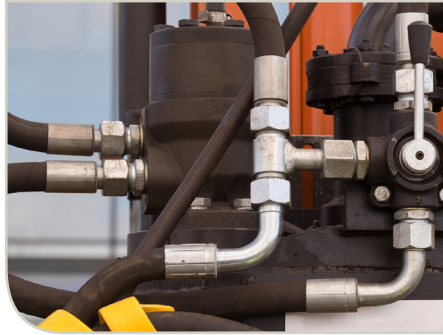


Specifying non-spill coupling technology for low-pressure fluid systems

By
Grant Wilhelm
*Senior Design Engineer, Medical
Colder Products Company*

Would you use this...



... inside of this?



Quick disconnect couplings have been around for well over 50 years. There are a wide variety of metal quick disconnects available in brass, aluminum, and stainless steel. Most manufacturers have adopted similar designs and functionality, all directed towards the high pressure, hydraulic fluid power market. These are well-suited to the needs and environment in construction, agriculture, and manufacturing. However, these traditional couplings may seem entirely out of place in a liquid cooling system for a high-performance computer or a modern blood analyzer in a medical lab. These types of systems require a coupling that has non-spill, dripless capabilities, but also is suitable to the environment. A bulky hydraulic connector just doesn't work in that environment.

Over the last 10 years there has been an increasing market demand for non-spill quick disconnect couplings with the appropriate materials and

performance required by the lower pressure fluid transfer market. This market includes such diverse categories as liquid cooling of electronics, printing and ink management, chemical handling, and life science lab equipment.

FACTORS TO CONSIDER WHEN SELECTING A FLUID HANDLING COUPLING

Quick Disconnect Couplings

Quick disconnect couplings are valved or non-valved, but for this paper we are only reviewing couplings that are valved on both sides, sometimes referred to as 'double shut-off couplings'. These couplings feature one of two basic styles of internal valves that automatically shut off the flow of liquid when the couplings are disconnected.

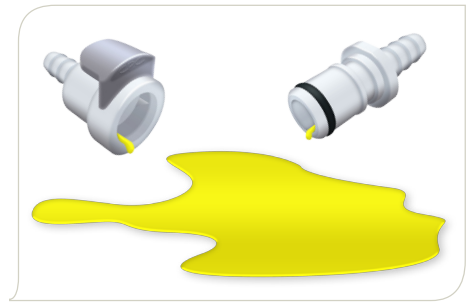
The disconnection process releases the volume of liquid between the valves' seals, known as 'spillage', into the environment. If the quick disconnect coupling uses poppet-style valves, the spillage volume will be larger than if it was made with flush-face or 'non-spill' valves. For many applications in the fluid transfer market, spillage of even small amounts has dire consequences. While many of the couplings made for fluid power could be adapted for use in the fluid transfer market, they do not have the specialized features or customization required by the OEMs in newer fluid transfer markets.

Selection Considerations

Design engineers faced with specifying fluid couplings for a product or system need to determine if non-spill couplings are required early in the design process. There are several good indicators that a non-spill coupling is the right choice for low pressure fluid handling applications.

- Safety**
 Safety and environmental concerns should be high on the list of attributes in the selection criteria for non-spill couplings. If the media is toxic, corrosive or poses an environmental hazard, minimizing the spillage volume through the use of a non-spill coupling is critical. For example, recent increases in the use of liquid cooling of electronics has necessitated the use of non-spill couplings, because of the safety risks of damaging expensive electronics. Similarly, if the system media is corrosive in nature, spillage must be kept to a minimum through the use of non-spill couplings. The connector itself can be a safety hazard – delicate medical equipment may not survive the impact of a hydraulic connector being dropped on it, but a lightweight plastic coupling may simply bounce off it.
- Ease of use**
 Ease of use should be a priority. Consider the physical and cognitive requirements placed on the user. It is important to be able to easily disconnect the couplings with no spills. Basic fitting components offer a high degree of security, but also make for slow repairs, may require specialty tools, and be prone to field failures if system repairs are made by untrained users. A non-spill quick disconnect coupling that clicks together offers audible and tactile feedback to the user that a secure connection has been made. Similarly, a connection mechanism, such as a thumb latch, that is obvious and easy to operate makes the process simple for the system operator or repair technician. The availability of color-coded couplings help ensure mistake-proof connections and non-interchangeable lines. Recent developments in non-spill couplings, particularly metal non-spills, have drastically reduced the force-to-connect, offering a much better user experience.
- Cleanliness**
 All quick disconnect couplings have an amount of spillage associated with disconnection. In a traditional coupling design that could be a several drops (up to 2 ml per disconnection). If the application is outdoors and the line is carrying water it may not matter. However, if the line is carrying ink and is in a clean office environment, a non-spill coupling minimizes the spillage.
- Rugged and reliable**
 The physical characteristics of couplings vary largely with the primary materials of construction. Non-spill couplings need to be durable and robust. Some systems

A NON-SPILL COUPLING MINIMIZES THE SPILLAGE



No shutoff valves



Standard shutoff valves



Non-spill valves

employ couplings developed for the hydraulics industry because of their perceived higher durability. However, the seals and internal valves of these couplings were not designed for low-pressure applications or where couplings are required to be connected for months or years at a time. When selecting quick disconnect couplings look for couplings that are designed specifically for low pressure applications and feature robust construction.

- *Media costs*

Media can reach up to hundreds of dollars per gallon. An engineer needs to consider what the accumulated cost is when there are frequent disconnections with several drops of spillage of a high-cost media. A non-spill coupling in these applications provides cost savings by not wasting valuable product.

- *Materials selection*

The coupling materials should be well-suited to the environment and application requirements. For many applications an engineered thermoplastic is more than adequate. Plastic non-spill couplings of this type offer reduced weight, impact resistance, and even color coding. However, some applications do require a metal product for strength, durability, or pressure. Brass, stainless steel, and aluminum are the most common options. Products might even have a mix of metal and plastic, maximizing the benefit of each for different components within the coupling assembly to achieve optimized performance.

- *Chemical compatibility*

Chemical compatibility of the coupling materials with the flow media and other components is closely related to the material selection criteria. If using a proprietary media, be sure to determine whether the fluid is compatible with coupling housings, seals, valves and tubing. There can be significant long-term effects of corrosion, material breakdown, o-ring swell (or shrink) and galvanic corrosion. Many good resources exist to establish basic chemical compatibility during the coupling selection process, and materials experts provide specialized support when the guides don't provide the required depth of knowledge.

- *Flow size and pressure drop*

The flow size of the coupling is usually dictated by the pressure drop across the coupling, along with the size and type of connecting tubing. The flow coefficient (Cv) is a rating given to a product by a manufacturer

$$C_v = \frac{Q}{\sqrt{\frac{\Delta P}{S}}}$$

$$\Delta P = S \frac{Q^2}{C_v^2}$$

LEGEND

C_v = FLOW COEFFICIENT

Q = FLOW RATE

S = SPECIFIC GRAVITY

ΔP = PRESSURE DROP ACROSS THE COUPLING

The flow coefficient (Cv) is a rating given to a product by a manufacturer based on testing its performance. By reworking the equation, the expected pressure drop is determined across the coupling, given the flow rate, specific gravity, and Cv.

based on testing its performance. By reworking the equation, the expected pressure drop is determined across the coupling, given the flow rate, specific gravity, and Cv. The coupling should be designed for low pressure drop in order to minimize flow restriction and the burden on fluid handling components.

- *Resilient seals*

Upon disconnection and reconnection, couplings need to function perfectly so there are no fluid drips or leaks. The seals must be compatible with the media to prevent seal swell, shrink, embrittlement or other distortions. In some cases, non-spill couplings may feature dual seals to enhance sealing capabilities in the quest for higher reliability and protection from debris. If designed properly, couplings with dual seals match the reliability of couplings with single seals.

- *Minimized leak points*

Many non-spill couplings are available with standard connections of tapered

pipe threads or even straight threads. An adapter may be required to convert from threads to a hose barb suitable for flexible tubing. This adapter is a potential leak point and increases the coupling size and weight. Consider using non-spill couplings with integrated terminations in the exact style to connect directly to the other fluid handling system component.

CONCLUSION

Like many decisions facing the design engineer, the choice of non-spill quick-disconnect coupling can seem overwhelming. However, with upfront design planning and the right support from the manufacturer, an ideal solution can be selected to provide the performance required to suit the application.

CUSTOMIZATION CONSIDERATIONS

While much of the fluid power market is defined by catalog products with little customization, some manufacturers have realized that OEMs require slight to moderate changes from standard catalog products in order to ideally suit the needs of the customer. The same is true for non-spill couplings.

CUSTOMIZATIONS USUALLY FALL INTO THE FOLLOWING CATEGORIES:

Category	Description
Materials/ chemical compatibility	Material selection is a delicate balance between many factors including strength, impact resistance, chemical compatibility, temperature resistance, weight, and cost. Proper material selection is facilitated by OEMs with industry experience and in-house technical expertise
Seal selection	Seals (e.g. O-rings and gaskets) are frequently the easiest change to make within a coupling, but they are also one of the easiest ways to make a misstep. Manufacturers with specialized knowledge are able to recommend seal materials that are best suited to the application
Spring materials	Much like O-rings, there are a number of spring materials that can be specified for particular applications. Stainless steel is the most common, but there are also Hastelloy™ C for chemical compatibility, beryllium copper for non-magnetic applications and PEEK thermoplastic when a metal-free flow path is required.
Fitment or adapters	Over the years many different fitments have been created (threads, barbs, instant fittings, compression fittings, and swivels). Many are standardized, but some are customer- or application-specific. The benefit of offering custom fitments means avoiding the use of secondary adapters and the cost, size, and additional leak points associated with them.

About CPC

CPC is the leading provider of quick disconnect couplings, fittings and connectors for use with tubing in low-pressure fluid-handling applications. Employed in a broad range of applications, CPC's 10,000+ innovative standard products allow flexible tubing to be quickly and safely connected and disconnected. CPC also engineers custom solutions to improve the overall functionality and design of equipment and processes for life sciences, bioprocessing, specialty industrial and chemical-handling applications.



Smart fluid handling to take you forward, faster.