

Choosing the right connector for low-pressure fluid handling: Three considerations

Selecting the ideal tubing connector can ensure product performance, increase ease of use, and add functionality to your product designs.

A wide range of products function by transferring liquids or gasses through small-diameter tubing—from patient beds and in vitro diagnostics in the medical market to ink management systems in printers and liquid cooling systems in server racks to condiment delivery in food applications and fuel lines in marine and engine systems. The primary need in each application is to move fluid from point A to point B. While this sounds simple, the fluid-handling process can be complicated by media characteristics, flow rate or pressure requirements, physical space limitations, air inclusion and spillage concerns, user-specific and environmental issues, and much more.

The tubing connector is a critical component in solving these fluid-handling challenges. Often bumped to a last-minute design decision, the connector you choose can make a big difference in product reliability, performance and user acceptance. There are thousands of connector options available to design engineers, and choosing among the differing capabilities, materials and types can be daunting. To simplify this process, the following three considerations can help as you choose which connector is right for your product. These considerations are not meant to be an exhaustive list, but they can be a helpful starting point for design engineers.



Figure 1: Connectors with built-in valves help prevent spills.

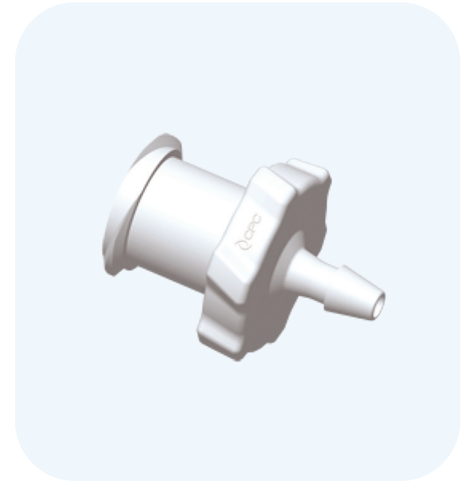


Figure 2: Luer connectors are designed without a shutoff valve.

CONSIDERATION 1: DEFINE THE FUNCTIONAL NEEDS OF THE APPLICATION

The operative demands of your application determine the parameters for tubing and connectors. Fittings, luers and quick disconnect couplings are the most common tubing connectors used in low-pressure environments. While each is appropriate for certain applications, they are not necessarily interchangeable. For example, in applications where spill prevention is desired, a valved connector may be a better choice than a luer (see figures 1 and 2). If the application involves frequent connecting and disconnecting, quick disconnects are an appropriate choice.

Overall, consider the following design options when analyzing your application:

- *Tubing* – What size tubing, both inner and outer diameter, are you using? The inner diameter (ID) size of the tubing is generally the first consideration for the size of the connector.
- *Termination type* – The most common termination styles are hose barb, compression fittings and push-to-connect (see figure 3). Hose barb terminations fit inside tubing and provide a secure connection over a wide range of tubing styles and materials. Single-hose barbs work well with softer tubing such as silicone rubber. Connectors with multiple well-made barbs (featuring sharp edges and free of parting lines) provide a secure connection that is not easily disconnected over a wide range of tubing styles and materials. Compression fittings fit over the outside

of tubing and use to use a nut and ferrule to make the connection. Push-to-connect terminations allow tubing to be pushed into the fitting.

- *Flow requirements* – What is the required flow rate and flow pressure? How much pressure drop is allowable? Pressure drops across connectors and valves vary greatly by manufacturer, and some designs exhibit less turbulence and resistance to flow than others. Be sure to allow for the effect of shutoff valves and tubing connections in your calculations.
- *Size* – You will need to know ID for hose barbs, OD for push-in-fittings and tube ID and OD for compression.
- *Valve options* – There are many styles of valves, and their flow rates and pressure drops vary. Connectors with integral valves are intended to mitigate both spills upon disconnection and air inclusion during connection. Connectors with precision flush-face valves, compared to a poppet-style valve, are considered true “dry-break” or “non-spill” connectors. They are designed for uses where there is a critical need to avoid spills, contamination or the introduction of air into the system upon connection (see figure 4).
- *Mounting options* – How is the connection going to be configured into your application? Common mounting options include panel mount, or direct mounting into NPT thread or ports.
- *Connector quality* – Manufacturing quality of a connector can affect its performance and aesthetics. Look to avoid defects in molded plastic couplings. Rough parting lines where two halves of the mold come together, for example could potentially catch or tear gloves or tubing.

CONSIDERATION 2: MATCH MATERIALS TO THE APPLICATION

The type of media will influence the selection of a connector. The connector and tubing materials selected need to be compatible with the fluid being used. Fortunately, connectors are available in wide ranges of both plastics and metals (see figure 5). In addition to considering media compatibility, the viscosity and corrosiveness of the fluid going through the connection should also be factored into your materials decision.

Couplings may also include components such as O-rings and panel nuts, as well as internal components such as springs, so you also need to take into account the chemical compatibility of these parts with your media. For example, applications involving bleach solutions will require a chemically resistant material in the flow path.

The following lists generally available connector and O-ring materials, plus guidelines for using these materials.

THERMOPLASTICS

- *ABS* – Economical medical-grade thermoplastic that withstands gamma and E-beam sterilization.
- *Acetal* – Strong, lightweight and economical material that has good rigidity over a broad temperature range, with toughness and durability.
- *Polyamide* (nylon) – Resists wear and abrasion, with good mechanical properties at elevated temperatures.
- *PEEK* (polyetheretherketone) – An engineered thermoplastic with high-temperature, chemical and fatigue resistance.
- *Polycarbonate* – Resistant to some chemicals, transparent, and withstands



Figure 3: Hose barb, compression fittings or push-to-connect terminations may be suitable for your low-pressure fluid-handling application.



Figure 4: Connectors featuring flush-faced valves reduce spills to near zero. Poppet-style valves, by virtue of their design, can spill.

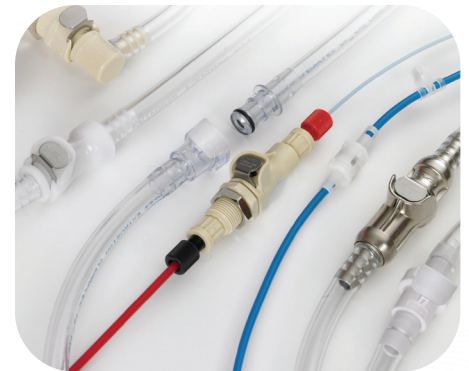


Figure 5: Connectors are available in thermoplastics, fluoropolymers, metals and various materials combinations to meet the performance and cost requirements of many low-pressure fluid-handling applications.

sterilization for medical applications.

- *Polyethylene* – Low-cost, chemically resistant, opaque thermoplastic.
- *Polypropylene* – Excellent general-purpose resin that is highly resistant to attack from solvents and other chemicals.
- *Polysulfone* – Rigid, strong and chemically resistant, it withstands repeated sterilization and higher temperatures better than most thermoplastics.

FLUOROPOLYMERS

- *PVDF* (polyvinylidene difluoride) – A tough engineered thermoplastic with a balance of physical and chemical properties that makes it suitable for many high-performance applications.

ALLOYS

- *Aluminum* – Lightweight metal with a high strength-to-weight ratio that is available with a durable anodized finish.
- *Chrome-plated brass* – Rugged and attractive, this metal is an excellent option for high-pressure and high-temperature applications.
- *Die-cast zinc* – Weighing about 20 percent less than brass, this durable and lightweight material withstands high pressure and high temperature.
- *Stainless steel* – Offers excellent rust resistance and is often used for connector components such as valve springs.

O-RING SELECTION

- *Buna-N* – This is the most common O-ring material due to its solvent, oil and water resistance.



Figure 6: RFID-enabled connectors such as CPC's IdentiQuik® line can add value to numerous product designs by combining data transmission with fluid handling.

- *EPDM* (ethylene-propylene-diene-monomer rubber) – Also known as EPR, this material offers excellent chemical resistance.
- *FKM* (fluorocarbon) – Known for its outstanding resistance to heat, oxidation, weathering and ozone.
- *Silicone* – Has as good or better temperature resistance as FKM. Medical-grade silicones also meet FDA Class VI requirements for biocompatibility in life science applications.

Some other media considerations include the range of temperatures (-40° to 93°C) and pressures the connectors might be subjected to in the application, in storage and during shipping, as well as cleaning solutions that may be used or other environmental exposure. Testing potential product materials is a good idea for evaluating material performance in the actual application.

CONSIDERATION 3: ENHANCED CONNECTOR FUNCTION

In addition to connecting tubing to facilitate and control fluid flow, today's

connector technologies can bring increased functionality and performance attributes to product designs. For example, intelligent connectors equipped with radio frequency identification (RFID) technology (see figure 6) allow data exchange at the point of connection. Communicating couplers transmit information that can protect equipment and improve processes in critical applications.

These intelligent couplings communicate by sending RFID signals between the two separated coupling halves. Data is stored on an RFID tag embedded in the passive half of the coupling or insert. Looking for the tag is an RFID reader housed in the active half of the coupling or body. When the two coupling halves are brought within a few centimeters of each other, the reader detects the tag, reads it, and sends the tag data to the control unit running the system. The control unit can also tell the reader to write new information to the tag.

For example, RFID-enabled couplers have been used in commercial printing applications to help confirm the correct ink color is used. Intelligent couplings

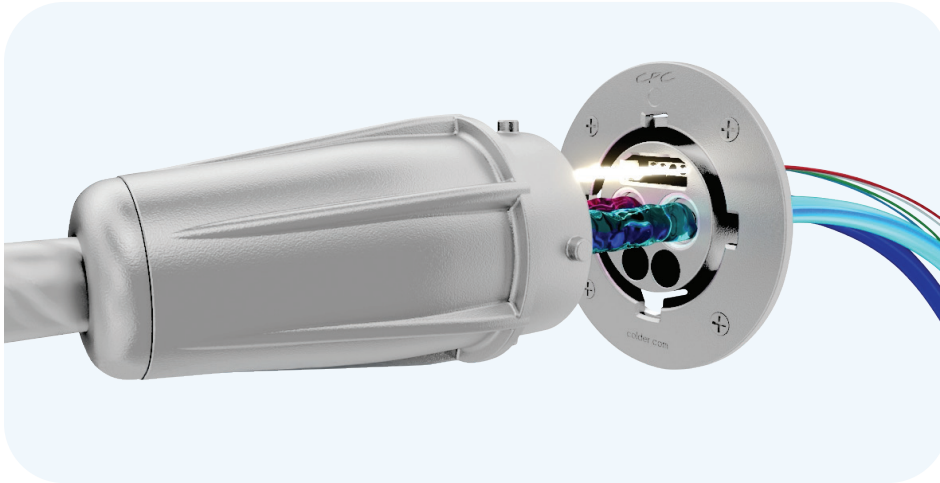


Figure 7: Multifunction connectors, such as CPC's Hybrid Connectors, can consolidate the connections for media, gasses and/or electrical signal, into a single unit.

can also be used to help ensure a product is retired at the end of its useful life, to prevent inferior media from damaging equipment, to enforce single- or limited-use consumable devices and to ensure correct connections in multiport environments.

Another connector approach that can enhance user experiences with end products is the multifunction quick disconnect (see figure 7). These connectors handle the transfer of power, signal and fluids (liquids and air) through a single device. Multifunction connectors are designed to eliminate the need for multiple connections and help prevent misconnection. They also simplify the user interface between remote tools and a device. In medical applications, technicians can quickly change or replace modular tools, umbilicals or hand pieces.

Connectors with enhanced functions can provide competitive advantages for your product in the marketplace. Available through select manufacturers, custom connectors with advanced capabilities can make your product easier to manufacture and easier to use.

CONCLUSION

Although connectors seem like a minor component in most products, they deserve to be more than an afterthought in your design process. Connectors are often a user's primary interface with your product, and they can help achieve your product performance and ease-of-use goals. As the design engineer, you are best positioned to select the right connector for your specific application and product. By taking the preceding considerations into account during the selection process, you can successfully move fluids from point A to point B while also moving your product to a more intuitive, compelling and functional design.

About CPC

CPC is the leading provider of innovative quick disconnect couplings, fittings and connectors for use with tubing in low-pressure fluid-handling applications. Our 10,000+ standard and custom products allow flexible tubing to be quickly and safely connected and disconnected. CPC solutions improve the overall functionality and design of equipment and processes for life sciences, bioprocessing, specialty industrial and chemical handling applications.¹

1. All of your design decisions must be made based on the particular circumstances of your application. CPC does not warrant the suitability of its products for any particular application. Determining product application suitability is solely the customer's responsibility. Learn more at <https://www.cpcworldwide.com/Resources-Support/Warranty-Statement#>.

We Inspire Confidence at Every Point of Connection

