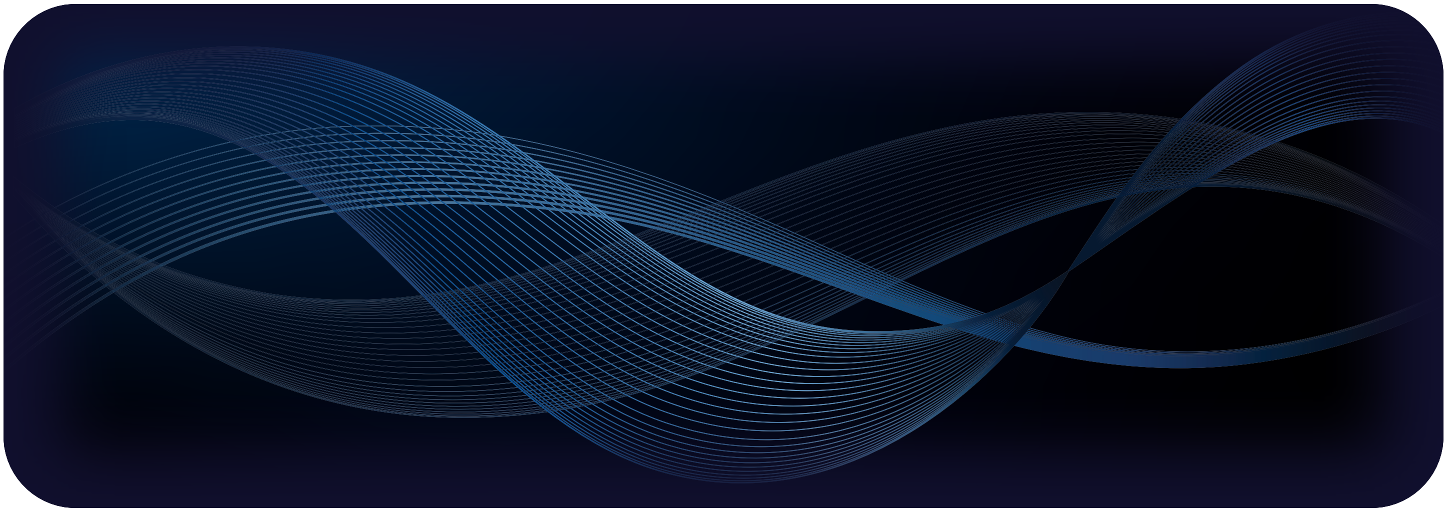
The ABC's of Quick Disconnects in Liquid Cooling Applications

Part 2: F-P, from Filtration to Pressure



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Quick disconnects (QDs) are critical components in liquid cooling of electronics systems. Understanding quick disconnects in context and specifying QDs correctly is essential to achieving performance as anticipated. Part 2 of this series, "The ABC's of Quick Disconnects in Liquid Cooling Applications" outlines key factors that can make or break a an effective liquid cooling system at the critical points of connection.

From filtration to pressure, fluid management in liquid cooling applications requires close attention to several specifications that influence overall performance. Fortunately, CPC's deep liquid cooling and QD expertise makes sure system designers pose and answer relevant questions, get the answers and have the necessary requirements covered.

FILTRATION

Q. How many and what kind of filters will you need and where will they be located in proximity to the QDs? What is their associated maintenance or replacement schedule?

A. Filtration is a sometimes overlooked feature that can improve liquid cooling system performance —which is interesting because some specifiers only regard filtration's negative impact to Cv or Kv during design phases. When developing a system, designers should consider particulate level and the filtration needed to remove debris from the coolant in order to keep the system operating properly. Particulate located in the fluid and flow path can affect QD performance if it settles in the connector's small crevices and features. This causes failure mode potential, most notably opening leak paths across an elastomeric seal, or blocking a valve component from retracting back to its intended position upon disconnection. Interestingly, QDs by their highly engineered nature, may be where a systemic problem manifests or becomes evident but they are in no way a cause of the issue. By looking at a system holistically, filtration's benefits and flow impact can be weighed appropriately. Examination of filtration components also can help system maintenance engineers identify potential corrosion or compatibility issues prior to system degradation or failure.

FLAMMABILITY

Q. Do system components need to be composed of materials that have a specific UL94 -rating? Does the application need to pass a particular flammability test?

Test Criteria	V-0	V-1	V-2
Burning time of each specimen (sec) [after the first and second flame applications]	≤ 10	≤ 30	≤ 30
Total combustion Time (sec) [10 ignition time]	≤ 50	≤ 250	≤ 250
Burning and afterglow times after the second ignition time (sec)	≤ 30	≤ 60	≤ 60
Dripping of burning specimens [specimens completely burned]	NO	NO	YES
Combustion up to holding clamp [specimens completely burned]	NO	NO	NO

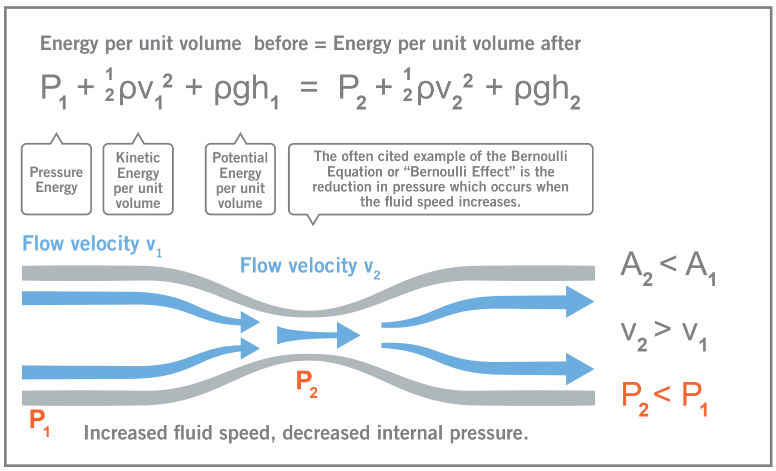
Test Criteria	Burning Rate in V	Flammability Rating
Test specimen thickness 3-13mm	≤40 mm/min	HB
Test specimen thickness < 3	≤75 mm/min	HB
Flame is extinguished before first mark	≡ 0 mm/min	HB

A. Liquid cooling is employed when electronics systems are simply too hot to be effectively cooled with air. In processing or energy conversion environments, liquid cooling components must maintain their shape and avoid flammability. If they were to catch fire, they should be self-extinguishing. A UL 94 rating is a classification that indicates how a plastic material burns under controlled laboratory conditions. The Underwriters Laboratories (UL) of the USA developed the UL 94 standard to help assess the flammability of plastics used in devices and appliances. Of the 12 classifications that are used to categorize plastics based on their burning characteristics, a V-0 rating indicates that the burning stops within 10 seconds after two 10-second flame applications with no flaming drips. An H-B rating is related to slow horizontal burning. QDs of metal and high-performance polymers meet these requirements; for specifics, refer to product information data sheets or look up material performance independent of manufacturer's product information. Engineers should avoid specifying commodity plastic connectors used in very hot or extremely sensitive liquid cooling applications.

FLOWRATE

Q. What is your required flow and desired target range for allowable pressure drop for each liquid cooling system subcomponent?

A. Liquid cooling system flow rates depend on several factors including media selection and the required fluid velocity to expel the heat generated in the system. First, the selected coolant will determine the amount of heat that can be taken away at a given flow rate. After media and fluid velocity have been determined, the volumetric flow rate can be calculated. Volumetric flow rate stays constant in a system, so flow path bends and elements like valves will cause pressure losses. The volumetric flow rate must be high enough to ensure sufficient fluid velocity at all points through the cooling loop. Other system components that contribute to pressure drop are filters, manifolds and the tubing/piping through which the coolant flows. Bernoulli's equation is helpful in understanding flow velocity and pressure drop.



FORM FACTOR

Q. What type of connector style is desired? Will you need single-handed operation as is offered with latch-style quick disconnects or will the connectors be panel mounted or affixed to a manifold?

A. With a variety of QD styles and features, it's important to start with system and application requirements and then identify a subset of products to evaluate and test. Here are four key considerations around QD form factor:

1. BLINDMATE VS. HAX`ND MATE

A *blindmate* QD is engineered for liquid cooling systems that use a panel or manifold. The fixed, mounted QDs require the couplings to be aligned with external alignment pins and then locked into place with an external latching mechanism. This completes the connection and starts coolant flow. Engineers should look for QDs with generous lead-in chamfers and optimized axial and radial tolerances. The use of panel mounting kits simplifies blindmate integration.

A latched hand mate QD is connected manually – easily via one-hand or a two-handed operation. Ball-and-sleeve style couplings are also hand mate connectors, but they require two hands to connect. Latched or hand mate QDs with a built-in latching mechanism are preferred when ease of use, technician ergonomics, and QD access are priorities

2. BALL VS. LATCH

A ball or ball-and-sleeve style connector is similar to industrial hose couplings where the connector's sleeve must be pulled back while the connector is pushed forward to complete the connection. This connection style is typically a two-handed operation and requires some dexterity.

A hand mate QD with a thumb latch is connected or engaged through a push to the mating part. Haptic and audible feedback provide connection status. Latched QDs are disconnected by depressing the integrated thumb latch, and can be operated with a single hand for connection and disconnection. Latched QDs have no drawbacks compared to sometimes cumbersome ball-and-sleeve connectors.

3. NON-SPILL (DRY BREAK) VS. WET BREAK

Non-spill dry break quick connectors or quick disconnects can be disconnected under pressure with no spills or drips. When non-spill couplings are disconnected, spillage is near zero— typically just a wetted valve surface—not even enough liquid to produce a droplet. CPC's Everis® QDs all feature non-spill valves for dry break functionality.

Wet break, or low-spill, QDs' valve system allows some fluid egress upon disconnection resulting in drips or small spurts. The amount of fluid will vary based upon product size and valve structure or design.

4. HOSE BARB VS. THREADED TERMINATIONS

A QD with hose barb terminations enables system manufacturers to attach a hose directly to the QD via ridges that grip the hose's inner diameter. For a secure leak-free connection, evaluate and specify corresponding hose properties carefully because there are several barb styles to choose from. Hose clamps may also be used with discretion.

Liquid cooling QDs with threaded terminations mount directly onto an equipment panel or manifold and are available in standard thread types: NPT, G-Thread or BSPP (British Standard Parallel Pipe), and SAE,). Threaded terminations on a QD provide a reliable and robust connection. The use of pipe tape is not recommended.

INCLUSION

Q. What is inclusion? Are there different types of inclusion? When do system designers need to pay particular attention to inclusion data?

A. Inclusion is the volume of air introduced into a system every time a coupling is connected. With flush-faced, non-spill valve designs, the amount of inclusion is drastically reduced compared to low-spill designs. The addition of air into the loop can negatively affect the system's performance, so engineers specifying QDs for liquid cooling should understand the frequency of QD connection and disconnection along with the number of QDs in each cooling loop. QDs specifically designed for liquid cooling of electronics include features like flush-faced valves that reduce the amount of inclusion upon connection.

MATERIAL

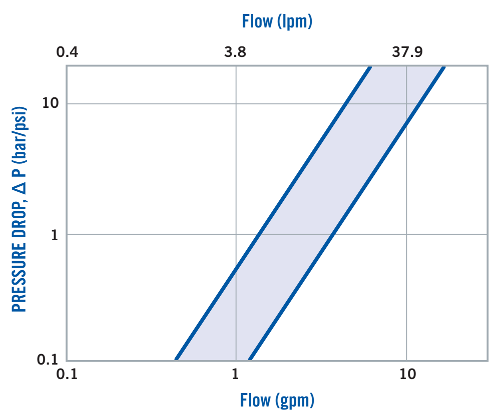
Q. What are the best QD housing materials? Why and how do the materials vary? Does material make up of subcomponents matter?

A. Quick disconnect material types include metals, high-performance plastics, and elastomers. These material options must be considered when selecting the right QDs for an application. Chemical incompatibility affects QD performance and/or the liquid cooling system as a whole, so selecting compatible materials given a particular fluid selection is absolutely crucial. The wrong combination of fluid and material can cause swelling, deterioration, flaking or cracking of critical system subcomponent parts. Specifying engingeers must consider the materials of construction of the rest of the cooling loop. The coolant connects all components in the loop, creating a risk of galvanic corrosion, even for components that are not physically touching each other. Refer to galvanic corrosion charts when selecting QDs and understand their materials of construction.

PRESSURE

Q. What is the maximum pressure the liquid cooling system will experience and subsequently, the pressure that connections will need to withstand? What is the standard operating pressure?

VOLUMETRIC FLOW RATE



$$C_V = Q\sqrt{\frac{SG}{\Delta P}}$$

Q = Flow rate in gallons per minute
SG = Fluid specific gravity (relative to water = 1)
ΔP = Pressure drop across connector (psi)

A. Calculating a liquid cooling system's pressure extremes is unfortunately a common starting point for narrowing down QD selection (ensuring that the QDs' operating pressures can withstand the minimum and maximum pressures of a system). Burst test results, for example, help determine how a QD would perform in a catastrophic situation and can be used as a safety factor. It's preferable, though, for system designers to begin the specification process by understanding flow needs for the predicted cooling load. Engineers should specify QDs by flow, taking into consideration pressure drop. They can then determine the number of QDs needed and where to assess system pressure drop. Pressure within a liquid cooling loop also is media dependent. If the specific gravity of the selected fluid is not 1, adjust the calculations. At the QD level, refer to Cv or Kv— imperial and metric flow coefficients – for accurate flow information. System designers also need to factor in pressure drop associated with every other system component or feature— e.g., filters or tubing bends/flow paths— for their impact on flow and pressure.

To learn more about CPC connector technologies and the Everis® line of products specifically designed for use in liquid cooling of electronics applications, visit our website or contact us at 1-800-444-2474. Also, see other technical guides and white papers on key topics in liquid cooling such as QD specification, chemical compatibility, flow and ambient conditions: https://www.cpcworldwide.com/Resources-Support/Literature/Liquid-Cooling.

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