THE SIX STAGES OF COUPLER EVOLUTION

Having grown from the basic threaded connection to next-generation dry disconnects, chemical processors now have a wide range of choices for their fluid-handling applications.

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As industries have evolved, engineered changes have occurred to satisfy new process and operational needs. One product that is an integral cog in the production and supply chain for all industrial processes is the coupler, the capabilities of which have also grown.

Today, couplers must ensure fluid-handling applications meet strict safety and regulatory standards. Simultaneously, couplers must provide optimised containment of a wide range of fluids that can have varying operational characteristics.

The remainder of this article looks at how couplers have evolved in six stages over the years and provides a general guide to the reader regarding which coupler may be the best fit for the specific fluid-handling application.

Threads

The first and still most common way to attach a coupler to a hose or pipe is through a threaded connection. Specifically, National Pipe Thread (NPT) remains the standard for all piping and valve threads in the United States. Unlike straight threads found on a typical bolt, NPT threads pull tightly together due to their tapered-thread design and increased torque, reducing the chance that leak paths will develop.

An important operational benefit of NPT-threaded couplers is that they are intuitive to connect in comparison to varying styles of hosing or piping. However, the main drawback of threaded connections is that they will wear out over time if coupled and uncoupled frequently. This means they must be monitored regularly, so no leak pathways form. Also, the connections can be prone to leaks if not sealed with Teflon® tape or another approved sealant. In high-pressure applications with excessive vibration or loading, threaded connections are also less reliable.

Though the design of threaded connections makes them simple to connect, the excessive force from using pipe wrenches to tighten them can create safety and ergonomic issues for operators. Another thing to keep in mind is that while more force usually results in a tighter connection, an equal amount of force will be required to undo the connection. This can damage the coupler, followed by leaks and, ultimately, repair or replacement.

Flanges

Flanges are another type of coupler technology that have proven effective in high-pressure fluid-transfer applications. Flanges differ from NPT connections in that they feature two discs connected with nuts and bolts and a gasket situated between them. The gasket, which must be installed appropriately, improves seal quality and reliability when compared to a basic threaded connection.

While they offer advantages in sealing capability, flanged connections require more space and are more expensive. Also, because flanged systems are heavy to handle, and a specific number

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of nuts and bolts are needed (4, 8, 16, etc.), they can be time-consuming to connect and may require more manpower to install.

Unions

The challenges of flanges led to the development of unions as alternatives. Unions are easy to connect since they do not require nuts and bolts. Instead, they are threaded for the initial connection then hammered into place with a mallet to ensure the seal is activated, hence their "hammer union" nickname.

The catch is that the force applied by the mallet must be distributed as uniformly as possible. If the force is applied non-uniformly, the union's flat gasket can be crushed, compromising its sealing capabilities and leading to dangerous and costly leaks or emissions. Because of the risk of gasket damage, the operator will also need to have a ready supply of replacement gaskets on hand.

Cam & Groove

The invention of cam-and-groove coupler technology was a true step forward. Designed for fluid-transfer operations that require repeated connection and disconnection of the coupler, the cam-and-groove technology ushered in the era of the "quick-disconnect" coupler.

Cam-and-groove couplers feature an auto-locking twin-arm design that locks one hose or fitting into place with another. The female side of the connector has two "cams" that lock into place in the "grooves" on the male connector.

The most noteworthy improvement in cam-and-groove design has been the development of auto-locking arms that minimise the risk of accidental product release if the arms become unlocked.

It is important to remember that the use of cam-and-groove couplers is generally limited to applications where the transfer pressure is 250 psi (17 bar) or less and that they should not be used in compressed-gas service, including steam or air.

Dry Disconnects

While cam-and-groove couplers were a step forward, they have a clear disadvantage: when they are disconnected, any residual product that remains in the hose, piping or coupler will spill. These open connections, which are often under pressure, could result in a slip-and-fall incident, expensive cleanup costs or, depending on the fluid being handled, the release of toxic or hazardous materials.

To minimise this risk, cam-and-groove couplers were combined with shut-off valves. This combination was the launching point for modern dry disconnects. The dry disconnect was a revolutionary coupler technology, and it has been improved over the years. These improvements have been driven by demands for higher flow rates with even less spillage. This led to the development of dry-disconnect couplers with increased flow paths and twist-to-connect technology.

The twist-to-connect technology originated in Europe because of the imperative to standardise connections for tank trucks and ISO containers. Additionally, twist-to-connect technology does not require an operating handle, which makes it ideal for use in small spaces.

The next step in dry-disconnect evolution was the development of a non-poppeted version. The elimination of the poppet results in negligible pressure drop and superior fluid-loss prevention during disconnection. Another advantage of the non-poppeted coupler design is an innovative double ball-valve system, which delivers a balance of unrestricted flow path and double shut-off reliability.

Extreme Condition and Safety Disconnects

The capabilities of the non-poppeted dry-disconnect coupler led to the creation of models engineered to withstand extreme high/low temperatures and pressures. These couplers are vital in preventing fluid leaks, reducing emissions of volatile organic compounds (VOCs) from cryogenic temperatures to upwards of 400ºF (204ºC), and pressures up to 15,000 psi (1,035 bar).

Finally, safety breakaway couplers prevent product spills during an unintended disconnect. These couplers are available in many types and sizes but are also application-specific. These systems cannot be installed without considering a host of operational criteria, including the characteristics of the media being handled, the system's pressures and temperatures, and the angle of pull and amount of supported weight on the loading system.

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