



# Shell Immersion Cooling Fluid

IN PARTNERSHIP WITH



## INTEGRATED IMMERSION COOLING SOLUTIONS

ENABLING GAME-CHANGING ENERGY  
USE REDUCTION AT DATA CENTRES



The internet is a fundamental part of modern life. The cloud enables us to work anywhere, watch on-demand movies and much more. The cloud may sound transient, but it has a physical, energy-hungry home – a network of data centres. These account for an estimated 1% of global electricity consumption,<sup>1</sup> more than a third of which is for cooling electronic components, and have half the carbon dioxide emissions of global air travel. To compound matters, data centre infrastructure is expanding by more than 20% every year,<sup>2</sup> so, without game-changing action, data centre emissions will increase exponentially. At the same time, society needs to cut carbon dioxide emissions by 50% to reduce the impact of global warming.<sup>3</sup>

## SHELL'S AMBITION IS TO BE A **NET-ZERO EMISSIONS ENERGY BUSINESS**

---

In tackling climate change, the focus is increasingly on limiting the global temperature rise to 1.5°C. To achieve this, society needs to stop adding to atmospheric greenhouse gases – a state known as net-zero emissions – by around 2060. More advanced parts of the world need to reach that point sooner.

That is why Shell has set itself an ambition to become, by 2050 or sooner, a net-zero-emissions energy business.<sup>4</sup> We are working towards this in many ways, including with Asperitas to tackle data centre energy use as part of a wider integrated offer to help centre operators meet their climate action ambitions.

---

# MORE DATA AND HIGHER PROCESSING POWER ARE CREATING A NEW COOLING ERA

Air cooling equipment for electronic components accounts for 38% of the electricity use in data centres,<sup>5</sup> takes up considerable space and has growing demands put on it.



**More data.** There are now more than 50 billion connected devices.<sup>6</sup>



**Extreme processing speeds that generate more heat.** High-performance computing is required for machine learning, speech and facial recognition, cryptocurrency mining, blockchains, artificial intelligence, etc.



**Increased demand for online services.** Examples include near real-time analysis for autonomous vehicle route finding, content distribution and fintech.



**Edge computing.** Data centres are being built on the network edge to reduce data transfer time and increase availability; these facilities often have space and energy-infrastructure constraints.

Traditional air cooling, with its low cooling capacity and practical limitations (noise, footprint and build complexity), cannot meet these growing demands without higher energy and space requirements, but there are cost-effective alternatives.

Full immersion in a thermally conductive, electrically non-conductive (dielectric) coolant is a highly efficient way to keep data centre hardware and computer components cool. It can cut energy consumption and reduce carbon dioxide emissions while reducing costs and increasing location flexibility. On a larger scale, immersion cooling offers standardised efficiency that is independent of location, facility and hardware requirements.

# WHAT IS THE BEST ENERGY-SAVING SOLUTION?

Using water-filled plates can upgrade the cooling capacity of some air-cooled facilities, but there is a high leakage potential with the risk of water damage to the system, and air cooling is still necessary. Also, this method is inflexible and expensive.

Two-phase immersion cooling offers a high cooling capacity without needing circulation pumps and thus has a lower energy requirement. However, these systems have very high capital costs and use expensive fluids with high global warming potential. Although these systems are sealed, fluid may be lost through evaporation. The effect of coolant vapour on people's health is unclear and the fluid needs topping up to replace losses. Access for maintenance is also more complicated with sealed systems.

Compared with two-phase systems, single-phase immersion cooling systems have a simple architecture for significantly lower capital costs. As there is no evaporation, open tanks can be used for easy maintenance. Compared with air cooling, single-phase immersion cooling offers<sup>7</sup>

- > up to a **33%** lower total cost of ownership through
  - up to a potential **48%** reduction in energy footprint
  - up to a potential **96%** cut in cooling costs
- > up to potentially **30%** less carbon dioxide emissions
- > up to **80%** less floor space
- > up to **40%** more CPU performance
- > **30–40%** less operating and capital expenditure
- > **high reliability** with no moving parts
- > **independence from climate**, as it works in challenging environments, including high ambient temperatures (up to 45°C), humid environments and industrial settings.

## WHAT IS IMMERSION COOLING?

Immersion cooling is a way of cooling IT components, including whole servers, by submerging them in a dielectric (electrically non-conducting) fluid. The fluid has more than a thousand times the thermal capacity of air (by volume), which makes immersion cooling a highly efficient alternative to air cooling. The liquid circulates by natural convection or is pumped to remove heat from the components. An added benefit is that this heat can be recovered by water-cooled heat exchangers for reuse in district heating projects. In single-phase immersion cooling, the coolant stays as a liquid, whereas the coolant boils to form a gas and then condenses back to a liquid in two-phase immersion cooling.

UP TO **48%**  
 ✓ REDUCTION  
 ✓ IN ENERGY  
 ✓ FOOTPRINT<sup>7</sup>

# WHICH COOLING TECHNOLOGY OFFERS THE BEST SOLUTION?

	Air cooling (traditional data centres) <sup>a</sup>	Liquid cooling		
		Single-phase cooling: cold plate (water) <sup>a</sup>	Single-phase cooling: immersion <sup>a, b</sup>	Two-phase cooling (high heat range applications) <sup>b</sup>
Cooling capacity	+	++	+++	++++
Hardware integration (for example, space needed)	+	++	++	++
Hardware reliability	+	-	++	+
Hardware performance	+	++	+++	+++
Heat recovery	+	++	+++	+++
Initial capital expenditure	+	-	--	---
Operating expenditure	+	++	+++	+++

The liquid coolant never changes state (no boiling/freezing, etc.), for example, it is used in high-performance computing

Mainly for high heat range applications such as crypto mining

<sup>a</sup> Infrastructure Services Group, reported in *Global immersion cooling market in data centers - Growth, trends, forecast (2019-2024)*, Mordor Intelligence (2019)  
<sup>b</sup> Customer feedback and internal evaluation

# IMMERSION COOLING – THE HEART OF AN INTEGRATED ENERGY SOLUTION

Single-phase immersion cooling solutions are at the heart of our integrated energy solution for data centres.

**FLUID SOLUTIONS.** We have developed Shell Immersion Cooling Fluid S5 X with our partner Asperitas to help you get the most from your natural convection or pumped/forced data-server liquid cooling systems. This synthetic fluid made from gas is inherently stable to provide superior performance and material compatibility. It is clear, odourless, non-toxic and so safe that it is approved for use in applications such as cosmetics.

**HEAT REUSE.** Immersion cooling gives you the opportunity to reuse the heat generated by your servers. For example, the Asperitas system is optimised for heat reuse scenarios. It is set up to recover up to 99% of the heat generated as 55 °C water for use in district heating projects or directly by industrial users.

**RENEWABLE ENERGY.** Immersion cooling can cut data centre energy use by up to 48%. We can help you to reduce your carbon footprint further through on-site solar power and/or renewable energy supply.

**CARBON CREDITS.** Once you have reduced your energy needs, we can deliver environmental solutions that enable you to manage your local and regional carbon dioxide compliance obligations and gain access to global markets. If you have made a strategic decision to reduce or eliminate your net carbon footprint, we offer a variety of high-quality voluntary carbon credit solutions. Most of the projects in our global portfolio are nature-based and focused on protecting, transforming or restoring land.

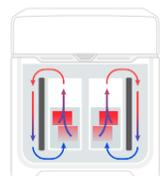


The integrated Asperitas Immersed Computing<sup>®</sup> and Shell Immersion Cooling Fluid solution is one of a handful of innovations featured in a World Economic Forum white paper<sup>8</sup> showcasing disruptive innovations in the energy sector judged to be **NOVEL, BENEFICIAL TO SOCIETY AND ACCELERATING THE ENERGY TRANSITION.**

Immersed Computing is a trademark of Aecorsis BV.

**In 2017, Asperitas launched its Immersed Computing technology commercially. The following year, the company won the international New Energy Challenge prize organised by Shell, Rockstart and YES!Delft. It was also named "Hottest Greentech Startup" and a "Global Changemaker" in other competitions.**

**Shell and Asperitas work in partnership to promote immersion cooling and develop cooling fluids. The technology enables the deployment of sustainable, high-density data centres wherever they are needed, regardless of climate.**



**Asperitas is a leading contributor to the Open Compute Project** and pushes the sustainability agenda by supporting energy efficiency demonstration projects and smart energy award winners. It offers complete immersion cooling systems, including supporting and servicing solutions such as leak trays, service trolleys, server cassettes and spill kits.

The **Asperitas AIC24** immersion cooling system uses the natural convection of a dielectric liquid to enable free cooling in high ambient temperatures and provide optimal heat reuse. This makes it a unique solution (other single-phase immersion cooling solutions rely on pumps), exceptionally reliable and low on maintenance needs, as there are no moving parts and it is independent of climate.

Each plug-and-play, fully self-contained unit can contain up to 48 servers (in a 21-in. server format) and two switches, and is scalable through modular expansion for flexible deployment.

## BENEFITS BY USER



**Cloud providers and hyperscale data centres**

can optimise their efficiency and achieve their sustainability goals while standardising facilities for a variety of hardware requirements.



**Telecom providers**

can operate edge data centres anywhere. They can also use existing buildings within power and cooling availability constraints.



**Enterprises**

can simplify their on-premise data centres for high efficiency and decreased dependency on the public cloud by adopting next-generation hardware.



**Research institutes**

can facilitate on-campus HPC environments without the need for advanced data centres with their associated energy and cost demands.



**Colocation providers**

can facilitate high density and performance compute users in a simple and scalable manner.



**Immersed Computing technology can cut energy use by 48%, boost CPU performance by up to 40% and reduce capital and operating expenditure by 30–40%.<sup>9</sup> It is optimised for climate independence and heat.**

# FLUID DEVELOPMENT

Asperitas has been using Shell fluids since 2014. The companies have been collaborating more closely since 2018 and working together to test fluids during the Immersed Computing research and development phase.

The result is **Shell Immersion Cooling Fluid S5 X**, a synthetic, single-phase immersion cooling fluid made from gas using Shell's gas-to-liquids technology.

It is designed to

- **reduce energy costs and emissions** through its high cooling efficiency, flow behaviour and excellent thermodynamic properties
- **cost less to manufacture** than fluorocarbon and incisively engineered fluids
- **improve product safety** through its high compatibility with computer components
- **be safe** and easy to handle.

Compared with the fluorocarbons typically used in two-phase systems, Shell Immersion Cooling Fluid S5 X has

- **better** heat capacity
- **higher** heat transfer efficiency
- **lower** volatility, which means that the tanks can be operated safely for the life of the data centre without being sealed or having the fluid replaced
- **lower** fluid density for less floor loading and possible reinforcement
- **no** direct global warming potential.

**Shell** and **Asperitas** are continuously optimising the fluid for specific applications and scenarios. In addition, Shell can monitor the fluid quality in operational environments to assure the long-term predictability and performance of your facilities.

**Shell Immersion Cooling Fluid S5 X** has been developed with Asperitas to achieve high levels of safety, performance and reliability. It is optimised for Asperitas' natural-convection-driven immersion cooling solutions but can also be used in pumped/forced circulation systems.

## Safety and purity.

Being made from natural gas gives Shell Immersion Cooling Fluid S5 X outstanding safety and purity. It meets EU and US pharmaceutical purity requirements, is a non-halogenated, food-grade product that is free from allergens and has extremely low volatility.

## Performance.<sup>10</sup>

Shell Immersion Cooling Fluid S5 X has excellent thermodynamic properties, a low density and a high flash point. It is non-evaporating.

## Protection and reliability.<sup>10</sup>

The fluid has high compositional consistency and very high oxidation and thermal stabilities. It contains virtually no sulphur, nitrogen or aromatics, and is non-corrosive.

**"Shell Immersion Cooling Fluid S5 X has major advantages over conventional fluids we have tested, including excellent thermal stability and flow behaviour, and a high flash point, enabling us to operate our modules at their design temperatures for maximum heat recovery."**

Rolf Brink, Asperitas Chief Executive Officer

<sup>1</sup> [www.iea.org/commentaries/data-centres-and-energy-from-global-headlines-to-local-headaches](http://www.iea.org/commentaries/data-centres-and-energy-from-global-headlines-to-local-headaches)

<sup>2</sup> [www.technavio.com/report/global-data-center-infrastructure-management-dcim-solutions-market-industry-analysis](http://www.technavio.com/report/global-data-center-infrastructure-management-dcim-solutions-market-industry-analysis)

<sup>3</sup> [www.shell.com/energy-and-innovation/the-energy-future/what-is-shells-net-carbon-footprint-ambition.html](http://www.shell.com/energy-and-innovation/the-energy-future/what-is-shells-net-carbon-footprint-ambition.html)

<sup>4</sup> [www.shell.com/energy-and-innovation/the-energy-future/shells-ambition-to-be-a-net-zero-emissions-energy-business.html](http://www.shell.com/energy-and-innovation/the-energy-future/shells-ambition-to-be-a-net-zero-emissions-energy-business.html)

<sup>5</sup> Centres using traditional air-based cooling technologies. 3M report referenced in Global Immersion Cooling Technology, Mordor Intelligence (2019)

<sup>6</sup> In 2020. Source: NCTA, [www.ncta.com/whats-new/behind-the-numbers-growth-in-the-internet-of-things](http://www.ncta.com/whats-new/behind-the-numbers-growth-in-the-internet-of-things)

<sup>7</sup> These figures are based on the *Global immersion cooling market in data centers - Growth, trends, forecast (2019-2024)* report, Mordor Intelligence, Asperitas' test results and Shell's internal evaluation. The benefits achieved will vary according to the actual site deployment.

<sup>8</sup> World Economic Forum white paper: *Global Innovations from the Energy Sector, 2010-2020*. Published May 2020

<sup>9</sup> These figures are based on Asperitas' test results. The benefits achieved will vary according to the actual site deployment.

<sup>10</sup> Based on Shell's internal tests and evaluations

**Shell**  
**Immersion Cooling Fluid**

IN PARTNERSHIP WITH



CONTACT US  
For further information, visit  
[www.shell.com/immersion](http://www.shell.com/immersion)

