Data Center Server Racks with Liquid Cooling

Overview

Liquid Cooling for High-Density Racks: A Guide | DataSpanHigh-density servers are becoming increasingly common in data centers worldwide. Learn why liquid.

Key Takeaways

Liquid-cooled racks are essential for high-density, AI, and HPC workloads, offering superior heat removal, energy efficiency, and scalability compared to traditional air-cooled systems.

Overview of Liquid-Cooled Racks

Liquid cooling in data centers uses fluids—typically water or dielectric liquids—to absorb and transfer heat from servers more efficiently than air. This is critical for high-density racks, where power consumption and heat generation exceed the limits of conventional air cooling, often surpassing 15–20 kW per rack and reaching 100 kW or more. Liquid-cooled racks are increasingly adopted for AI, machine learning, and HPC workloads due to their ability to maintain optimal operating temperatures while reducing energy costs.

Types of Liquid CoolingLiquid-to-the-Rack (Rear Door Heat Exchanger)Chilled water coils are installed at the rear of the rack. Hot air from servers passes through the coils, transferring heat to the liquid loop. Suitable for medium-density racks and hybrid cooling setups.

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Direct-to-

Chip (Direct Liquid Cooling)Cold plates are attached directly to CPUs, GPUs, DIMMs, and other heat-generating components. Coolant flows through sealed tubes, removing heat efficiently without contacting electronics. Supports extremely high-density racks, often exceeding 100 kW per rack.

Immersion Cooling

Servers are fully or partially submerged in dielectric fluid. Single-phase systems circulate liquid to a heat exchanger; two-phase systems allow the fluid to boil and condense, enhancing heat transfer. Provides maximum thermal coverage and near-silent operation, ideal for ultra-high-density deployments.

Key Components

Coolant Distribution Units (CDUs): Supply and return coolant to racks, often with redundancy and intelligent pump control. Capacities range from 70 kW to over 1 MW per unit. Cold Plates: Interface directly with chips to extract heat efficiently.

Manifolds and Hose Kits: Ensure flexible and scalable coolant distribution within and between racks. Integrated Monitoring: Systems track temperature, flow rates, and pump performance to maintain reliability and prevent downtime.

Benefits of Liquid-

Cooled Racks

Higher Efficiency: Liquids have higher heat capacity than air, reducing energy consumption and PUE (Power Usage Effectiveness) by up to 40%. Space Savings: Supports more compute per floor tile, enabling 2–2. 5x higher density than air-cooled racks.

Noise Reduction: Eliminates or reduces fan usage, lowering sound levels to near 0 dB in immersion setups. Scalability: Modular designs allow incremental deployment and integration with existing infrastructure. Sustainability: Efficient heat capture enables reuse for facility heating or other applications, reducing water and energy usage.

Considerations for Deployment

Rack Density and Workload: Determine current and future thermal loads, especially for AI and HPC servers with high TDPs. Facility Infrastructure: Evaluate floor load capacity, water supply, and piping routes.

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D and flow network modeling help optimize placement. Hybrid Cooling: Combining air and liquid cooling can optimize costs and efficiency, using air for low-density racks and liquid for high-density racks. Maintenance and Reliability: Redundant pumps, hot-swappable CDUs, and leak detection systems ensure continuous operation.

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Vendor Solutions: Companies like Supermicro, Flex, Rittal, Schneider Electric, and AIRSYS offer turnkey liquid-cooled racks with integrated CDUs, cold plates, and monitoring systems for AI and HPC environments. Liquid-cooled racks are now a critical component for modern data centers, enabling higher compute density, energy efficiency, and reliable operation for AI, HPC, and other high-performance workloads. Selecting the right cooling architecture—direct-to-chip, immersion, or hybrid—depends on rack density, workload type, and facility capabilities.

Article Content

Liquid Cooling for High-Density Racks: A Guide | DataSpan

High-density servers are becoming increasingly common in data centers worldwide. Learn why liquid cooling is optimal for facilities with high-density equipment.

Rack-Scale Liquid Cooling Solutions | Supermicro

Linus heads to the roof to see how Supermicro is transforming data center efficiency with their complete liquid cooling solutions, offering everything from cold plates to cooling towers, with capacity to deploy

Liquid-cooled rack solutions | Flex

The Flex liquid-cooled system and rack solutions provide a versatile platform for hyperscalers and data center customers to design customized AI

Deploying liquid cooling in the data center

Liquid-cooled systems are often used with air-cooling systems to cool racks at higher densities. Here''s high-level guidance any team can use to navigate the process of developing a hybrid air-liquid

LiquidCool Solutions: Immersion-Cooled Rack Servers

Meet soaring compute demands efficiently with LiquidCool Solutions'' versatile, immersion cooling for high-performance GPU dense servers. Perfect for data

MSI Brings Liquid-Cooled ORv3 Racks, NVIDIA MGX

At COMPUTEX 2026, MSI showcased a broad range of AI and data center infrastructure platforms, with a clear emphasis on liquid cooling as rack

AI Data Center Liquid Cooling Pumps: CDU & Immersion Selection

Engineering guide to selecting magnetic drive pumps for AI data center liquid cooling — direct-to-chip cold plate loops, CDU primary and secondary loops, single-phase and two-phase

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Liquid and Immersion Cooling Options for Data Centers

Data center operators are evaluating liquid cooling options, as processing-intensive computing applications grow. The market for liquid cooling is slated to reach $3

Upgrade legacy data centers for AI workloads with RDHx liquid cooling

Retrofitting AI servers with an existing outdoor chilled water heat rejection system For air-cooled servers in a data center that has an outdoor chilled water system, you can use a ''bolt on

Liquid Cooling: The 2026 Mandate for 100kW AI Racks

In 2026, liquid cooling is mandatory for 100kW AI data centers. Learn how key partnerships are solving the power crisis and shaping the future of cooling. Discover more.

Data Center Cooling: Trends and Insights for 2026

Explore key data center cooling trends for 2026, including liquid cooling, AI demands, and energy-efficient strategies.

Liquid vs Air Cooling for Data Centers 2026: Cost

Data Center Cooling 2026: Liquid Immersion vs Air — TCO & Performance Institutional TCO comparison of liquid immersion vs air cooling for data centers:

Liquid, Immersion, Hybrid: The Cooling Architectures

AI workloads are pushing data center cooling beyond air. Explore why liquid, immersion, and hybrid cooling architectures are emerging as the

Optimizing Cooling Efficiency in Modern Data Centers

Optimizing Cooling Efficiency in Modern Data Centers Cooling systems in data centers account for roughly 30% to 40% of total energy consumption. As rack densities grow and

Liquid Cooling vs Air Cooling for AI Data Centers | Introl Blog

Air cooling fails at 41.3kW while liquid cooling handles 200kW+ per rack. Compare $2-3M/MW retrofit costs against 40% energy savings for AI infrastructure.

Data Center Liquid Cooling: The AI Heat Solution

In two-phase immersion cooling, a server is dunked into a vat of liquid. The liquid actively boils next to the heat-producing

AI Datacenter Liquid Cooling TCO: Cold Plate vs CDU Cost Models

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Explore AI datacenter liquid cooling TCO: Cold Plate, D2C, and CDU cost analysis. Covers 48V, GaN, SiC, and PUE impact on procurement.

How Data Centers Work: Power, Cooling, and

Learn how data centers work, including power systems, cooling methods, redundancy design, and the infrastructure that keeps servers running.

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