



The Datacentre of Now



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Emilia oversees the development and execution of marketing strategies, branding, events, PR and omnichannel content creation, contributing significantly to awareness and lead generation. Asperitas is a cleantech company providing cutting edge immersion cooling infrastructure for datacentres. Their mission is to enable sustainable and high performing datacentres that facilitate all emerging digital technologies, anywhere and on any scale.



INTRODUCTION

Traditional air-cooled systems are nearing their operational limits, prompting industry leaders to explore the best datacentre cooling method for the long term. Effective thermal management, specifically through immersion cooling, addresses the key datacentre industry challenges of performance, sustainability, costs and reliability. The technology submerges the IT equipment directly into a synthetic, single-phase dielectric fluid, providing direct and efficient heat transfer. It also offers an exceptionally reliable and scalable solution that is not only energy-

efficient but also future-proof through increased density and power, high energy efficiency and lower cost.

The Open Compute Project (OCP) has released several papers such as Design Guidelines for Immersion Cooled IT Equipment and Immersion Requirements. These documents form the first and only industry references for IT equipment OEMs to build their portfolios for immersion. The primary role is to generate and qualify requirements for immersion solutions. The aim is to foster a landscape of accurate, fact-based technology positioning.

Asperitas provides a wide spectrum of immersion cooling solutions – ranging from the Perpetual Natural Convection through to and including the Direct Forced Convection platforms. These platforms dramatically reduce datacentre infrastructure energy consumption by driving down the energy required for datacentre cooling by up to 90%. This is in addition to enabling higher server density for unmatched workload performance. This is tried, tested and reliable technology, is science driven and focused on the facts, ensuring that datacentres have the licence to operate.

BENEFITS OF EFFICIENT DATACENTRE COOLING

On a performance level, there is a huge density benefit. Immersion cooling enables much higher compute density compared to traditional air-cooling methods. Since the dielectric liquid can dissipate heat more efficiently than air, this enables high in-tank server density. Furthermore, tanks can be packed more closely together than racks in a smaller space, increasing the amount of compute housed in that area.

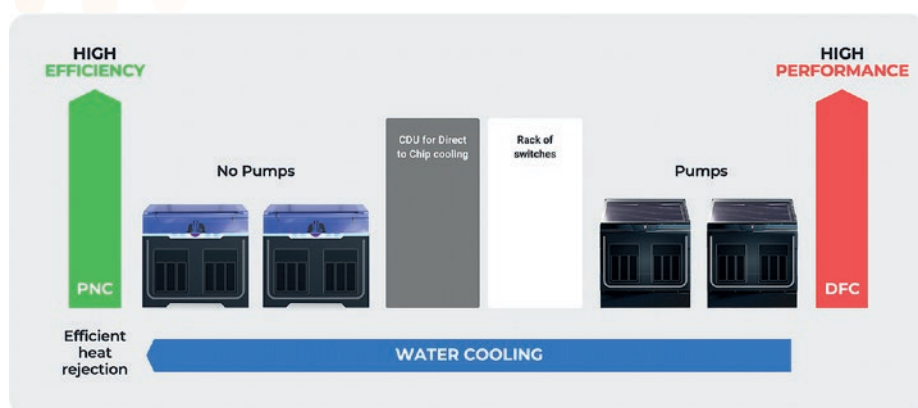
Trust and reliability are key when adopting an innovative technology. The last few years have seen this trust increase as more fluid suppliers and liquid cooling solutions enter the market. On an IT level, immersing the servers reduces the risk of overheating, thermal stress and oxidation of server components by displacing air from the server components, leading to fewer hardware failures and longer equipment lifetimes. On a redundancy level, continuous cooling and maintainability can happen concurrently, and this happens alongside autonomous safety and comprehensive monitoring.

Immersion cooling generates a cost saving of some 45% in datacentre CAPEX and OPEX. Air cooling requires substantial amounts of energy to continuously circulate and cool the air, not to mention run the compressors in refrigeration air chillers within the datacentre. Immersion cooling reduces energy consumption by leveraging the high heat capacity of the cooling liquid, resulting in significant energy savings.

The high heat capacity of liquid allows IT to operate within higher temperatures compared to air. This means that running IT in higher environmental temperatures, still allows the IT components to operate well below the maximum component temperature tolerances. The Asperitas platforms are aimed towards 40+°C cooling temperatures, so there are normally no chiller units required, and energy overhead is reduced to a minimum.

Energy reuse is greatly optimised as all IT energy is captured in the form of heat inside water. After all, the enclosed system is liquid cooled and there is no other way for the heat to go besides the facility (water-based) coolant which runs through the convection drives. Warm water can easily be transported or even stored for energy reuse scenarios.

This award-winning technology offers the highest energy efficiency of IT environments. A single 1U fan consumes about 12 watts at full power. A fan assembly usually consists of two fans. 1U servers often require at least four of these assemblies across the width of the chassis and additional fans for the power supplies. This adds up to about 120 watts. With low powered servers, this is up to 45% of the energy footprint. Any air-cooled IT equipment requires air circulation. In servers, this consumes between 6% and 45% of the total energy footprint. 1U servers with average CPU power with good utilisation (i.e. 80W per CPU) often end up with the highest fan overhead. Larger servers (2-5U) have larger fans which consume less energy, but these servers take up a lot more space in a rack which makes the rack less effective. This fan overhead and space limitation is eliminated with immersion cooling, as the server fans are removed.



High efficiency and reliability (PNC) <> high performance and density (DFC) spectrum



Perpetual Natural Convection and Direct Forced Convection platforms



Multiple immersion cooling tank deployment in their packaging

IMMERSION COOLING PLATFORMS

Immersion cooling platforms such as Perpetual Natural Convection (PNC) and Direct Forced Convection (DFC) not only optimise cooling efficiency but also align with global green initiatives. By minimising energy consumption and utilising environmentally friendly fluids, immersion cooling technology contributes significantly to reducing the carbon footprint of the datacentre.

The PNC platform offers ultra-low energy overhead (circa 100W overhead out of 44kW capacity per tank) and is the most efficient immersion cooling solution on the market. The DFC platform is designed for enhanced thermal performance and scalability, with high power cooling exceeding 2kW per processor.

PNC PLATFORM

The PNC tank allows for twenty-four 1U 21" wide servers to be integrated, with two additional switches, and the solution is designed to meet the demand for high density compute both on a system and server level. The 21" wide server space allows OEMs and integrators flexibility to design innovative servers utilising the full potential of sustainable datacentre cooling.

The ensured high quality of the immersion technology is facilitated by the purity of the dielectric fluid, the lack of moving parts and the fact that everything in touch

with the fluid has been thoroughly tested and certified before commissioning. No air is ever mixed into the fluid in the system and the lid is closed by default, since a closed lid improves the effectiveness of the thermodynamic process. This prevents oxygen from reacting with the fluid. The thermal stability of the fluid is also guaranteed by liquid quality and extensive safety mechanisms which are integrated into the cooling tanks.

NATURAL CONVECTION FLOW

Passive circulation of the single-phase dielectric fluid is where this technology is unique and ground-breaking. The PNC

technology eliminates any infrastructure for the dielectric liquid. Instead, the liquid is circulated by natural means and does not leave the immersion system. The liquid circulates by the heat generated by the IT equipment and water-cooled convection drives, which means that the primary circulation is completely driven by the thermal expansion of the liquid and gravity. The only requirement for heat rejection is any common liquid coolant infrastructure. This approach enables immersion cooling to be both climate independent (free cooling up to 48 degrees Celsius) and fully heat reuse ready (more than 98% energy transformed into hot water). Each system comes with a smart sensor-based monitoring and management control system, which supports common datacentre management protocols e.g. MODBUS, OCP-UA and RESTful.

ENCLOSED AND SELF-CONTAINED

The focus is on compute, as IT is at the basis of every platform or datacentre. All other aspects of a server, rack, cooling or even power system only facilitate the IT. Immersion cooling allows for a shift in focus from cooling to compute. The self-contained approach allows for a much deeper level of integration than any other rack or liquid solution. Everything required to facilitate and manage IT like power and data connectivity is integrated and fully manageable.

Each PNC tank is equipped with two integrated heat exchangers. Left and right. Both heat exchangers require a water feed and a return connection. Integrated power distribution is used



Asperitas PNC



Asperitas Natural Convection flow



PNC front panel



PNC inside of tank



Asperitas DFC Flow

for powering all IT in the system. The solution has one or two power connectors for 400V/63A, grounding connection and RJ45 management interface port. The power distribution system can be redundant and fully managed and must be applied in such a way that cable management is simplified, and nothing needs to be routed outside the immersion system. Integrated universal switching allows for the distribution of ethernet connectivity throughout the system and the network connections are distributed to each server with minimised and intuitive cable management. The integrated cable management approach allows for standardised and optimised serviceable cabling and logical cable management without bundles or over lengths. Only backbone/uplink cabling comes out of the system.

DFC PLATFORM

2024 saw the launch of Direct Forced Convection technology, enabling Intel Targeted Flow, which is designed for scale, power and reliability across all workloads. The DFC platform doubles the power density, meaning the cooling capacity is as high and even higher than the power capacity of the tank – meaning that datacentre cooling is no longer the limiting factor for scale-up and scale-out.

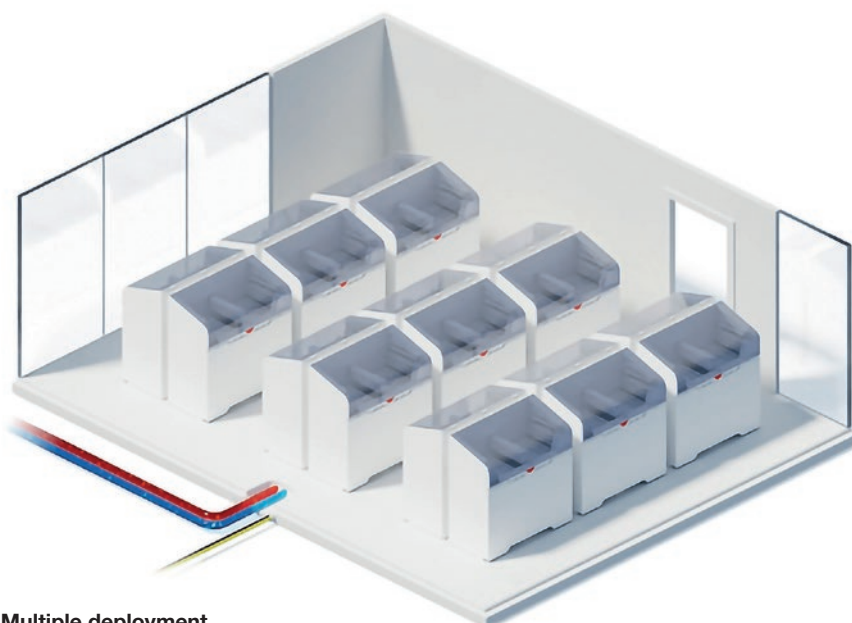
Scale-up meaning higher power chip densities that track the chip OEM roadmaps (Moor's law). Scale-out meaning more racks, tanks, datacentre power capacity (Business growth). Enabling unlimited scale-up and a cooling capacity beyond 3.6kW per U,

the DFC technology ensures that high power density components at chip and chassis levels are precision cooled with an extremely low power overhead. This allows datacentres to stack more powerful servers in a smaller footprint without the risk of overheating, a crucial consideration for datacentre efficiency.

TARGETED FLOW

Targeted Flow is essentially DTC cooling in an immersion tank, where the chips are precision cooled using the same fluid as in the immersion tanks. So now datacentres get the high-powered density cooling of DTC (scale-up) combined with both the benefits of PNC technology and reliability of immersion. This enables warm-water cooling and higher power CPU and GPU cooling. It is used in combination with the performance block which increases the flow focus further to specific 'slots' in the chassis. Targeted flow immersion cooling is capable of cooling the same high-power chips combined with the ability to liquid cool all server equipment.

For both platforms, a double hull protects the environment of the system from any fluid or thermal leakage. The double hull is insulated and provides an optimal safeguard against any form of leakage. The only place for the heat to go is into the water circuit. This means that expert immersion cooling solutions enable cooling with the same amount of thermal energy as the IT electrical consumption. Simply put, 22kW IT equals 22kW heat captured in the liquid, which is rejected with water at minimised losses.



Multiple deployment

PNC and DFC datacentre cooling solutions not only allow for higher server density and better performance (aligning with the increasing computational demands of applications such as HPC and AI), but they reduce the energy consumption of cooling systems. This is particularly valuable for datacentres needing to comply with regulatory reporting requirements like the Corporate Sustainability Reporting Directive (CSRD) and Energy Efficiency Directive (EED).

Lastly, the embedded autonomous control system of the PNC and DFC continuously monitors the temperature state of the tank. It reports on any exceptions to the optimal cooling environment, providing alerts and escalations and ultimately isolates tank flow and power systems to safeguard the IT and datacentre integrity.

Ultimately, adopting immersion cooling is the logical choice for today as it prepares companies for what is coming from compute in the next few years.

SERVICING AND MAINTENANCE

An essential element for datacentre thermal management tooling and maintenance is the Asperitas Service Trolley, which is made of a stainless-steel body on caster wheels with an integrated electrically driven server lift. Transport capability for 12 cassettes and 8 switches, the hoisting system enables automatic lifting of the cassettes for placement and removal without interaction with the dielectric fluid. The body contains a large storage compartment that can be loaded with server and/or switch cassettes from the top with the lifting system. Furthermore, the body is equipped with a cabinet for

the liquid pump and various trays for accessories.

The ESD protected Service Trolley has been developed and optimised for immersion cooling to be used with the PNC and DFC platforms. It addresses all maintenance: hoisting servers, servicing and transporting IT and cleaning up any spills. The lifting interface slides forward and backward on a guide rail. The rail is mounted on an extendible boom on top of an electric driven vertical lift system, creating the lift and trolley combination.

IMMERSION COOLING ADOPTION SCENARIOS

Companies need to consider how to adopt immersion cooling with specific scenarios in mind. Setting sustainability objectives is one thing, but it is important to also identify the performance requirements for the next few years. Planning and road mapping is required. The below shows different implementation strategies paired with practical guidance on the challenges and uncertainties the planning may face.

SMALL-SCALE PILOT PROGRAMME

A small-scale pilot is the ideal entry point for those considering immersion cooling but hesitant about the investment. This approach allows datacentres to test the performance, compatibility, and management of immersion cooling without overhauling an entire facility.

How to Proceed

Select suitable hardware: Identify workloads that can benefit from higher densities and thermal management, such as AI training or scientific simulations.

Choose a turnkey solution: Immersion cooling solutions are designed for simple integration and minimal disruption. The modular systems allow users to introduce immersion cooling without major changes to existing infrastructure.

Datacentre managers may question how quickly they will see a return on investment. Clear KPIs related to energy savings and performance improvements will need to be tracked during the pilot. It's important to prepare well when setting up pilot programmes, including defining operational metrics to measure the effectiveness of the immersion cooling deployment. Fluid management and monitoring services should be included to ensure long-term efficiency.

IMPLEMENTATION IN AN EXISTING DATACENTRE: REPLACING A CLUSTER

For datacentres facing the need to replace aging clusters or increase rack density, retrofitting with immersion cooling provides a highly efficient solution. Immersion cooling deployments already co-exist with traditional air-cooled systems now, allowing datacentres to gradually transition as needed.

How to Proceed

Assess compatibility: Analyse which clusters in your current facility would benefit the most from immersion cooling, such as high-performance applications or energy-intensive systems.

Design integration plans: Immersion cooling solutions allow for modular deployment. Consider starting with a section of the datacentre that is easy to isolate and retrofit.

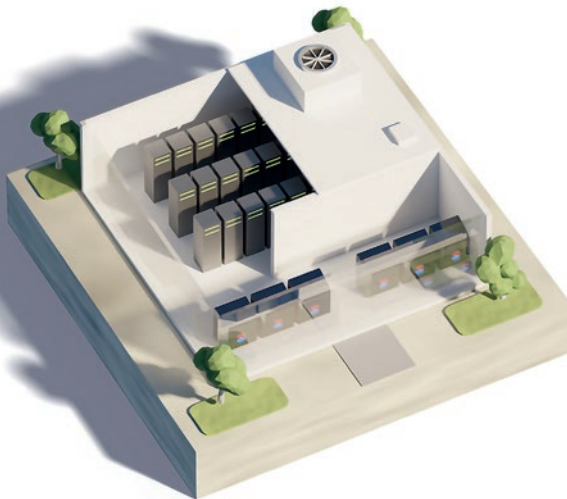


Service Trolley in Use

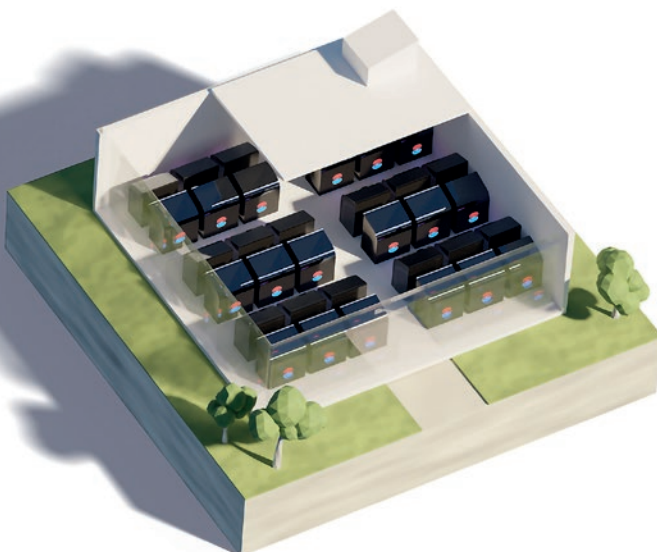




Small-scale out



Implementation in existing datacentre



Datacentre full new build

Datacentre managers may be concerned about downtime during installation. Proper planning and phased integration can minimise this risk. It's important to enable comprehensive planning support for retrofitting existing datacentres, including fluid management services and remote monitoring systems.

DATACENTRE FULL NEW BUILD

Building a new datacentre provides the perfect opportunity to integrate immersion cooling from the ground up. This approach to datacentre cooling results in massive savings in energy costs, space utilisation, and future-proofing for high-performance workloads.

How to Proceed

Design for immersion from day 1:

Planning a facility around immersion cooling allows datacentre managers to maximise density, reduce physical space requirements, and optimise energy use.

Heat reuse integration: With a new build, datacentres can take full advantage of immersion cooling's heat reuse potential. The captured heat can be repurposed for external applications such as district heating or industrial processes.

While immersion cooling offers long-term energy savings, the initial infrastructure investment may be higher than traditional cooling systems. Managers need to clearly understand the cost-benefit curve over time. Asperitas partners with new build projects to provide full immersion cooling design, implementation and maintenance support.

This ensures that datacentres are not only optimised for today's workloads but are scalable for future demands.

CONCLUSION

Immersion cooling offers significant advantages over traditional cooling systems, especially as industry trends point toward higher densities and energy efficiency. For datacentres, the path to adoption can be phased based on organisational needs, from small-scale pilots to full facility integrations. It's important to choose a vendor that caters to each phase of this adoption journey, ensuring a smooth transition and clear support across planning, implementation, and operational management.