Liquid Cooled Computing

Enabling The Digital Enterprise In The Advent Of Industry 4.0

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One of the core tenets of mass manufacturing is centralization. It's an idea pretty much as old as the Industrial Revolution itself. Putting everything in one place – raw materials, workforce, machines, post-production – enabled scale and scale meant efficiency.

The advent of Industry 4.0 has disrupted these long established paradigms. Smart factories are challenging the accepted thinking underpinning volume manufacturing.

- **Innovative manufacturing techniques** – 3D printing has undermined the relationship between volume and cost efficiency. The significant capital expenditure of investing in new tooling meant that any part had to be produced in high volumes to be justifiable.
- **Increasing automation** – factories of the future will be ever less reliant on a local workforce to staff the production line. Factories will be part of a distributed network and contain machines that are more capable of intelligent operation independent of human interaction.
- **Autonomous vehicles** – automated machines will shift the logistics of manufacturing. Rather than relying on a centralized distribution network, manufacturers will use autonomous vehicles, robots and drones to move parts between factories or deliver products directly to retail and even end-users.
- **The "Digital Twin"** – from initial designs through to simulation, materials and production, the digital twin concept will accompany every machine in order to create, test and build products. Taking a digital approach for critical parts of production will open new ways of productivity and efficiency.

This fundamental shift from centralized manufacturing to a flexible network of smart factories is supported by micro and edge data centers. Just as factory hardware no longer has to sit under a single roof, IT systems will also be spread across a network.

Datacenters and high performance processing systems will sit throughout a manufacturer's network, perhaps on the factory floor itself. Through wireless technology, computers will be in constant communication with other smart factories in the network, the cloud, and a range of connected devices.

Digitalization Puts Strain On Existing Infrastructure

Despite these exciting advances in automation and communications, let's not forget that manufacturing is still about making products – it's a physical business. Machining parts can generate huge amounts of noise, heat, and dust which combine to create a very challenging environment for IT systems.

As systems will be 'edge' deployed as part of a decentralized network they could well exist in remote locations where local on-hand IT support is not guaranteed. Therefore it is paramount that smart factory devices are easy to manage, secure, and resilient to the environmental challenges of the factory floor.

As new technologies such as the Internet of Things (IoT) are driving volumes of data, along with substantial investment at the Edge of Network, it's clear that cost effective and efficient cooling technology is needed.

Cooling is essential to high powered electronics and should not burden your IT investment. Traditional air-based cooling equipment cannot cope with ever-increasing

heat loads that hotter processors and applications demand. Sticking with the legacy approaches will only lead to larger footprints and increasing cost and complexity, with no competitive benefit.

Roughly 25% of datacenter unplanned outages are caused by weather, water, heat or air-conditioning related issues. Combine this with air cooling equipment being bulky, power-hungry and costly, sufficient cooling methods are crucial for business operation and continuity.

Redefining The Cooling Landscape For Industry 4.0

Liquid cooling has been around for many years but, until now, has been regarded as a niche technology with many compromises. However hotter processors and new technologies are driving the need for faster speeds, better flexibility with minimal disruption and downtime.

ICEOTOPE, developers of immersion liquid cooling technology, enables IT infrastructure to operate seamlessly in any environment. The patented technology revolves around immersing and protecting high powered electronics in a specially engineered coolant.

Thanks to Iceotope's total immersion cooling technology, expenses such as chillers, computer room air handling (CRAH) equipment, raised floors or ducting are no longer necessary. The result is an advanced product portfolio ranging from tower to server-level to suit a range of computational demands and environments.

EdgeStation™ - Fan-Free, Resilient Workstation

EdgeStation adds robust, portable powerful computing resource to the digital enterprise. Bringing critical applications closer to the manufacturing operation reduces latency, therefore improving your time-to-market.

Without the industrial drone of fans and pumps, you can put a high performance machine to work side-by-side with your team. Removing the fans ensures a sealed system which protects critical IT components from hot, harsh or contaminated environments delivering reliable performance.

ICEOTOPE has worked with the Advanced Manufacturing Research Centre (AMRC) to solve the problem of dust particles from its carbon fiber facility. This caused continuous IT equipment failure and unscheduled downtime. The AMRC deployed an EdgeStation™ system, which fully encloses and protects

Figure 1. ICEOTOPE EdgeStationTM fan-free resilient workstation

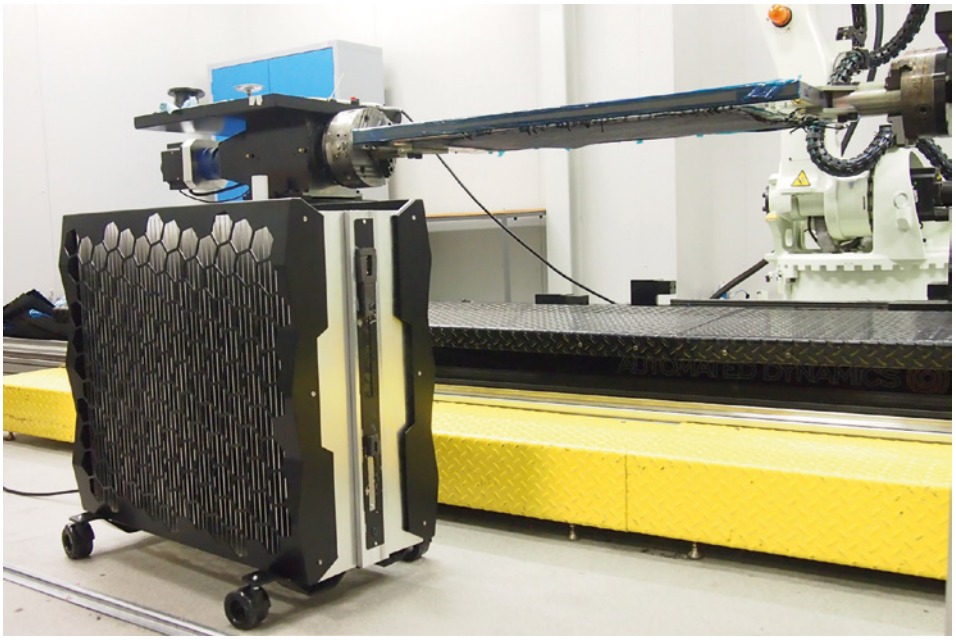

Figure 2. EdgeStationTM deployment at the AMRC carbon fiber laboratory

high-powered electronics to sustain performance and therefore increase product lifespan.

EdgeRack - Simplified Edge Data Center Deployment

EdgeRack is the modern data center to deliver more power in significantly less space so your business can scale one rack-at-a-time.

ICEOTOPE uses a two-stage cooling process – the first stage being a specially engineered liquid to cool all components with the second stage transferring the heat away using a coolant loop. Consider that EdgeRack saves up to 80% energy consumption, and you can reuse the waste heat for district heating, liquid cooled datacenters become a sustainably smart business model.

Summary of ICEOTOPE liquid cooling:

- **Double-digit capex savings** – Iceotope's technology requires next-to-no additional infrastructure leading to significant capex reductions for datacenters..
- **Significant floor space reduction** – using anywhere between 50% - 75% less floor space, savings for customers are substantial. This leads this need to defer or obviate major capex in extending or building new datacenter space.
- **Full integration** – Iceotope can retrofit their servers into existing infrastructure meaning you can get immediate opex benefits without having to redesign your entire datacenter, alter your supply chain or retrain your staff.
- **Consumes less energy** – without the need for power-hungry computer room air handling equipment and zero fans inside the servers, Iceotope's technology can reduce energy bills by up to 80%. Iceotope also allows the recapture and reuse of waste heat leading to an improved corporate risk and social responsibility strategy.

CFD Is Vital For Product Development

The combination of network modeling and CFD are vital to our engineering design processes and greatly reduce the cost and time for development. From prototypes, to performance optimization and design approval, CFD modeling is used for a range of features within the immersion cooling system from natural convection of IT components to forced convection of pipe networks and heat exchangers.

Liquid is 1,000 times more effective at transferring heat than air, however, using liquid comes with challenging physical behaviors. To overcome this, ICEOTOPE uses CFD software to analyze the natural convection inside our server blades, providing details of flow distribution.

To deliver significant energy and cost savings to our customers, we also use CFD to characterize hydraulic resistance in our manifolds to achieve sufficient coolant flow while limiting the operating pressure.

Harnessing the power of digitalization, ICEOTOPE can now utilize its CFD design simulations to create their own "digital twin" to validate and optimize designs.

Figure 3. From one to three chassis, ICEOTOPE delivers business scalability