

Coolant Distribution Units

Improve Cooling and Performance of Cloud, Enterprise & 5G Applications

Overview

Boyd Corporation has been the leading innovator in Enterprise cooling and engineered material solutions since data centers first started to emerge and evolve. Boyd utilizes these decades of expertise to develop advanced thermal solutions and systems to stay ahead of rapidly rising processing power, thermal density, and heat loads. This includes forward thinking liquid cooling innovation and system components such as Coolant Distribution Units (CDUs). This article covers CDU technology for improved liquid cooling systems and integrated solutions that help OEMs increase compute density in the same footprint, iterate designs quickly and accelerate speed to market, increase efficiency and reliability, and lower total cost of data center ownership with a scalable thermal management plan that outpaces processing power and application requirements.

TRENDS IN THERMAL MANAGEMENT FOR ENTERPRISE & 5G

There has been a sharp rise in global digitalization and electrification across all major industries as smart technology innovation, processing ability, and technology reliance are increasing exponentially. Consumers require faster connectivity, more information, and improved functionality across all markets. This is driving the need for larger, more efficient data centers with faster, more powerful chips to support cloud and edge computing as well as increased processing and storage. One of the most significant barriers to technological advancement and improved processing for these data centers is managing the excess heat generated by the increase in data and storage as well as power generation and supply.

New, higher power applications require more efficient cooling for high heat loads in compact volumes; this typically leads engineers to turn to liquid cooling solutions. Design engineers have creatively driven air cooling innovation to impressive performance levels for product design teams reticent about introducing liquid cooling into high reliability data center systems. However, new requirements are making it increasingly difficult to avoid liquid entirely. Overlapping technology portfolios enable liquid, immersion, two phase and air cooling innovation to co-exist, allowing engineers to blend the right solutions for each custom application to extend the performance boundaries of traditional air cooling systems and assure a safe migration to liquid cooling systems when appropriate. Thermal and power density demands of next generation designs have now reached air cooling limitations, requiring the transition to liquid. Liquid is much more efficient and has the capacity to transfer heat up to 4X higher than the capacity of forced air of the same mass. This enables faster, more cost-efficient, quieter, better



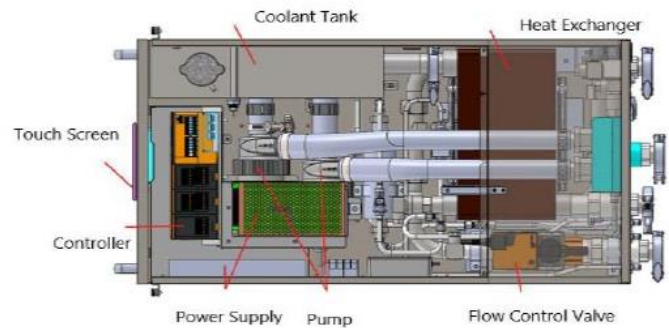
Data Center Racks

performing applications through efficient, improved heat transfer and higher thermal performance with increased design flexibility and scalability. Increased efficiency and smaller systems also save space, allowing for more racks and servers operating at higher performances.

A liquid cooled system is a hydraulic circuit that typically consists of a cold plate that interfaces with a heat source in a device, hoses and pumps that circulate fluid through the system, and a heat exchanger that rejects heat into the ambient environment. Liquid cooled systems are becoming much more common as air cooling is unable to handle new, higher heat loads and liquid cooling reliability is proven through many hours of in-field installations with leak-free performance. CDUs are the core of the liquid systems and are designed to increase overall system efficiency and reduce total cost of ownership for the data center.

WHAT IS A COOLANT DISTRIBUTION UNIT (CDU)?

A Coolant Distribution Unit (CDU) is a system that enables smaller, more efficient, more precise liquid cooling in a data center at Rack level, often integrating facility water. The CDU circulates coolant in a closed loop system within the rack on the secondary (Cooling Application) side and utilizes facility water on the primary (Heat Rejection) side. A CDU has a pump, reservoir, power supply, control board and a heat-exchanger as the key components. Filters, flow meters, pressure transducers, and other devices are also used in managing the operation of the CDU in conjunction with the Server Rack.



CDU Schematic



In-Row CDU

Smaller, improved cooling with the design flexibility and customizations available for CDUs allows for data center operators to increase compute density by including additional racks. CDUs also provide the opportunity to rethink data center footprint configuration to maximize power density and energy efficiency.

When server or chassis heat loads outpace what traditional air cooling can achieve, CDUs offer higher thermal performance in smaller packages. Negating the need for bulky heat sinks, fan trays and components in air cooled systems that create significant environmental noise pollution and consume more energy, integrated CDUs enable greater server power density with quieter operation and more efficient natural resource utilization.

Boyd CDUs are right-sized and custom configured for specific applications so that they receive the exact, optimal cooling performance the system needs, when it needs it. Intelligent controllers with operation logic, automatic diagnostics and troubleshooting, protection and warning functions, as well as smart flow, pressure and temperature controls manage system performance to spike with peak demand while remaining economical and efficient during non-peak operation and prevent

problems before they occur. Blind mate quick disconnects with 360 swivel fittings make servicing systems fast for minimized maintenance downtime.

CDUs can integrate directly into facility water or facility-level cooling systems or can be designed as self-contained CDUs that offer a different level of flexibility. Cool the chassis, server or integrate CDU cooling capacity down to the processor or silicon. CDUs can be designed to integrate into existing data center or chassis configurations to retrofit for improved efficiency. Boyd CDUs are designed to meet IEC62368-1 and tested to withstand 3X maximum working pressure. All new subcomponent designs undergo harsh maximum pressure testing to destruction. Reliability testing includes thermal cycling, min /max storage and packaging testing to ensure long-lasting, high quality, leak-free cooling.

Boyd has developed two key types of CDUs that are available based on size and implementation: In-Rack CDU and In-Row CDU.

In-Rack CDUs are designed to integrate into a server chassis and distribute coolant to a series of servers or heat sources. In-Rack CDU configurations are available for 2U - 5U sizes, installed within server chassis and offer 60 - 80kW of cooling capacity. These feature redundant pump design, dynamic condensation-free control, automatic coolant replenishing, a bypass loop for stand-by operation, and automatic leak detection.

Freestanding In-Row CDUs are larger and designed to manage high heat loads across a series of server chassis in data center environments. These full liquid cooling systems distribute coolant in and out of server chassis and can integrate into existing facility cooling systems or be designed to be fully self-contained. In-Row CDU capacity ranges start at 300 kW with models in development that cool up to 700kW.



In-Rack CDU

CUSTOMIZATIONS & DESIGN CONSIDERATIONS

BOYD CDU KEY FEATURES & BENEFITS

- **REDUNDANCY**

Increase reliability and enable continuous operation for less downtime and lower maintenance requirements through design redundancies such as multiple pumps utilizing N+1 configurations.

- **HOT SWAP**

Further decrease downtime and enable continuous operation for a more efficient, higher producing facility by ensuring components such as pumps and cold plates can be swapped out or replaced while still hot, negating the need for cool down time.

- **COMMUNICATION PORTAL**

Increase precision, monitoring, and control for greater efficiency with improved connectivity and control of the system through an advanced communication portal. Better data and monitoring to proactively scale or alter thermal systems for optimized application performance.

- **WETTING CHEMISTRY**

Leverage Boyd's decades of experience in liquid cooled systems that has resulted in a wealth of knowledge and innovation, including a deep understanding of wetting materials for the components in a liquid loop and how to best integrate technologies for fully optimized, highly reliable systems.

CDU DESIGN CONSIDERATIONS

- **MECHANICAL DESIGN**

Each component must be carefully selected for high reliability and long life independently and as a system. This includes all pumps, power supply, and the heat exchanger. One flaw could cause the entire system to fail, causing downtime and device failure. It is vital that suppliers are streamlined and well-vetted to ensure high quality components. Boyd Engineers ensure that all components within the system are tested to ensure they will work reliably and to customer specifications.

- **COMMUNICATION / CONTROLLER AND MONITOR**

Save on maintenance costs and potential downtime by ensuring that the system can easily communicate with the resident network to control the system remotely and monitor alarms. The quicker that issues can be identified and handled, the less potential for device failure, emergent maintenance needs, inefficient energy usage, and other risks.

- **LEAK DETECTION / CONDENSATION RISK**

Many facility managers hesitate to utilize liquid cooling because it could cause major application failure if any amount of liquid gets into the compute devices. It is essential that liquid cooled systems and CDUs are completely leak-free with no condensation. Boyd has decades of expertise in leak-free development and testing as well as liquid cooling systems installed in market applications since 2007 with over 30.6 billion field hours with zero leaks. As an additional measure of protection, Boyd installs leak detection systems to monitor potential leaks, provide alarms, and drive preventive maintenance. The system can also be used in data centers operating below dew point to monitor condensation risk on pipes within the system.



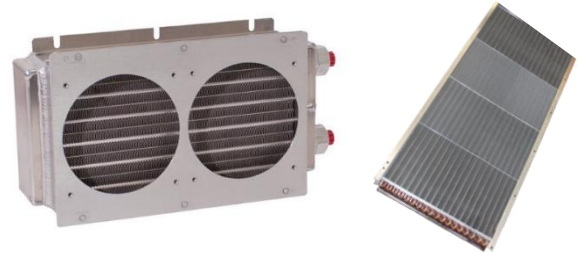
CDU with Monitors & Controls

- **MAINTENANCE**

In addition to monitoring with controls and communication portals, liquid cooled systems for data centers require regular preventative maintenance to ensure higher reliability and optimum performance. Be sure that your organization understands the maintenance costs required when considering liquid cooling and how these are off set by improved efficiency, more available space, and better application performance.

- **HEAT EXCHANGER**

Your choice in heat exchanger has a significant effect on the overall efficiency, size, and performance of the liquid system. To augment the reliability and performance benefits of utilizing a CDU, a high efficiency, brazed, heat exchanger is recommended. Depending on liquid cooling system design, compact heat exchangers in fully self-contained CDUs or rear door heat exchangers integrated into a server chassis may be most appropriate to optimize full liquid system efficiency and performance.



Compact Heat Exchanger, Rear Door Heat Exchanger

WHAT'S NEXT?

Processing and data storage needs will continue to increase exponentially as organizations and individuals further demand digitalization, greater functionality, increased speed and service, better connectivity, and more electrification globally. To support this global trend, data centers and enterprise applications need to be larger, more efficient, and operating 24/7 with improved processing and storage efficiency. This will, in turn, generate greater thermal density and higher heat loads as never seen before in Enterprise Technologies. Data Centers will need to adapt their thermal management strategy quickly to accommodate the fast changing landscape and increased heat. Liquid Cooling Systems and CDUs will play a big part in these new strategies.

With decades of innovation expertise, experience, and supplier partnerships, coupled with the unique approach of integrating multiple technologies into a streamlined product, Boyd Corporation will continue to stay at the forefront of innovation and improved manufacturing that offers unsurpassed reliability and performance while lowering overall costs to the data center operator. If you are looking to solve current issues or tackle new challenges for the next generation, start by contacting Boyd Corporation to learn more about engineered materials, thermal solutions, customizations, and improved processes for Cloud, Enterprise & 5G Applications.

To receive more information regarding Boyd Cloud Data Center solutions, please visit www.boydcorp.com.