

A hand is shown holding a blue cable that is connected to a submerged electronic device. The device is partially submerged in a liquid, and the hand is holding the cable above the liquid. The background is dark and blurry, suggesting a laboratory or industrial setting. The text is overlaid on the left side of the image.

What makes Submer's SmartCoolant So Smart?



by **Peter Cooper**,
(**Chemical Engineer** at **Submer**, [Peter's LinkedIn](#)).

Dr Peter Cooper was awarded his PhD in Chemistry from the University of Western Australia. After years working in university and government institutions researching next generation lubricants, Peter joined Submer in May 2019. Working within the Submer Engineering department, he leads the SmartCoolant R&D lab.

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Intro

As we usher in the third decade of the century, the case for adopting Immersion Cooling has never been stronger. As explained in our previous ebook *The 3W's of Immersion Cooling: What, Why & When!*, Immersion Cooling affords end-users with a range of benefits including reducing 95% of electricity cooling costs, zero water consumption, and deployment in almost any location.

Read Submer's ebook:

[The 3W's of Immersion Cooling: What, Why & When!](#)

With the benefits of switching the Immersion Cooling clear, which coolant should you use? This ebook outlines some of the key concepts for Immersion Cooling fluids and how we used our hands-on experience with them to design our dielectric, proprietary coolant, the **SmartCoolant**.

The new user of **Immersion Cooling** is overwhelmed by the options available in the dielectric fluid market:

- Vegetable oils
- Mineral oils
- Fluorocarbons
- Synthetic fluids (hydrocarbons)

This smorgasbord of coolants raises a number of questions for the end user: which of these liquids will be **compatible with my IT hardware**? Which will be **safe and easy** to work with? Which one **will last the longest** so that I do not have to replace it every year? Will they create any **environmental issues** in the future? Is there any difference in the **cooling performance**?

Initially, we experimented with each and every one of these options in our search for **the perfect dielectric fluid**. Unfortunately, none of the options seemed to provide us with the characteristics which we demand for ourselves and our customers, whether it be the lack of stability, or poor impact on the environment. Even some of the supposedly high performance coolants seemed to simply be rebranded transformer oils or motor oils which had been shoehorned into Immersion Cooling applications. In the same way that we do not use transformer oils to lubricate our car motors, we do not want to use them to cool our servers.

After exploring all the options that the market had to offer, we decided we had to take matters into our own hands and **create our own dielectric fluid**. The SmartCoolant is our goldilocks solution to the Immersion Cooling problem based on our hands-on experience designing immersion cooling systems. By going back to the molecular chemistry of the fluid we have created a dielectric coolant that strikes the **perfect balance** between **compatibility** and **performance**, between **stability** and **biodegradability**.



"After exploring all the options that the market had to offer, we decided we had to take matters into our own hands and create our own dielectric fluid."

Compatibility

The single greatest concern for the new user looking to make the switch to Immersion Cooling is the **compatibility of the coolant with their IT hardware**. After all, we have been taught all our lives that liquids (water) and electricity do not mix, so the thought of submerging very expensive server equipment in a liquid naturally sets off alarm bells. In fact, not only are dielectric coolants compatible with IT hardware, they actually **protect** them!

Dielectric coolants are, by definition, **electrically resistant liquids**. This means that they will not conduct electricity or cause short circuits. To ensure that this remains the case throughout the lifespan of the SmartCoolant, we have designed it with a dielectric buffer so that it is **8 times more electrically resistant than air**.







When it comes to compatibility with materials, our **extensive in-house testing** has proven that the SmartCoolant is **fully compatible** with common metals and many plastics and elastomers. Since the SmartCoolant does not contain any trace aromatic and other impurities like mineral oils, we have observed significant improvements in compatibility with cable sheathing plastics.

Additionally, the hydrophobicity of the SmartCoolant protects against metal corrosion seen in air-cooled IT hardware.

The SmartCoolant is 8 times more electrically resistant than air, and fully compatible with common metals and many plastics and elastomers.

Owing to its high flash point, the SmartCoolant is also **non-flammable** with an NFPA rating for flammability of 1 out of 4. This greatly reduces the risk of fires that would otherwise occur in air-cooled systems. Furthermore, the SmartCoolant protects against the damaging effects of smoke in the event of a building fire.

See Submer's SmartCoolant non-flammability in this [video](#)

SmartCoolant Property	Impact on Compatibility
<p>Extremely high dielectric strength (8 times higher than air)</p> 	<p>Eliminates short circuits and sparks</p> 
<p>Hydrophobic</p> 	<p>Prevents moisture from corroding metals</p> 
<p>High flash point</p> 	<p>Reduces fire risk compared to air and protects against smoke damage</p> 

Safety and Easy Handling

Presently, data centre maintenance and operation require **human interaction**. Although there are strong signs that **this will change in the future**, for the time being it is imperative that Immersion Cooling fluids do not pose any risk to the human operators.

The SmartCoolant is a **single phase** fluid. This means that the fluid does not evaporate and avoids the need for any expensive ventilation systems or hermetic tank designs. We take great pride in the fact that the SmartCoolant is made only from food-grade components. To demonstrate this our SmartCoolant is certified by NSF international as a HT1 food grade fluid.



Nonfood Compounds
(Category Code HT1)

*We take great pride in the fact that the
SmartCoolant is made only from
food-grade components.*

Stability

The **long term stability** of the dielectric fluid is of great interest to the user. Ideally, Immersion Cooling fluids would not lose any of their properties over time. In reality, many Immersion Cooling fluids oxidise quickly, creating particles and other contaminants in the fluid that over time reduce their dielectric properties and change the colour.

A stable, long-lasting fluid means that the end-user does not have to carry out potentially expensive and time consuming fluid changes. It also minimises the risk of unexpected fluctuations in dielectric properties that jeopardise the IT hardware.

To avoid these impurities, the SmartCoolant comes from an entirely synthetic origin. That is, the molecules in the SmartCoolant are created in a specific chemical reaction, avoiding any undesirable impurities.

Many fluids oxidise quickly because of initial impurities in the fluid that act as either catalysts or are themselves oxidised. These impurities are inherent to the source of mineral oils and vegetable oils and cannot be removed even after heavy refining.

To ensure that the SmartCoolant remains stable **throughout the lifespan of a datacenter**, we decided to tackle stability from a molecular perspective. To avoid these impurities typically found mineral oils and vegetable oils, the SmartCoolant comes from an entirely synthetic origin. That is, the molecules in the SmartCoolant are created in a specific chemical reaction, avoiding any undesirable impurities.

Biodegradability

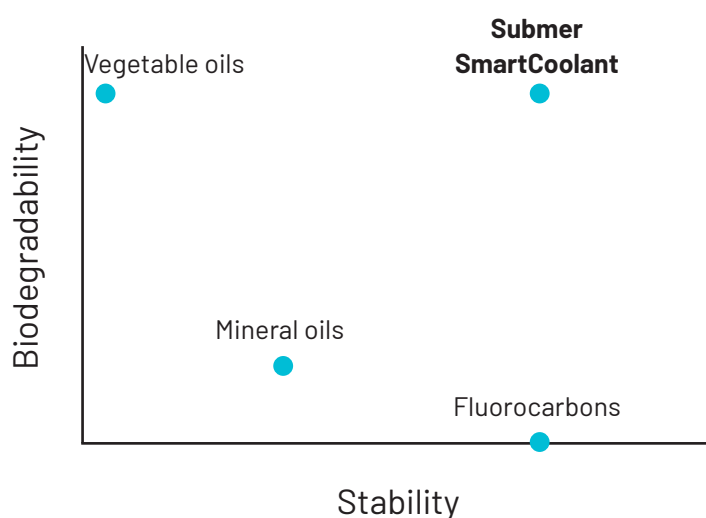
Good design practice dictates that one should not solve a problem by creating another. Immersion Cooling technology, when adopted at scale, needs to consider the **full lifecycle of all materials**. It is therefore imperative that all Immersion Cooling fluids be **readily biodegradable**. But what does this mean?

A fluid is biodegradable if it breaks down from its more complex molecules (hydrocarbon chains) into simpler molecules such as water, CO₂ and methane in the presence of naturally occurring enzymes and microorganisms. In the absence of this process, complex molecules may cause long-lasting problems for the environment.

Unfortunately, most of the options available in the market including mineral oils and fluorocarbon fluids are not biodegradable. In fact, fluorocarbons are known to persist indefinitely in the environment which is why they are often referred to as 'forever chemicals'.

We take great pride in the fact that our **SmartCoolant** has been **certified** as readily biodegradable as per the OECD 301 guidelines. This ensures the long term sustainability of the solution and eliminates any threat to the environment.

*Our **SmartCoolant** has been **certified** as readily **biodegradable** as per the **OECD 301 guidelines**.*



High Performance

While we have looked at the big differences between dielectric fluids, **is there really any difference in cooling performance between fluids?**

All dielectric coolants will transfer heat away from IT nodes more efficiently than air. However, differences in their thermal properties can result in real differences in performance. To put it simply, the ideal single-phase dielectric coolant will have a low viscosity, high thermal capacity and high thermal conductivity.

Based on our experience, neither fluorocarbons, nor mineral or vegetable oils strike the balance between the key thermal properties. For instance, while the viscosity of fluorocarbons is low, their thermal conductivity is very low. Similarly, while the thermal conductivity of mineral and vegetable oils, their high viscosity hampers heat transfer.

The ideal single-phase dielectric coolant will have a low viscosity, high thermal capacity and high thermal conductivity.

Considering these three properties, **we designed SmartCoolant to optimise the viscosity, thermal capacity and thermal conductivity.** By introducing the SmartCoolant in our Immersion Cooling systems, we reduced the tank temperature by three degrees compared to the previous coolant.

In the table below, you can see the thermal properties of Submer's SmartCoolant compared to other fluids.

	SmartCoolant	Fluorocarbons	Mineral oil	Vegetable oil
Viscosity @ 40°C (cSt)	5	2	12	>14
Heat capacity (kJ/kg K)	2.3	1.1	1.7	2.0
Thermal conductivity (W/m K)	0.14	0.07	0.13	0.18

In the following table, you can see a **comparison of key properties** between our SmartCoolant and other fluids.

	SmartCoolant	Fluorocarbons	Mineral oil	Vegetable oil
Material compatibility	✓			
Low volatility	✓		✓	✓
Non-toxic	✓			✓
Biodegradable	✓			✓
Oxidation stability	✓	✓		
Food grade components	✓			✓
Excellent heat transfer properties	✓			

Q&A

"Is the liquid flammable or combustible?"

No, our SmartCoolant is non-flammable and non-combustible.

"What is the lifespan of the liquid? When do you need to change it?"

The lifespan of the liquid is rated up to 15 years, and the units have filtration systems. The liquid must be removed/added when servers are added/removed to maintain the fluid level.

"What is the cost of replacing the fluid?"

Around 5€ per litre as a "topping-up" price. You would only need to replace the whole tank in the case of critical contamination (i.e.: say you drop a large amount of a contaminant into the tank!). Of course at that volume the price is lower.

"How did you solve the problem of cooling volume when you take of a lot of servers or you install them on an working unit?"

Level sensors and reservoirs allow you to manage fluid level and understand when you need to stop to top-up or remove fluid during the install or removal of large amounts of nodes.

"What is the global warming potential (GWP) of the Smart Coolant?"

The SmartCoolant is certified as biodegradable and has a GWP of 0. It is totally innocuous from a global warming perspective.



**Do you want to know more about
our clean technology? Are you
planning to switch to Immersion
Cooling and make your datacenter
smarter? Let us help you!**

Book a 30 minutes call with us and
we'll analyze and draw together
your SmartDC strategy!

BOOK A CALL