Hypertec

Adapt or Fail: Immersion Cooling for High-Density, Sustainable Computing

Special Report
2024

Summary

This paper analyzes the transformative benefits of immersion cooling for data centers. Leaders stand to gain significant cost reductions, enhanced scalability, and boosted sustainability through its implementation.

The relentless surge of AI spending, forecast to exceed $300 billion by 2026, is fuelling an unprecedented data center transformation. Yet, maximizing power and capacity within limited space remains a critical bottleneck. Traditional air-cooling systems struggle to keep pace with escalating heat densities and scalability demands. The choice is stark: Adapt or Fail.

Immersion cooling emerges as the vital adaptation. By submerging IT equipment in non-conductive liquid, it radically improves thermal management. This translates to dramatic cost reductions – organizations can achieve OPEX savings surpassing 90% while lowering CAPEX. Increased computational density unlocks new levels of performance. Two-phase immersion, with its superior heat transfer capabilities, is especially potent for high-performance computing.

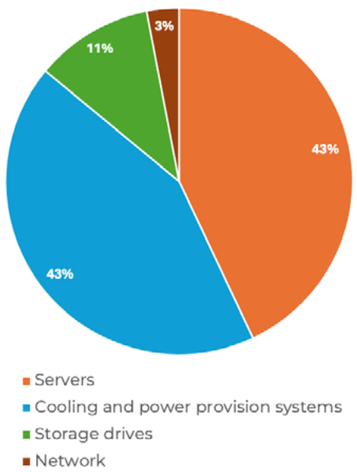
Content

Introduction

The urgency of maximizing efficiency, minimizing foot-print with immersion cooling solutions

Our critical infrastructure is in a state of rapid evolution. Data centers, those pillars of the digital age, are pushed to their limits by the unyielding demands of Artificial Intelligence, Automation, and Machine Learning. Legacy cooling solutions gasp to keep up with escalating power densities and thermal bottle-necks. Constraints on power, heat dissipation, and adaptability threaten the very foundations of cloud computing and big data. The imperative for efficiency is clear - the time for radical innovation is now.

Figure 1.



In this crucible of necessity, immersion cooling shines as a beacon of transformative potential. Recent studies expose the stark reality: servers and cooling systems devour the majority of data center energy (Figure 1). A single large-scale data center, housing tens of thousands of IT devices, can consume the equivalent power of 80,000 U.S. households (U.S. DOE 2020). This glaring fact mandates a rapid evolution in data center cooling, maintenance, and optimization.

Immersion cooling, while not a new concept, is experiencing a technological renaissance that's fuelling its rapid adoption across the data center industry. Intensifying investments in high-density technologies, the insatiable demands of HPC, and the explosion of AI-driven workloads are pushing data centers to their limits.

Operators must embrace innovative cooling solutions to ensure reliability and efficiency. Currently, data centers and data transmission networks consume 2-3% of global energy and contribute 1% of energy-related GHG emissions (IEA). Immersion cooling eliminates water waste, transforms heat dissipation, and offers a compelling path to reduce both power consumption and carbon impact. This is why it's emerging as a critical solution for forward-thinking data center design.

Key Forces

Let's examine the key forces driving this transformation

- **Escalating Power Demands with Environmental Consequences:**
  Data centers and networks already account for 1% of global energy-related GHG emissions (IEA), and projections indicate an accelerating growth in their energy consumption.
- **HPC, AI, and Big Data Demand a New Approach:**
  High-performance computing (HPC) is vital for research and complex analysis, but its heat output overwhelms traditional data center cooling. Immersion cooling offers superior heat management for densely packed HPC systems, unlocking greater computational power. As data-intensive applications proliferate, the need for both efficient and sustainable solutions positions immersion cooling as a game-changer.
- **Disruption Extends Beyond HPC:**
  Machine learning, financial services, healthcare, CAD modeling, and rendering all require increased density, reliability, and sustainability – driving them to explore immersion cooling.

Market research confirms a surge in immersion cooling adoption driven by its superior efficiency. Technavio highlights its rapid uptake compared to air-based cooling, with liquid-based cooling leading the way. Dell EMC's in-depth study reveals the economic imperative behind this shift: 50% of operators report a significant impact of cooling costs on overall operating expenses, and 78% acknowledge at least some impact.

This translates into real-world adoption:
25% already employ liquid cooling in production environments, with **32%** utilizing it in some capacity.

The survey demonstrates the versatility of liquid cooling:

39%	**use it for high-density cabinets or racks**
20%	**deploy it for high-performance computing (HPC)**
17%	**leverage it for big data processing**
15%	**integrate full-package systems with primarily liquid-based heat removal**

With the rising demand for dense, compute-intensive solutions, the scalability of traditional air-based ecosystems is in question. Immersion cooling pushes the boundaries of efficiency and density, offering a vital bridge to support next-generation customer workloads.

Modern immersion solutions are vastly improved, making adoption increasingly accessible. Let's explore how immersion cooling revolutionizes data center design.

Part 1

Immersion Cooling: A Critical Imperative for Data Center Sustainability and Efficiency

Rising energy costs, environmental concerns, and the ever-increasing need for computational power are squeezing the data center industry. Efficiency is no longer a luxury - it's a necessity. Immersion cooling presents a compelling solution, redefining thermal management and unlocking significant increases in equipment density. This technology holds the potential to reshape the very principles of data center design.

New business demands translate to new infrastructure challenges

Global shifts towards remote work, coupled with the proliferation of data-intensive applications, have fundamentally transformed both connectivity and digital infrastructure requirements. This explosion of remote users and workloads strains legacy systems. The convergence of HPC, cloud computing, and virtualized environments (VDI) further complicates the landscape. Technology leaders seek versatile platforms capable of adapting to these dynamic forces, optimizing resource deployment for maximum return on investment (ROI) while maintaining superior user experiences.

Key challenges facing digital infrastructure include:
Constraints on both space and time-to-market pose a critical challenge for data center leaders. As DataCenterHawk reports, North American primary market vacancy has plummeted to a record low of 4.4%, with regions like Northern Virginia nearing a mere 1%.

This drastically limited availability forces a fundamental rethinking of data center design and deployment strategies. The imperative is clear: maximizing capacity and efficiency within existing footprints.

Data center leaders face the daunting task of maximizing output within constrained footprints while simultaneously driving down operational costs (OPEX).

Immersion cooling offers a compelling solution, enabling significantly higher density and slashing cooling-related OPEX by over 95%. Moreover, the streamlined infrastructure requirements of immersion cooling translate into a substantial 50% reduction in capital expenditures (CAPEX) for new builds.

Data centers urgently need to maximize performance while driving radical improvements in energy efficiency. Immersion cooling presents a compelling solution for cost reduction, streamlined management, and a significant efficiency boost. These advantages align with both financial and operational goals, making immersion cooling a key technology for infrastructure transformation.

Legacy infrastructure poses a significant obstacle to technological innovation and agility. Data center leaders recognize that while existing systems may be functional, they often hinder modernization efforts and fail to deliver the value modern workloads demand. This realization is driving initiatives to transform and upgrade critical infrastructure. Importantly, modernization doesn't always necessitate a complete "rip and replace" approach. Strategic integration of cutting-edge technologies alongside legacy systems can offer a smoother, less disruptive transition. This paves the way for transformative solutions like immersion cooling, explicitly designed for the demands of today's data centers. Immersion cooling supports high-efficiency, high-density deployments powering HPC, data-intensive applications, IoT, edge computing, and cloud architectures.

Innovative immersion platforms often feature modular, integrated designs resulting from industry partnerships. These modern solutions address key challenges, including:

SUSTAINABILITY:

Meeting environmentally conscious design goals and addressing potential regulatory pressures.

POWER CONCERNS:

Mitigating rising energy costs and the insatiable power demands of advanced CPUs and GPUs.

EFFICIENCY IMPERATIVE:

The urgent need for less power-hungry cooling systems.

Let's dive into the groundbreaking advancements in immersion cooling and see how they directly address the challenges we've outlined.

In a dedicated subsection, we'll debunk a few outdated myths surrounding immersion cooling.

Part 2

Immersion Cooling: Top Five Design and Deployment Considerations

The urgency to embrace immersion cooling is undeniable. Regulations, escalating power demands, and AI's computational thirst necessitate a break from traditional cooling methods. Immersion cooling provides a compelling solution, but successful deployment demands strategic planning. While its flexibility allows gradual integration alongside existing air-cooled systems, the focus for maximum impact should be on its optimization of energy efficiency and data center performance.

Technologies like solid-state drives, converged systems, HPC, and supercomputing underscore the need for innovative cooling approaches. These technologies often have specific operating temperature thresholds. Sub-optimal temperatures within traditional data centers lead to wasted energy without commensurate performance gains.

01

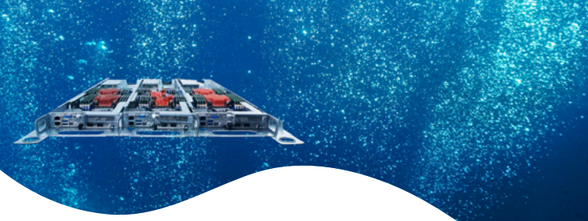
Legacy Infrastructure and Integration

Planning for a Seamless Transition.

Assessing your existing infrastructure is crucial when considering immersion cooling. Older data centers often necessitate wider overhauls, while even modern systems can reach their limits when faced with the extreme demands of HPC, AI, and ML. Strategic integration of legacy systems with immersion cooling can ensure a smoother transition for critical workloads, minimizing disruption. The rising power density of cutting-edge chips puts a strain on traditional air-cooled approaches. According to a recent study by the Uptime Institute, the average server rack density in 2023 is 8kW, with 25% of new deployments exceeding 20kW. This highlights the growing need for high-density solutions like immersion cooling, especially since 90% of data centers still primarily rely on air-cooling.

A phased approach, with parallel deployments of immersion alongside existing systems, helps manage complexity and risk. Advanced management tools and system integrators can streamline this process, ensuring seamless integration across different cooling technologies. Importantly, a well-planned transition offers IT staff, leaders, and stakeholders valuable insights for future capacity optimization. While a retrofit might be viable, exploring immersion-born designs where possible can significantly simplify deployment and long-term management.

While retrofitting existing servers for immersion cooling might seem like a cost-effective option, it often introduces significant complexity to your data center. Retrofits require specialized expertise, either from the server vendor or a system integrator, to remove fans and adapt components not originally intended for liquid submersion. This can lead to compatibility issues and increased reliance on external vendors. In contrast, immersion-born servers are designed from the ground up for immersion environments. They offer simplified deployment, streamlined maintenance, and often superior performance due to their optimized design.



FEATURES	RETROFIT	ADVANCED RETROFIT	IMMERSION-BORN DESIGN
Availability	Multiple Vendors	Some vendors + Hypertec	**Hypertec Exclusive**
Base	OTS Air-Cooled Servers	CTS Air-Coooled Servers	Immersion-Born
Vanity-Free Design	X	X	✓
Ease of Installation and Serviceability	Low	Medium	High
Performance Availability (OC or Turbo Lock)	X	**Hypertec Exclusive**	✓
Supports both AC & OCp Power	X	X	✓
Sustainable Composite Material	X	X	✓
Custom Immersioon Cooling Heatsink	X	✓	✓
Intel Xeon and AMD EPYC 4th Gen Compatibility	✓	✓	✓
Intel Xeon W (SP/ER) 5th Gen Ready	✓	✓	✓

02

Airflow at Breaking Point

Immersion Cooling as the Vital Solution.

While airflow management has seen continuous improvement, the relentless demands of AI, HPC, and other data-intensive workloads are overwhelming traditional air-cooling systems. In the past, the focus was on managing increasing server power densities. As cabinet densities exceeded 5-10kW, solutions like rear-door heat exchangers and in-row cooling systems became more common.

However, the widespread adoption of accelerators like GPUs, ASICs, and FPGAs presents a new challenge: extreme computational density. Air-cooling often falters in these scenarios, leading to underutilization or inefficient space usage.

A recent study by Gartner estimates that air-cooled data centers experience a significant inefficiency of up to 30% at rack densities exceeding 15kW. This translates to wasted energy and limited performance potential.

Immersion cooling offers a compelling solution. It can support 10x or greater server density increases while consistently maintaining optimal operating temperatures. Advanced modular immersion systems are capable of handling configurations of up to 144 nodes, 288 CPUs, and 98kW per 48U tank – a level of capacity unattainable with conventional air-based approaches.

A recent study by Gartner estimates that air-cooled data centers experience a significant inefficiency of up to 30% at rack densities exceeding 15kW.

Part 2 (con't)

03

The Performance and Efficiency Imperative

Purpose-Built Immersion Designs

Maximizing efficiency is a universal goal for data centers, but optimizing for performance is equally critical. The early days of liquid cooling often involved direct-to-chip solutions that demonstrated the superior heat transfer capabilities of liquids compared to air. However, modern modular immersion systems elevate this concept to a new level of sophistication.

Purpose-built designs integrate all essential components – compute, network, and storage resources – within a fully enclosed immersion environment. This approach offers significant efficiency and performance gains. Since the entire system is optimized for immersion, power distribution, heat management, and fluid flow are streamlined for maximum thermal efficiency. Additionally, the compact design of immersion cooling eliminates the need for complex airflow management, translating into reduced energy consumption and overhead costs.

It's important to note that not all immersion solutions are created equal. Advanced two-phase immersion systems with engineered, high-performance fluids can achieve PUEs (Power Usage Effectiveness) as low as 1.03. This means for every 100 watts of power used by IT equipment, only an additional 3 watts are required for cooling. By contrast, traditionally air-cooled data centers typically have average PUEs of 1.5-1.8.

04

Strategic Vendor Partnerships

Building Trust in Immersion Technology

The immersion cooling landscape has evolved significantly, offering more integrated and streamlined solutions. This simplifies deployment but highlights the importance of careful vendor selection. Despite the ease of deploying these new systems, thoroughly evaluating vendors remains critical. Choosing partners that align with your unique requirements ensures a successful long-term implementation.

Consider the following:
a recent survey by AFCOM found that over 60% of data center professionals cite vendor compatibility as a key concern when adopting new technologies. During your selection process, scrutinize potential vendors just as you would with any other major technology purchase. Evaluate their designs, ensuring they integrate seamlessly with your existing architecture while supporting projected growth and business operations. Research their track record, industry reputation, and commitment to ongoing support during and after system implementation.

Strategic vendor partnerships offer tangible benefits. Established immersion cooling specialists have the expertise to guide you through system selection, integration, and maintenance, de-risking the implementation process. Additionally, these partnerships can foster innovation and collaboration. According to a McKinsey study, companies that collaborate extensively with external partners are more likely to report above-average revenue growth.

05

Understanding True Cost

The Compelling Economics of Immersion Cooling

Escalating energy costs are a major concern for data center operators. This makes it critical to assess infrastructure investments from a holistic cost perspective. While traditional air-cooling systems may appear more affordable upfront, this perspective shifts as rack densities increase. Air-cooled solutions quickly reach their economic limitations, leading to sprawling data center expansions, inefficient resource utilization, or underpowered hardware.

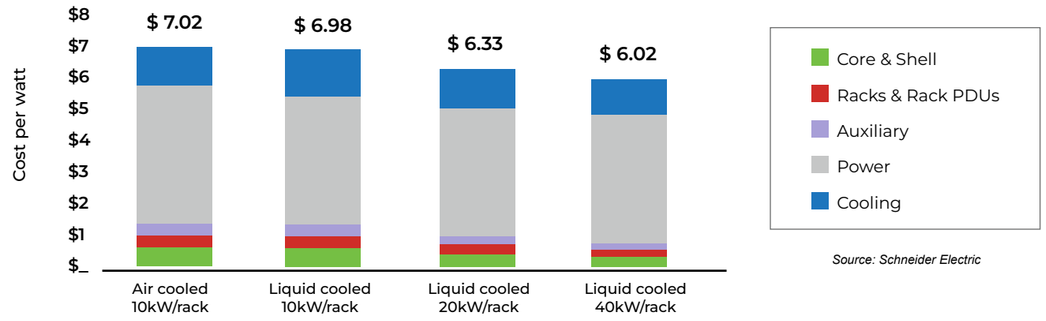
A recent study by Schneider Electric offers valuable insights into data center design costs. While the initial costs of air-cooled and immersion-cooled solutions may be comparable at standard densities (10kW/rack), immersion cooling demonstrates its true value at higher densities. Here's the breakdown:

2x Compaction (20kW/rack):	Immersion cooling offers a 10% reduction in initial costs (CapEx) compared to a traditional air-cooled data center.
4x Compaction (40kW/rack):	Savings rise to an impressive 14%.

The latest AFCOM State of the Data Center report (2023) highlights increasing operational expenditures (OpEx) and capital expenditures (CapEx) as critical challenges. A majority of respondents (57%) reported rising OpEx in 2022, primarily driven by energy costs, equipment service, and personnel expenses. Similarly, 53% faced increased CapEx due to supply chain issues, investment in existing facilities, IT refreshes, and new facility construction.

Immersion cooling delivers significant advantages in reducing both OpEx and CapEx. Single-phase immersion systems can reduce cooling-related OpEx by up to 95%. With PUE values as low as 1.03, many operators see a return on investment (ROI) in less than a year, based on energy savings alone. Moreover, the streamlined design of single-phase systems enables rapid, flexible deployment. Since there's no need for raised floors, cold aisles, and complex retrofits, CapEx is reduced by up to 50% for new builds.

It's important to look beyond immediate costs. Immersion cooling's optimized environment extends hardware lifespan by up to 30%. The absence of moving parts, dust, and vibration minimizes wear and tear, leading to less frequent IT refresh cycles and further cost optimization.



Source: Schneider Electric

TOP FIVE
IMMERSION COOLING MYTHS

Myth #1
Immersion Cooling Requires Complex Water Treatment and Harms the Environment

FACT: Modern immersion solutions integrate seamlessly with existing data center cooling loops, eliminating the need for specialized water treatment. Additionally, the fluids used are fully biodegradable and non-toxic, ensuring environmentally responsible operation.

Myth #2
Immersion Cooling Fluids are Highly Flammable

FACT: Presently, many immersion liquids, including those used in closed-loop systems, contain oils. If these oils are heated to the point of evaporation or condensation, they can technically become flammable, as indicated by the labels on these liquids. Enclosed loops and single-phase immersion solutions offer the highest level of safety regarding combustibility. Solutions like Hypertec utilize single-phase immersion cooling, where servers are submerged in a thermally conductive dielectric liquid or coolant—a significantly better heat conductor than air, water, or oil. Importantly, the coolant remains in a stable state, and the liquid utilized in leading immersion cooling solutions does not pose a risk of combustion.

Myth #3
Immersion Cooling Systems are Complex to Maintain

FACT: Next-generation immersion cooling solutions are designed for simplicity and streamlined maintenance. Even retrofit scenarios offer improved serviceability compared to legacy immersion approaches. Immersion-born systems take this a step further, offering exceptional ease of access to all critical components.

Myth #4
Immersion Cooling is More Complex than Traditional Air Cooling

FACT: While air cooling may be more familiar currently, modern immersion cooling systems are engineered for simplicity. They integrate seamlessly with standard data center infrastructure, including power, connectivity, and often existing water loops. This compatibility, coupled with the superior efficiency of immersion cooling, can lead to a significantly lower PUE compared to air-based systems.

While immersion cooling may be a newer concept within the data center industry, it's crucial to recognize that liquid cooling is a well-established, reliable technology widely used in various industries. From nuclear reactors and powerful car engines to large-scale manufacturing like paper mills, liquid cooling has proven essential for managing high thermal loads. This underscores the potential for immersion cooling to address the unique demands of modern data centers, where energy-intensive computing operations necessitate innovative and efficient cooling solutions.

Myth #5
Immersion Cooling Poses an Electrical Hazard

FACT: Modern immersion cooling systems prioritize safety by utilizing specially engineered dielectric fluids. These fluids are non-conductive, ensuring that even in the unlikely event of a leak, critical IT components are protected. Furthermore, they are designed to leave no residue, minimizing any potential long-term impact on hardware.

Part 3

Immersion Cooling Readiness Checklist

We've explored how immersion cooling addresses critical data center challenges and dispelled common myths holding back its wider adoption. Now, it's time to determine if immersion cooling is the right solution for your specific needs.

Let's dive into a practical readiness checklist to help you evaluate your data center's potential for successful immersion deployment.

Submersion compatibility

The First Step in Your Immersion Journey

Before embarking on any immersion cooling project, it's crucial to assess which components of your existing infrastructure are suitable for immersion.

	AIR	IMMERSION
	✓	✓
Fabric (Copper single mode fiber)	✓	✓
Network Switching	✓	✓
Solid State Storage and NVMe Drives	✓	✓
Spinning Media	✓	Spinning media if sealed (HDD)
Power Supplies	✓	✓

Direct Immersion Cooling

While there are various immersion cooling approaches, let's focus on direct immersion cooling, as it offers several advantages for data center deployments.

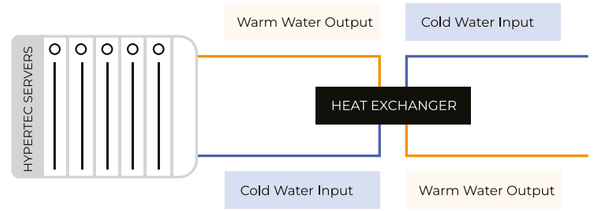
Direct Liquid Cooling (Immersion)

In this system, heat-producing IT components are fully submerged in a specialized, non-conductive dielectric fluid. The fluid absorbs heat directly from the components through convection, providing highly efficient cooling. Heat removal in immersion cooling systems is achieved in a few ways. Most commonly, the heated coolant is circulated through a heat exchanger, where it transfers thermal energy to a secondary cooling medium (often water) and is subsequently recirculated back to the immersion tank.

Alternatively, in some systems, heat passively transfers from the liquid to the sealed enclosure, which then dissipates the heat to the surrounding air through natural convection – a method similar to the cooling of power transformers on utility power lines.

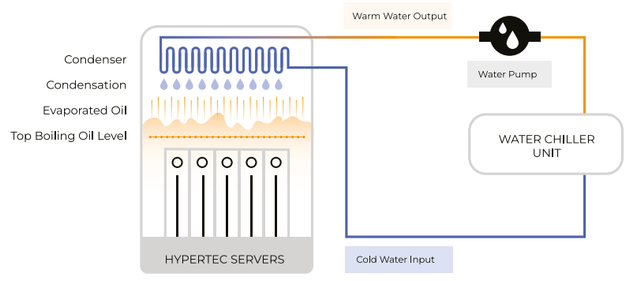
Within the category of immersion cooling, there are two primary types to consider: Single phase and Two Phase immersion cooling

Single Phase Immersion Cooling



Single-Phase Immersion Cooling

Single-phase immersion cooling offers a compelling approach for data centers seeking efficient and reliable thermal management. In this method, IT components are fully submerged in a specially formulated dielectric fluid. This fluid directly absorbs heat from the servers, similar to two-phase immersion. Unlike two-phase systems, the single-phase coolant doesn't boil off or undergo a phase change. It remains in a liquid state throughout the cooling process. The heated dielectric fluid is then circulated through a heat exchanger within a Cooling Distribution Unit (CDU). This heat exchanger transfers the thermal energy to a separate cooling medium, typically a closed-loop water system. The cooled dielectric fluid is then pumped back to the immersion tank, completing the cooling cycle.



Two-Phase Immersion Cooling

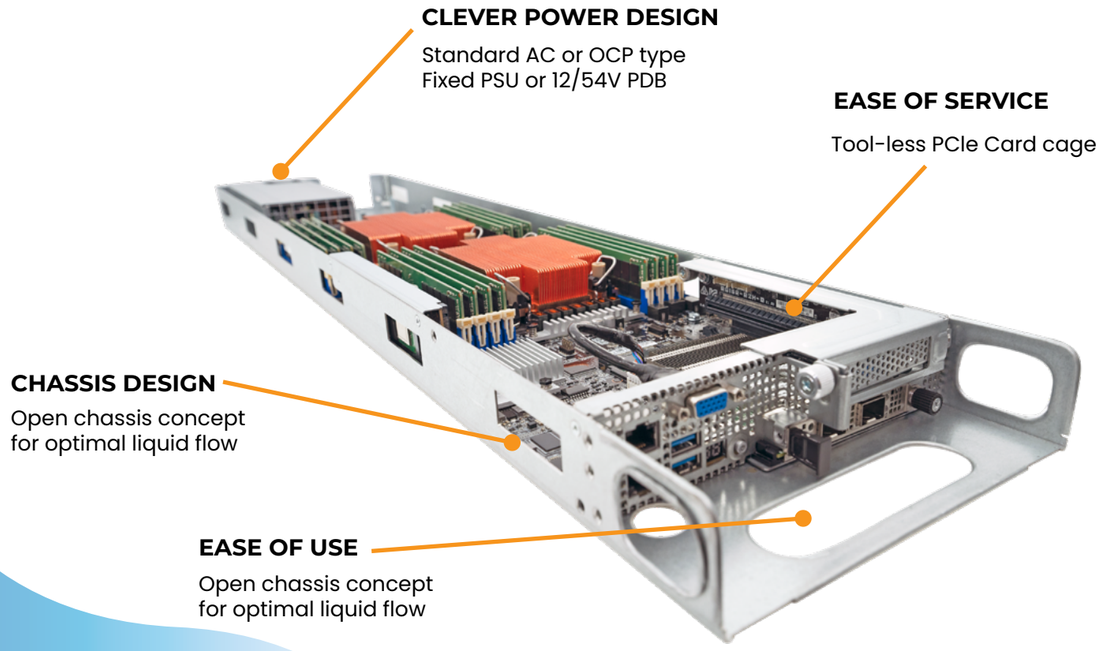
Two-Phase Immersion Cooling:

In a two-phase immersion cooled system, electronic components are submerged into a dielectric heat-transfer liquid bath, a much better heat conductor than air, water, or oil. Selecting the right immersion cooling solution is a decision driven by a data center's specific needs. To optimize its technology roadmap, Hypertec conducted a comprehensive assessment of both single-phase and two-phase systems. This analysis revealed a strong case for prioritizing single-phase immersion due to its balance of efficiency, reliability, and adaptability for a wide range of data center use cases.

Summary

The following table summarizes key distinctions between the technologies, providing insights into the factors considered in this evaluation:

CRITERIA	SINGLE PHASE	TWO PHASE
Power Usage Effectiveness (PUE)	✓	✓
Fluid Loss	✓	X
Toxicity of Fluid	✓	X
Biodegradability of Fluid	✓	X
Material Compatibility	✓	X
Cost	✓	X
Maintenance	✓	X



HOW TO BECOME READY FOR IMMERSION?

Understanding your specific workloads and use cases is crucial for determining the potential benefits of immersion cooling. To reap the full advantages of this technology, business needs must align with its technical capabilities. Immersion cooling excels in a variety of scenarios; however, the optimal server configurations, tank designs, and overall system architecture can vary.

For data centers focused on highly demanding workloads, immersion cooling offers significant advantages. Here are use cases where it often provides substantial value:

CRYPTOCURRENCY MINING

Efficient cooling supports the constant computational demands of crypto mining hardware.

AI & ML

Immersion cooling effectively supports the power and cooling requirements of artificial intelligence (AI) and machine learning (ML) training and inference.

DATA SCIENCE

Enables complex data analytics and computationally intensive data science workloads.

How to become ready for immersion

The emergence of ChatGPT and similar AI models underscores the growing demand for powerful, resource-intensive computing

Their capabilities come with a cost:
a single Google search can power a 100w lightbulb for 11 seconds, while a ChatGPT session is estimated to be **50-100 times more energy-intensive**. This massive increase in computational power generates significant heat that must be efficiently managed. Immersion cooling offers a compelling solution, with its superior efficiency and ability to dissipate the intense thermal output associated with training LLM models and running AI applications like ChatGPT.

01 The Environmental Impact

A critical step towards immersion readiness involves careful calculations of your data center's workload and its environmental impact. Understanding the total heat output (in BTUs) generated by your IT hardware is crucial for selecting the right immersion tank. Consider how a specific tank's maximum heat load (in kW) and the number of supported physical nodes align with your needs. Additionally, the high densities achievable with immersion cooling are game-changing.

For example, you can fit 144 servers within a 48U rack at approximately 100kW, significantly increasing your computational capacity within the existing footprint.

Immersion cooling delivers a compelling financial impact, a point we explored further in Section 2. Solutions like Hypertec's can slash cooling-related operational expenditure (OpEx) by up to 95% and boast a certified PUE of 1.03, resulting in a rapid ROI often achieved in less than one year. Additionally, when combined with immersion-born servers like the Ciara Trident, you can potentially reduce the total number of servers and storage devices required, lowering your total cost of ownership (TCO) by up to 33%. This highlights the significant and multifaceted cost-saving potential of immersion cooling for data centers.

Let's put some real numbers behind the potential of immersion cooling. Using an Immersion Cooling Savings Calculator, a 1MW data center paying $0.10 per kWh could achieve an impressive $500,000 in annual savings.

This is a direct result of the dramatic reduction in PUE achievable with immersion cooling compared to traditional air-cooling methods. The exceptional efficiency of immersion cooling means that data centers of all sizes can experience significant financial benefits.

02 The Facility's Readiness

An architectural review is essential to determine your facility's readiness for immersion cooling.

This will help you determine if your facility can support immersion cooling or if you'll need to make retrofits.

Owning the data center building simplifies this process. If you work with a colocation provider, collaborate closely to assess the feasibility of immersion cooling.

03 Partnering with an Expert

Choosing the right partner is crucial for a smooth and successful transition to immersion cooling. A leading partner eliminates the need for in-house expertise by offering a comprehensive white-glove service.

This includes site assessments, installation planning, tank design, factory assembly, software setup, onsite installation, and even cabling and labeling.

Partnering with an expert ensures a seamless deployment and alleviates the complexities associated with adopting immersion cooling.

Taking all of this into consideration, let's conclude by examining a few immersion cooling solutions and exploring how to begin the journey.

Part 4

The Immersion Cooling Journey: Innovation in Infrastructure

Before you embrace immersion cooling, it's crucial to comprehend your specific use cases and identify where immersion cooling can deliver significant benefits. Keep in mind that depending on the component and the solution, liquid cooling may only dissipate a portion of the heat. Consequently, not all equipment will or should be cooled through immersion methods. As previously mentioned, the fascinating aspect is that immersion cooling has the potential to create a comprehensive solution where every component in your design receives adequate cooling. Therefore, designing around your use case is of utmost importance.

For those organizations looking to leverage immersion-born technology, it's vital to look at immersion servers currently leading the market. For example, The Ciara Trident line of servers was the first to be developed specifically for single-phase immersion cooling. These servers offer ultra-high-density compute performance, up to 288 CPUs per 48U (144 nodes/18,432 cores). They are engineered to accommodate next-generation CPU, GPU, and FPGA cards, ensuring your data center is ready for a wide range of demanding workloads.

The Ciara Trident server line exemplifies how immersion-born design goes hand-in-hand with sustainability. Optimized for single-phase immersion cooling, these servers significantly reduce energy and water consumption while maximizing heat capture efficiency. This results in a substantial reduction in carbon emissions, up to 40% compared to air-cooled setups. Moreover, Hypertec's commitment to using recycled materials in future Ciara Trident systems underscores their dedication to minimizing environmental impact, offering a compelling choice for data centers seeking powerful and eco-conscious solutions.

Immersion cooling isn't a one-size-fits-all solution.

The right partner can help you design a hybrid cooling ecosystem that leverages both immersion and air cooling for optimal efficiency. This adaptability makes immersion cooling a powerful tool for a wide range of applications, including HPC, rendering, edge computing analytics, AI, machine learning, and deep learning. By working with an expert, you can harness the benefits of immersion cooling to propel various business-critical workloads.

The transformative potential of immersion cooling is reflected in the experiences of data center leaders. Patrick Quirk, CTO at Nautilus Data Technologies, highlights the strategic value of partnering with Hypertec:

> **"Partnering with Hypertec was a logical next step in offering our customers even more sustainable, cost-saving energy reductions from immersion cooling. The Hypertec immersion cooling solutions open the door for Nautilus customers to push the limits of increased Kilowatts for unrivaled power without increased electricity consumption."**
>
> NAUTILUS® DATA TECHNOLOGIES
>
> **Patrick Quirk**
> CTO at Nautilus Data Technologies

FINAL THOUGHTS

As data center technologies continue to evolve, there's no doubt that data and the systems that process it will become even more central to organizations across industries. To successfully handle these increasing demands, data center leaders must proactively rethink their infrastructure strategies. Embracing innovation is essential to deliver the necessary capacity, density, and efficiency for a data-driven future.

Throughout this whitepaper, we've explored the compelling advantages of single-phase immersion cooling in addressing critical data center challenges. Let's recap some of the essential points we've discussed:

Energy Efficiency:

We examined the alarming growth of data center energy consumption and how immersion cooling can dramatically reduce cooling-related costs and improve PUE.

Demanding Workloads:

Immersion cooling offers a solution for the increasing power and heat demands of HPC, AI, machine learning, and deep learning applications.

Retrofitting:

We discussed strategies for integrating immersion cooling with existing infrastructure and the considerations for successful retrofits.

Two-Phase vs. Single-Phase:

We compared these technologies, highlighting the advantages of single-phase immersion in terms of simplicity, reliability, and scalability.

Immersion Readiness:

We outlined steps for assessing your data center's readiness and the importance of partnering with an expert for a smooth transition.

Continuous Innovation:

We highlighted how immersion cooling drives innovation in data center infrastructure, paving the way for greater efficiency and performance.

To embark on your immersion cooling journey, start by asking critical questions about your current data center infrastructure and business goals. If you prioritize high-density, data-driven workloads, immersion cooling offers significant technological and business advantages. Its superior efficiency, density, and scalability unlock the full potential of your IT investments. Furthermore, the ability to access and process data faster empowers you to make more informed, timely business decisions.

Special Report
Immersion Cooling
2024

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