The Quick Connect
Solution Provider

Quick Connect Couplings: A Critical Component in Liquid Thermal Management Systems

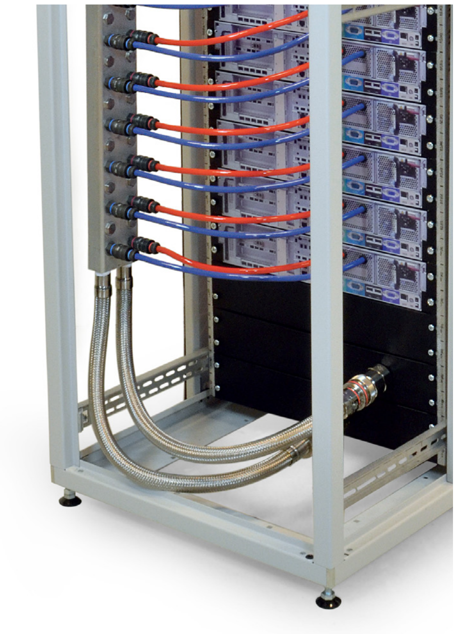
White Paper

Quick Connect Couplings: A Critical Component in Liquid Thermal Management Systems

Due to the impedance of electronic circuits, energy is dissipated in the form of heat. As platform sizes decrease and densities increase, these high-powered electronic devices produce potentially limiting or even damaging amounts of heat which necessitate effective cooling systems.

Liquid cooling - A dynamic solution

Conventional air-cooling systems offer cheaper upfront costs, but can become impractical in terms of size, efficiencies, and effectiveness as the heat generated by the electronic systems increase. When the heat produced by the electronic components is too great or costly for an air-cooling system to dispel, liquid cooling systems are favored. Along with the benefit of higher thermal conductivity properties, liquid cooling is quieter and requires less space and energy to effectively regulate and maintain optimal operating temperatures.



Liquid cooling meets the demands for increasing computing requirements

Liquid cooling comes in a multitude of forms with copious design variants to fit different applications and operating conditions. Although there can be numerous disparities in the design, the fundamental actions of the technology make these liquid cooling systems far more alike than they are different. These liquid cooling system designs are still evolving to meet the demands of faster, smaller and more powerful technologies; but the fact is that it has already proven itself to be a dynamic solution for thermodynamic problems.

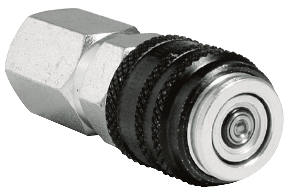
Focus on reliability

Like many technologies moving from niche to mainstream markets, the adoption of a liquid cooling system is not without risks. Despite the factors pointing to an inevitable future in which liquid cooling is a mainstay for many technologies, concerns about mixing fluids and electronics persist. Engineering an efficient and effective system requires understanding technologies from seemingly disparate industries. A reliable system saves costs, reduces scheduled and unscheduled downtimes, and protects the integrity of the system. Understanding that the cooling system is only as reliable as its weakest part bolsters the importance of being conversant with all cooling system componentry.

Methods to build a highly reliable fluid cooling system include integrating redundant components that take over upon a primary component's failure. For example, building a system with multiple pumps to prevent any loss of circulation if one was to go down. However, an individual quick connect coupling in the cooling system represents a single point of failure because it puts a critical focus on the design, construction and quality of the coupling.

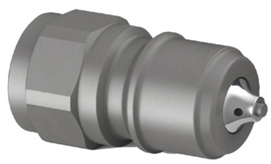
Choosing the right connector type

Originating from the hydraulics industry, dripless connectors featuring a flat/flush face design have become a staple for fluid handling installations across a multitude of industries and disciplines. Previous connector types used a "poppet" style valve. Issues with this design stemmed from its inability to disconnect without losing a small amount of fluid from within the valve cavity. Conversely, the valve on a dripless connector allows no more than an ultrathin film to remain on the valve surface upon disconnection. As such, this design is favored by adroit engineers working with sensitive and costly electronics.



Flat-face coupling for hydraulics

Flat-face coupling for liquid cooling



Poppet style connector

Pressure drop requirements

In a liquid cooling system, pump size puts the limit on the total allowed pressure drop. A bigger pump is a bigger investment and has higher running costs. Most cooling systems will not allow more than 0.2 bar (2.9 psi) pressure drop over the coupling. Pressure drop adds up and the total pressure drop will limit the overall performance of the cooling system.

Keeping a low pressure drop over the couplings should be a prioritized goal for any cooling system. A lower pressure drop will allow a cooling circuit with higher capacity or a pump with a lower total pump pressure. Both will have a positive impact on the investment.

Design requirements

The design and componentry variants inside the analogous flat-face profile of non-drip couplers can be numerous. As the design of the inner workings of a quick connect may differ, so will the way in which the cooling fluid contacts the walls and seals as it passes through the fitting.

While many valve designs are employed to prevent pressure drop or flow restrictions, others are used to avoid patent issues, work around production limitations and minimize material costs.

The tighter and more indirect the path through the quick connect, the higher the chances flow restrictions and pressure drop will occur. Understanding the many nuisances of these different valve designs is inessential for the majority of engineers. More significant is being cognizant of the fact that the differences within the quick connect will make the size of the fitting less relevant than the flow rates and pressure drop data.

A parallel concern to matching the parameters of flow and pressure of the quick connect to those of the cooling system is that of the materials used to construct the quick connect coupling. This includes the body of the fitting, internal seals, valves, plungers, springs, locking mechanisms, sleeves, flanges, etc. Like the differences in flat-face quick connect designs, the materials used to manufacture them can vary greatly in type and quality. These materials must be compatible with the cooling chemicals/liquid/media, withstand surge and maximum pressures and hold up against normal and extreme internal and external temperatures. Seals are available in numerous rubber compounds, each with different properties. The material and quality of the seals are critical to maintaining a reliable connection.

Manufacturing requirements

After the design and material selection process, a quick connect manufacturer must adhere to tight machining tolerances. The fitment of the body and the seal of the valves are reliant on exacting construction practices. Loose or misaligned fittings can result in the premature breakdown and wear of the connection. Depending on the system, a quick connect can be left connected as part of the system for years. Regardless of how often the quick connect will be used, adhering to stringent machining tolerances will help to ensure that it remains securely fastened during periods of connection as well as facilitate a dripless disconnection when disconnections for system service, expansions or system upgrades are required.

The design of the quick connect, the materials used in the build of the fitting, and manufacturers' tolerances, all attribute to the compatibility of the quick connect in regards to the requirements of the system. Liquid cooling systems are rarely the same, and therefore, each will demand different flow rates, pressure ratings, acceptable pressure drop, physical size and material compatibility. The employment of the correctly sized and spec'd purpose-built quick connect coupler provides efficiency and maintainability in a flow network that requires 100% uptime.

CEJN is a leading global niche company providing innovative quick connect solutions for hydraulics, pneumatics, fluids and breathing air. CEJN is committed to high quality products with focus on performance, safety and environment, secured through own development and production.