



SELECTION OF THE PROPER CONNECTION METHOD IN HYDRAULIC SYSTEMS AND NEW TECHNOLOGIES

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Hydraulic systems provide reliable and powerful solutions for high-force applications. From mining and construction to defense and aerospace, these systems are indispensable in numerous sectors. However, one of the most critical aspects of hydraulic efficiency and safety lies in connection elements. Choosing the right connection method can significantly impact system performance, durability, and safety.

Improper connection methods can lead to oil leaks, pressure drops, and even catastrophic failures. With advancements in technology, new and improved connection techniques are emerging, offering enhanced sealing reliability, installation efficiency, and long-term performance. This article examines the various types of hydraulic connections, conventional connection methods, and the latest technological advancements in hydraulic fittings and connections.

HYDRAULIC CONNECTION ELEMENTS

Connection elements are essential components in hydraulic systems, ensuring seamless fluid transmission between pipes, hoses, and valves while preventing leakage. Depending on the application, operating pressure, and industry requirements, various connection types are used. The most common types include:

JIC (SAE J514, 37° Flare) connection is widely used in hydraulic applications, particularly in the U.S. market. Sealing is achieved through the 37° flare contact rather than by tightening the threads, which provide the mechanical connection. Primary sealing occurs at the mating flare surfaces. This connection type is known for its reliability in high-pressure and vibration-prone applications.

ORFS (SAE J1453, O-Ring Face Seal) connection is one of the most reliable sealing solutions in high-pressure hydraulic circuits. The male end has a flat face with an O-ring, while the female end has a smooth flat surface. Sealing is achieved by compressing the O-ring against the flat face. Depending on the operating temperature, NBR or Viton O-rings should be selected. Due to its superior leak prevention, ORFS is widely used in mining, construction, and other heavy-duty applications.

British Standard Pipe (BSP) connection is commonly used in Europe and the UK. BSP fittings come in two variations. The first is the BSPP (Parallel Thread - ISO228-PT), for which sealing occurs between the male fitting's 30° seat and the female fitting. The second variant is the BSPT (Tapered Thread - ISO7-PT): The male fitting has tapered threads, which require the use of Teflon tape or sealing compounds to ensure leak-free operation. Although BSP connections share similarities with NPT (National Pipe Thread) standards, they are not fully interchangeable.

DIN 2353 metric connections are widely used in European hydraulic systems due to their superior adaptability and ease of installation. Sealing is achieved through a 24° cone interface, which provides excellent reliability. The system is commonly used in pipeline applications where ease of assembly and maintenance are critical.

APPLYING TRADITIONAL CONNECTION METHODS AND UNDERSTANDING THEIR LIMITATIONS

In hydraulic systems, the three most common connection methods are ferrule-based connections, welded connections, and tube forming connections. Each has its advantages and drawbacks.

In the ferrule-based connection system method, a ferrule or compression ring is tightened around the pipe to create a seal. However, this technique presents several challenges. It is not suitable for pressures above 20 MPa (2,900 psi), as leaks may develop. It is also dependent on the operator for installation; if the ferrule is over-tightened, it may crack, and if under-tightened, it may leak.

Welding connection systems are often used in high-pressure and high-vibration environments, but they have several drawbacks. Vibrations may cause cracks in the welds, leading to leaks. Poorly executed welds can introduce contaminants into the hydraulic system, increasing the risk of failure. Additionally, weld beads inside the pipe can restrict the flow area, causing pressure loss and turbulence.

NEW TECHNOLOGIES: WELDLESS AND FERRULE-FREE CONNECTIONS

In recent years, hydraulic connection technology has evolved, eliminating the need for ferrules and welding. These modern methods improve reliability, simplify installation, and enhance safety. For example, tube-forming connection technology involves forming the pipe's end into a specific shape using specialized machinery, eliminating the need for ferrules or welding. This allows for superior sealing, with no risk of ferrule cracks or welding defects. It withstands pressures up to 120 MPa (17,400 psi), tested for both static and dynamic conditions. Furthermore, standardized assembly reduces human errors, ensuring consistent installation quality. This innovative technique is particularly beneficial in mining, defense, and heavy industry applications, where extreme conditions demand high reliability and minimal maintenance.

HYDRAULIC CONNECTIONS AND SAFETY CONSIDERATIONS IN MINING

Mining equipment operates in harsh environments with extreme pressures and mechanical stress. Selecting the right hydraulic

connections is crucial to ensuring minimal pressure loss, optimal energy efficiency, along with reduced downtime and operational failures. It's vital to the prevention of environmental contamination due to oil leaks as well.

SAFETY GUIDELINES FOR HYDRAULIC SYSTEMS

- Always depressurize the system before working on any hydraulic connections.
- Use protective gear to prevent injuries from high-pressure oil injection accidents.
- Regularly inspect fittings to detect wear, damage, or leaks before they lead to failures.

CONCLUSION

The selection of hydraulic connection methods significantly affects system performance, safety, and long-term operational costs. While traditional ferrule-based and welded connections are still in use, new technologies like weldless and ferrule-free connections offer improved reliability, easier assembly, and enhanced safety. For industries such as mining and defense, investing in modern connection technologies can lead to increased operational efficiency, reduced maintenance and downtime, and greater overall system safety.

By adopting the right connection methods, companies can ensure longer-lasting, leak-free, and cost-effective hydraulic systems. ●



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