GR Deshpande

MAKING THE RIGHT CONNECTION

Hydraulic connectors are the unsung heroes of the machinery world – the ones who keep everything running smoothly, while staying humble and out of the spotlight. Just like the backstage crew of a Broadway musical, making sure the show goes on without a hitch while the stars take all the credit, without hydraulic connectors, the whole show would fall apart. Connectors, hoses, and tubes allow fluids to flow from one component to another and this article, we'll be taking a look into the world of hydraulic connectors. **Mr. G R Deshpande** from **Hyloc Hydrotechnic** explores their importance, the various types, and the materials they're made from. Whether you're a seasoned hydraulics professional or just a curious engineer, you'll come away with a greater appreciation for the humble fitting.

Of Ferrules and Fittings

The ferrule fitting consists of a tapered metal sleeve, called a ferrule, and a threaded nut that holds the ferrule in place. To use a ferrule fitting, the tube to be connected is inserted into the ferrule and rested on the cone angle of the fitting. The nut is then tightened with the fitting, which compresses the ferrule around the outside diameter of the tube. This creates a tight seal that prevents hydraulic fluid from leaking out of the connection.

Ferrule fittings are commonly used in hydraulic systems because they are easy to install and provide a reliable, leak-proof connection. They are also designed to withstand high pressures and temperature variations, making them ideal for use in demanding hydraulic applications.

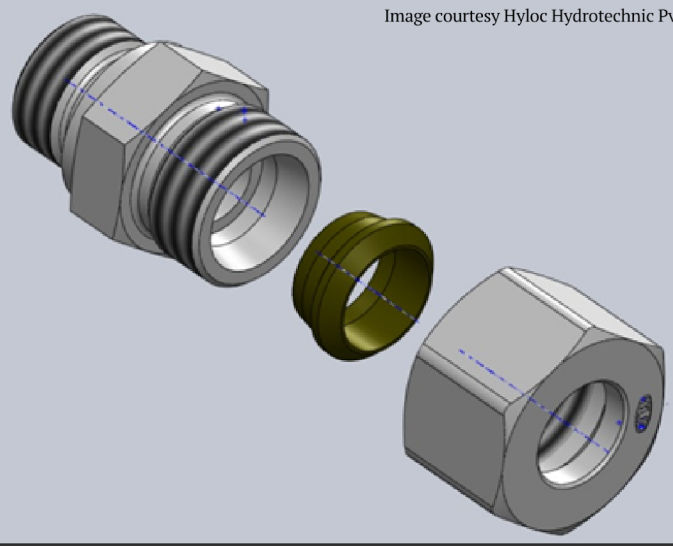


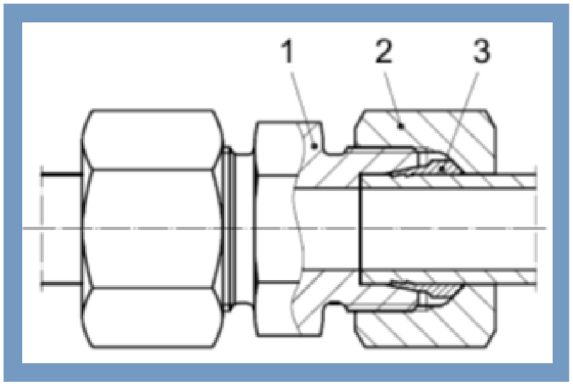
Image courtesy Hyloc Hydrotechnic Pvt. Ltd.

Fluid connectors, specifically tube fittings, are an essential component in hydraulic systems used in various industries. They are responsible for connecting hydraulic components, hoses, and tubes, among others, to enable efficient fluid transfer.

Tu-be or not tu-be

Let us start from the very beginning, understanding the term "tube". Hydraulic tubes are seamless precision pipes specially manufactured for hydraulics. The tubes have standard sizes for different pressure ranges, with standard diameters up to 42 mm. A seamless tube is one that does not have a welding seam, making it solid metal from end to end. Tubes lengths are interconnected with each other or to hydraulic elements (such as pumps, valves, actuators, and manifolds) via flanges, welding nipples, flare connections, or ferrules. Direct joining of tubes by welding is not acceptable since the interior cannot be inspected. The presence of a weld seam on tube acts as a weak point and cannot be guaranteed to withstand various physical forces and hydraulic pressures while in operation.

A fitting, on the other hand, is a manufactured metallic component that connects one component to another. It can connect one tube to another tube, a tube to a hose, or a tube to other hydraulic elements (such as pumps, valves, actuators, and manifolds). These fittings have two primary functions, namely sealing under hydraulic pressure and physically holding the tube under pressure. The most widely used hydraulic tube fittings in India for fluid power system connections are 24° Cone or Bite type. These fittings have a tube end configuration as per international standards.



ABOVE: **Figure showing the assembly of tube fitting with tube 1. Fitting Body with 24° Cone, 2. Coupling Nut, 3. Ferrule (Cutting Ring). Seamless tube shown being bitten into by the ferrule**

Making a leak-proof joint is essential in hydraulics, and proper assembly is the key factor in achieving a perfect and leak-proof joint. Cutting rings or ferrules are one way to provide a safe connection between a tube and the fitting. They provide a good seal and easy assembly of a hydraulic tubing system.

Making a connection

To install, the cutting ring and nut are inserted over the steel tube and the seamless tube's end is inserted into the fitting's 24° cone end. The nut's threads are engaged with the threads of the fitting and rotated by hand while holding the tube in place. Once the nut stops rotating, this is an indication of the initial bite of the ferrule. From this point, with the help of a spanner, the nut is further rotated one to one and a half turns.

The ferrule positions itself by cutting into the tube (but not piercing through) providing a proper sealing and increased safety for high operating pressures. The joint is now ready for installation.

PRESSURE SERIES SELECTION GUIDE FOR TUBE FITTINGS

Series	LL (Very Low pressure)	L (Low pressure)	S (High pressure)
Design	Very Light (100 bar)	Light (250 bar)	Heavy (630 bar)
Sizes	4mm to 12mm	6mm to 42mm	6mm to 38mm
Tightening effort	Very Low	Normal	High
Space	Very Low	Low	High
Typical Applications	Lubrication Air brake Fuel lines	Machine tools Agricultural Equipment	Hydraulic presses Ship building Mobile Hydraulics Construction Equipment

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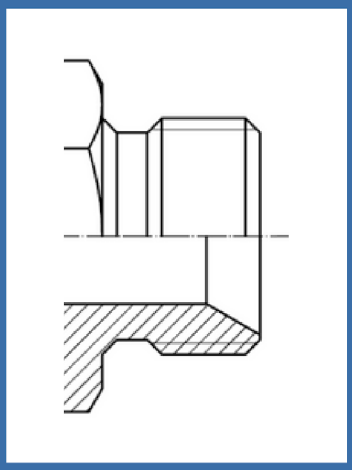
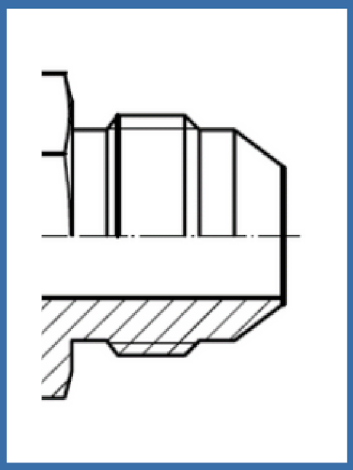
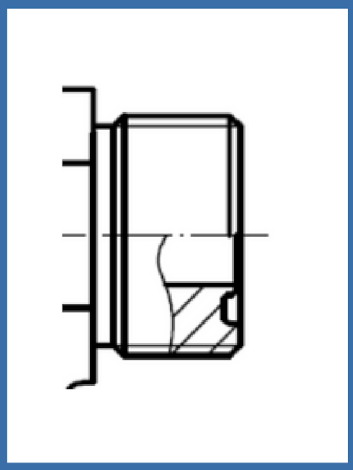


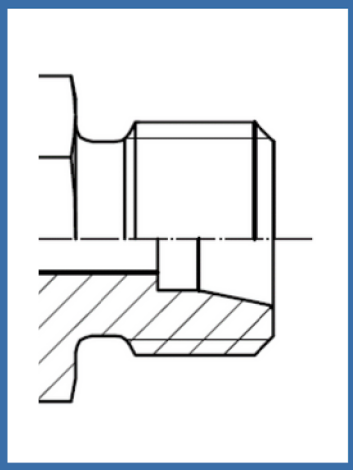
60° cone connectors
Designed with a 60° cone-shaped end on the fitting and a corresponding 60° cone-shaped seat on the component being connected, Cone connectors can also have their mating parts be spherical which provides a leak proof contact on assembly. These are often used in industrial and manufacturing applications such as in the chemical, oil and gas, and pulp and paper industries.



37° flared connectors
Also known as JIC (Joint Industry Council) fittings, these are designed with a 37° cone-shaped end on the fitting and a corresponding 37° cone-shaped seat on the component being connected. They are commonly found in aircraft, aerospace, and military applications, as well as in industrial and manufacturing applications.



O-ring face seal (ORFS)
Designed with a flat face on the fitting and a corresponding flat face on the component being connected, an O-ring placed in between the two creates a seal. Most commonly found in applications where leak-free connections are critical, such as in hydraulic systems used in construction machinery, agricultural machinery, and other heavy equipment.



24° cone connectors, also known as DIN fittings, are designed with a 24° cone-shaped end on the fitting and a corresponding 24° cone-shaped seat on the component being connected. They are commonly found in heavy equipment, such as construction machinery and agricultural machinery, as well as in industrial and manufacturing applications.

Various tube fitting designs are available worldwide with the tube fittings based on the tube's outer diameter (OD) which will be assembled into these fittings.

Regardless of fitting design patterns, designers must consider some criteria before selecting the right fitting for the right application. These criteria can include but are not limited to the following.

Pressure: Working and peak pressure are two parameters to check for when selecting tubes and fittings. The hydraulic fittings must be suitable for your pressure range, including the pressure spikes (peak pressure). Operating beyond this range can cause damage to fittings and personnel standing in the vicinity during failure.

Flow rate and tube size: The internal and external diameter of the fittings are two important sizes to consider. These diameters of the fitting should be compatible with the hose diameter and should be proportional to the flow rate of the

Over or under-sized fittings can cause leakage or the connection to fail. Oversized fittings in the pressure line reduce the fluid's velocity while undersized fittings and tubes can increase pressure drop causing inefficiencies.

Material: The material of the hydraulic fitting should be compatible with the hydraulic fluid and with the operating environment. The most used fitting materials are steel, or stainless steel. For soft sealing, NBR (Nitrile) O-rings seals are the most widely used followed by EPDM seals.

Temperature: Temperatures (stationary, in operation, and environment) at which the fittings will be used must fall within the operating parameters specified by the manufacturers. The hydraulic fittings should be suitable for the entire temperature range since metals and polymer seals act differently at very low and very high temperatures.

Medium: Hydraulic oil, compressed air, desalinated or sea water, or any other fluid used can have different requirements from the fittings and tubes. Corrosion resistance, heat dissipation and the medium's flow forces all need to be considered during selection.

Application: The type of application also determines the fitting type to be used. Tee- or cross- fittings are used for mixing or distribution application.

Assembly: If the hydraulic system requires frequent connecting and disconnecting of the hose or tube, the hydraulic quick-connect fittings can be used. Similarly, hydraulic compression fittings as discussed before can be used to remove the need for welding or soldering of the fitting. It can be used in areas with high temperatures as welded joints can leak in such environments.

BELOW: **Hydraulic compression fittings mitigate the need for welding or soldering connections. Off late, taper fittings are falling out of use with preference being given for O-Rings sealed fittings that can be removed and re-assembled repeatedly without losing sealing capability.**

ABOVE: **Construction and Earthmoving equipment generally deal with higher working and peak pressures due to the power density of the machines. This makes it even more imperative to have fittings that are properly sized and installed. (Images courtesy Getty Images)**

The material selection guide for tube fittings is another important aspect that designers must consider. Tube fittings can be made of steel or stainless steel, or brass, among others. The selection of materials depends on the specific application. Steel tube fittings are are commonly used in machine tools, mobile, construction equipment, and paper industries, while stainless steel tube fittings are ideal for shipbuilding, offshore, coastal installations, laboratory environments, lubrication and, food processing, where corrosion resistance or cleanliness are paramount. Brass tube fittings are also available for specific applications such as pneumatics and cooling water applications.

Seal material selection is also a critical aspect of tube fitting design. The selection of the correct seal material is responsible for preventing fluid leakage in the joint. Metal-to-metal seals are commonly used in process industries and agriculture.

NBR seals (also called soft fittings) are ideal for machine tools, hydraulic presses, mobile, and construction applications, while Viton® seals are suitable for steel mills and casting equipment where temperatures play an important limiting factor or where the fluid medium contains phosphate esters (a flame-retardant hydraulic medium) which reacts negatively to Nitrile seals.

In conclusion, hydraulics fittings play a critical role in the functioning of hydraulic systems. These small yet essential components connect different parts of the system and ensure the smooth transfer of fluids and energy.

Without proper fittings, a hydraulic system would be prone to leaks, pressure loss, and other failures, leading to expensive downtime and repairs. Furthermore, hydraulic fittings today offer a level of flexibility and customization to systems allowing engineers to tailor fittings to the specific needs of the application. This customization ensures that the system can operate at maximum efficiency, reducing waste and conserving energy.