe joints compared to threaded systems, are much faster and safer to install than threaded and welded systems, and offer reduced total installed costs.

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[1] http://www.victaulic.com/