

*Mechanical couplings can be direct buried following the same guidelines as welded and split sleeve systems*



# Grooved Pipe Joining Systems for Buried Piping

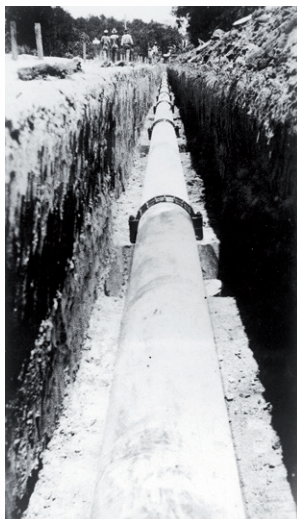
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## Introduction

Grooved mechanical piping systems can offer advantages for buried pipework that make them a superior choice to alternative joining techniques like welding and flanging. Direct buried piping systems were one of the original applications for mechanical couplings and they have been incorporated successfully in buried services for over 95 years.

## Joining Choice

Unpredictable conditions can make the outdoor installation of pipework more difficult. A full range of pipe-joining solutions can be used



*Figure 1: Direct buried piping systems were one of the original applications for mechanical couplings*

in buried piping – including welding, flanging and mechanical grooved systems – and these all offer different performance benefits and disadvantages.

While the age of techniques varies considerably – flanging was employed by the Romans and mechanical pipe joining is a relatively recent 20th century development – pipe joining remains a critical area where choice of method can have a great impact on a project. Skill levels and ease and speed of operations are key factors that determine not only installation costs, but also maintenance costs over time.

## About the Author

**Simon Ouellette** is Engineering Services Supervisor with Victaulic, a leader in mechanical pipe joining and fire protection systems. With a degree in Industrial Engineering from the University of Montreal's Ecole Polytechnique and a background in piping systems, pumps, instrumentation and fire protection, he leads the company's engineering team in EMEA-I regions. He is currently focused on educating customers and employees. His long-term goals involve the development of new products for HVAC, fire protection and industrial markets.

A traditional welded system requires highly-skilled workers and is labour intensive. To install and repair welded piping systems, workers have to cut out a damaged pipe section, which is time consuming, can cause operational concerns and safety hazards.

In a traditional flanged system, multiple bolts are needed to create a joint and adding and removing these bolts is a time-consuming process, as this must be done manually and there must be space around the joint for this operation to take place. For example, a 12-inch flange joint requires 12 bolts to be added or removed.

### Grooved Advantage

With mechanical pipe joints, typically only two bolts need to be removed to access the system, allowing more time-efficient maintenance procedures. Additionally, unlike a flanged joint, a two-bolt coupling can be “free floated” around the pipe for quick alignment adjustment and easy access. Mechanical pipe joining systems also require fewer installation man-hours than alternative methods.

Grooved mechanical pipe joining is a no-flame joining technique of forming or cutting a groove in pipe ends and then joining them with bolted housings around a sealed gasket. Since being made commercially available in 1919, it has become a preferred joining method on many piping applications when compared with welding, threading and flanging, and is commonly used in water systems technology projects.

A mechanical joint is comprised of four elements: grooved pipe, a gasket, coupling housings, and a pair of nuts and bolts. The pipe groove is made by cold forming or machining a groove into the end of a pipe. The key section of the coupling housings engage the groove and the bolts and nuts are tightened with a socket wrench or impact wrench and hold the housings together.

The coupling housings engage in the groove around the circumference of the pipe and encase the gasket. A pressure responsive gasket then creates a seal unified joint that is enhanced when the system is pressurized.

For engineers, the benefits of the grooved system are many: the design versatility of the joint can allow both rigidity and flexibility throughout a system when necessary; a mechanical joint provides noise and vibration attenuation, seismic relief, and accommodates for thermal expansion and contraction.

Added to these benefits, the system provides a union at every joint for ease of system maintenance and expansion.

### Buried Joints

Installing pipe-work outdoors can create numerous difficulties for engineers. Many problems may be caused by harsh external

conditions, including the weather, difficult terrain, ground swell and landslides. Access to basic amenities is also often an issue. It is not always easy to bring a generator to remote areas in tough climatic conditions, whilst ensuring maximum safety levels are maintained. Delays are a common outcome.

Over a number of years, land may be subject to ground movements and displacement, which can create stresses on pipes and even lead to underground breakages. This is very difficult for engineers to control, but flexible couplings offer additional security and can accommodate these potential misalignments without the need to install expensive and delicate specialized equipment.

The deflection characteristics of grooved systems offer significant benefits. They minimize the stresses that result from movement caused by ground and system thermal changes, settlement, and seismic effects.

Flexibility must also be provided at ground breakthroughs to accommodate differential settlement of piping. None of these characteristics are simultaneously available in any other alternative joining technique, such as flanging, threading, or welding.

In fact, mechanical couplings can be direct buried following the same guidelines as welded and split sleeve systems and there are no special design considerations with respect to pipe and joint loading. Direct burial will not adversely affect joint performance or reliability. Mechanical joining systems provide a fully restrained pipe joint while also allowing for flexibility at the joint.

### Field Benefits

Grooved systems help alleviate many of the other problems associated with using alternative joining methods in the field. Mechanical joints are perfect for outdoor, remote use as they can be hand assembled with no need for power tools and can be mounted under any weather conditions, unlike welds which need dry pipe.

Couplings provide visual confirmation of proper installation and there is no need for X-ray testing. With a union at every joint, they offer added flexibility and are more easily adjusted, if alterations are needed.

Another benefit of using grooved mechanical piping systems is that their flame-free assembly reduces the risk of fire as well as other hazards during installation. This is very important in outdoor installations where the risk of using hot-works in dry conditions is high.

In addition, a trench carrying a flanged or welded pipe must be nearly twice the width of a trench carrying a grooved line, so using grooved technology lowers labour and time requirements, as well as the environmental impact.

In other systems, such as district heating, there is likely to be many hundreds of metres – sometimes kilometres – of pipework, which may include large-diameter pipe (350mm and above). Often, pipe will be located in inaccessible trenches or buried, requiring solutions for accommodating thermal movement.

Whilst welding has traditionally been used to join pipework, on large projects with poor access, not only the welding operation

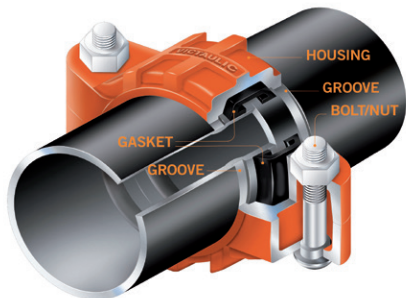


Figure 2: The anatomy of a grooved mechanical joint

itself, but also the essential site preparation and the need to move welding equipment during the job will take considerable time.

### Speed and Maintenance

Whether the project owner is a public agency or a private company, the speed of implementation is a very important factor. Grooved systems are faster than conventional solutions even in perfect construction conditions, lowering costs and limiting exposure to risk.

With measurable time savings between 35% and 50% compared to welding, grooved systems can contribute significantly to meeting tough deadlines. In harsh climatic conditions, the difference is even more impressive. Also, pipe misalignments during installation are easier to resolve as angles can be changed more easily.

Maintenance is also much easier with grooved joints, which are easily maintained and easily expandable. It can take all day to unbolt a flanged joint depending on size. Compare this with only few minutes to unlock even a large diameter grooved coupling.

### Corrosion Protection

As with other alternative methods of joining pipe, the effects of soil conditions on buried systems must be incorporated into the system design to prevent corrosion. Special coatings and/or cathodic protection may be applied to ensure system longevity. Product applications and processes regarding direct burial and corrosion protection methods are not unique to pipe joints installed with mechanical couplings.

System designers should review ground soil conditions and make a determination of the appropriate coating for the application. On steel or iron piping systems, the same type of protection system used on the pipe may also be used for couplings.

While some grooved couplings are manufactured from ductile iron with zinc electroplated carbon steel hardware as a standard, coatings may also be applied in the field directly onto installed couplings.

External coverings such as heat shrink tubing, tapes or wraps, mastics, wax and asphaltic tapes may also be applied directly over couplings. These coverings will provide the same corrosion protection as they do with other alternative joining methods and can be installed in the same manner. For added corrosion protection, stainless steel bolting is an alternative to plated steel for buried applications.

### Grounding and Bonding

It is important for all pipe joining methods that system designers follow good piping practices and ensure buried

systems are adequately protected. Grounding of buried systems is necessary to ensure proper protection of a piping system from outside sources of electrical activity such as lightning strikes, power line breaks and stray currents. Grounding is also necessary to ensure static electricity within a pipeline does not build to a potentially dangerous level.

Stainless steel and bare steel direct buried systems are naturally grounded and do not require additional grounding. However, systems that incorporate coatings or wraps may need earthing along selected locations of the piping system.

Stainless steel, bare, painted, or galvanized grooved and bolted couplings, when installed on uncoated, galvanized, or enamel painted pipe ends will provide continuity across the pipe joint through the coupling housing. This is important for systems that are grounded only at select locations and where continuity across the pipe joints is required. Joint continuity is achieved by the high contact forces that occur between the coupling housings and the pipe in the area of the groove/restraint ring.

Similar to other joining methods, when the mating surfaces of either the pipe end or coupling are coated with something other than paint or galvanizing prior to coupling installation, the use of grounding clips and/or grounding blocks will maintain continuity across the joint. It should be noted that in the event cathodic protection of the piping system is incorporated, the coupling housings must always be connected to the grounding method to ensure bonding of the coupling housing to the protected pipeline occurs.

Bonding of buried systems may be necessary to ensure electrical continuity through pipe joints and/or continuity with adjacent piping systems. Bonding is achieved by direct connection of the two materials to be bonded together through the use of jumper wires, continuity clips, or some other means of providing continuity between the two materials.

### Cathodic Protection

Cathodic protection is a technique used to control the corrosion of a material by making it the cathode of an electrochemical cell. It is employed to protect a wide range of ferrous metallic equipment and structures in various environments such as pipelines, ships, tanks, casings, and offshore platforms.

Cathodic protection of a piping system can be accomplished by several methods, the most common of which are the use of hot dip galvanizing and high zinc content coatings. The zinc coats the carbon steel surface acting as a sacrificial anode preventing the corrosion of the underlying and surrounding material.

However as with all sacrificial coatings, the coating will eventually become depleted and will no longer be able to protect the underlying material, typically carbon steel, from corrosion. Other methods of cathodic protection include the installation of zinc anodes directly onto the surface of the material to be protected or the use of zinc rich corrosion resistant paints and coatings.

In areas where pipeline integrity and longevity is required, and where pipeline integrity must be monitored, the use of

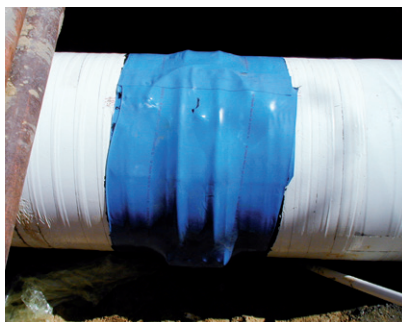


Figure 3: External coverings such as heat shrink tubing may be applied directly over couplings

imposed current cathodic protection can be applied. This method of protection utilizes localized sacrificial anodes or remote anode beds along with an imposed current to ensure corrosion protection is even along the length of the pipeline. This method is often used in conjunction with pipeline coatings.

As with grounding, continuity of the pipeline is required to ensure the imposed current can freely travel the length of the protected area.

Couplings installed in an area protected by cathodic protection must be in direct contact or bonded to the pipe to ensure continuity through the connection and even protection of the joint. Continuity between the pipe and coupling is necessary to ensure the couplings do not experience accelerated corrosion.

### **Conclusion**

Summing up the benefits, there is scope for significant financial savings by using mechanical grooved piping systems. Faster field installation, elimination of hot-works and reduced need for expansion joints all add up to advantages that are particularly important when choosing a system for a project in the current economic environment.

Selecting a high quality and innovative mechanical grooved piping system can bring improvements in productivity. In a sector where margins are increasingly tight, this is an increasingly attractive option for consultants, engineers and system designers alike. ❁