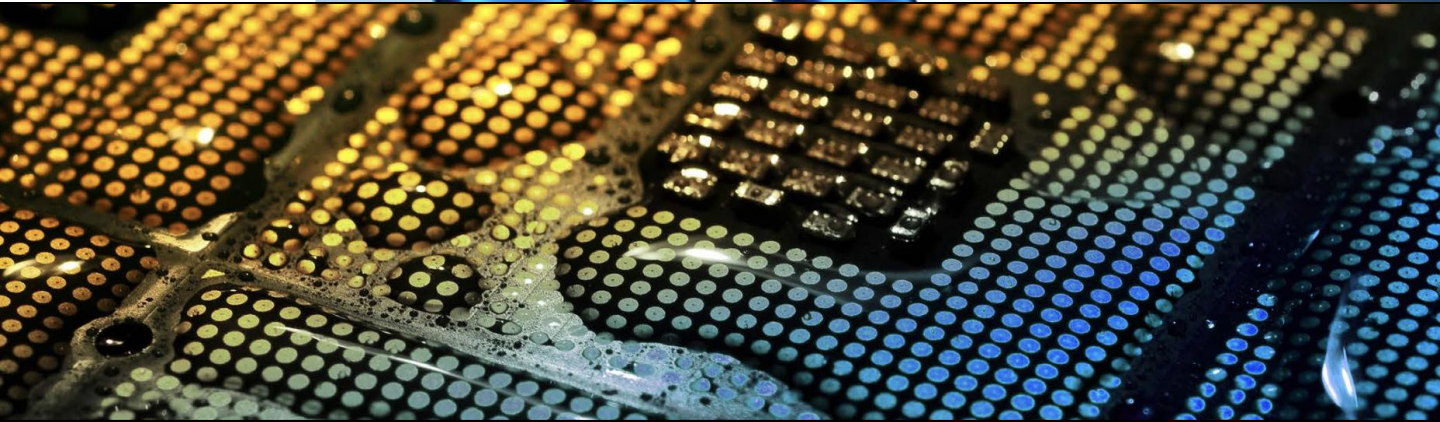


Dielectric High-Performance Chemicals

Inert dielectric **perfluorinated heat transfer fluid** for use in:

- Semiconductor manufacturing
- Transformers
- Pharmaceutical manufacturing
- Recirculating chillers
- Chemical manufacturing
- Compute cooling
- Vapor phase heating

[Read more](#)



The Future of Immersion Cooling for the AI Data Center





- Tyrell Chemical is a premier manufacturer of high-performance dielectric heat transfer fluids engineered for the rigorous demands of semiconductor manufacturing.
- Tyrell solutions are trusted by the world's largest foundries to maintain precise thermal stability and ensure the integrity of electronic circuitry during complex chip fabrication cycles.
- Tyrell has designed and developed new chemical formulas specifically designed for immersion cooling in the AI Data Center.

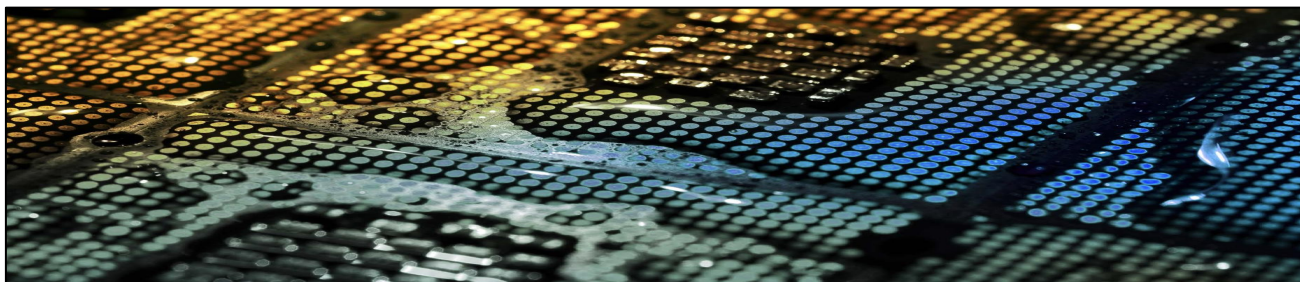


The Past and Future of Super Computing with Fluorinated Fluids.

Perfluorinated fluids have been used in computing since the early 1960's. Early concepts and patents go back to IBM in the 1960's. Cray Research would go on to pioneer immersion cooling for "high density electronic assembly" in 1982.

The Cray-2 supercomputer nicknamed "Bubbles" was released in 1985 and implemented full immersion cooling IN a submerged system using a perfluorinated fluid. Bubbles had around a 200kW peak power draw, was 7ft high and 14ft wide.

The standard methods of cooling in the compute space have been traditionally air-cooling, liquid-to-air heat exchange, or direct-to-chip liquid cooling using cold plates.



By 2019, Alibaba moved to large-scale deployment in AI Data centers in what the company described as "world's first immersion cooling server cluster in history."

In 2024, TSMC stated at its annual technology seminar that data center needs to prepare an immersive liquid cooling system for AI resulting in the need for a thorough restructuring of the data center structure.

With increasing power demand, higher density racks, and a focus on environmental sustainability, cooling in the data center may be about to change. Perfluorinated fluids used in immersion cooling will be at the center of the data center design.

Current Data Center Liquid Cooling Methods

Direct-to-Chip (Cold Plate) Cooling

Coolant is piped through cold plates mounted directly onto high-heat components like CPUs and GPUs. This is often used as a "hybrid" approach, where liquid cools the chips while supplemental air handles the remaining thermal load.

Single-Phase Immersion cooling

Using glycol based oils. (dielectric, non-conductive) liquid absorbs heat through convection as the oils circulate over components without changing states. Best for moderate to high-density applications. Simple. Ease of Maintenance. Downside is that these fluids damage and degrade electronics over longer periods.

Two-Phase Full Immersion Cooling

The original solution in HPC's were servers submerged in a non-conductive (dielectric) fluid that absorbs heat directly from all components. The Servers are placed in sealed tanks filled with dielectric coolant. The coolant absorbs heat from chips and boils, turning into gas. The vapor rises to the top of the tank, where it hits a water-cooled condenser coil. The gas liquefies and drips back into the tank, creating a continuous, passive cycle that requires no internal fans.

Uses perfluorinated fluid with a low boiling point. Provides 2-3 times the heat removal compared to Single-Phase making it extremely beneficial for high density servers.

Greatest Heat removal. Quieter. Extends life of GPU'S. Most environmental friendly solution.

	Fluorocarbon	Mineral Oil	White Oil	Vegetable Oil
Heat Transfer Effectiveness	Very Good	Good	Good	Good
Electrical insulator Characteristics	Good	Good	Good	Good
Chemical stability	Very Good	Fair	Fair	Fair
Material Compatibility	Very Good	Good	Good	Fair
Oxidation Stability	Very Good	Good	Fair	Poor
Flammability	Very Good	Poor	Poor	Good

What is Driving Change to 2 Phase Immersion Cooling?

HARDWARE DENSITY IS SKYROCKETING

TDP requirements in the H100 & H200 maxed out at 700 Watts.
The new Rubin architecture will be 2.3 kW.

A full Rubin NVL72 rack is expected to have a power density of 350 kW.

Hardware Density Trends



"Within five years, ten on the outside, there will be no alternative to immersion cooling."

- Dr. Satoshi Matsuoka, Tokyo Institute of Technology

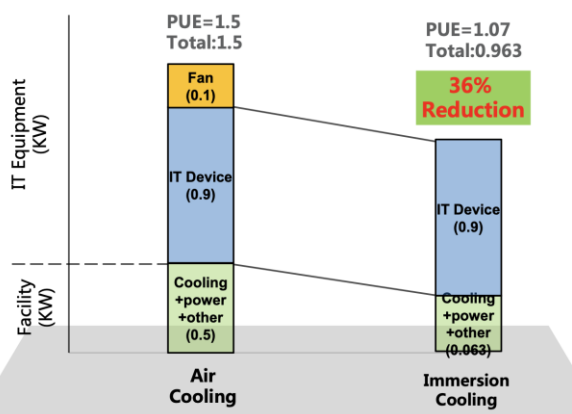
ENERGY USAGE BOTTLE NECKS.

LIFE EXTENSION OF HARDWARE

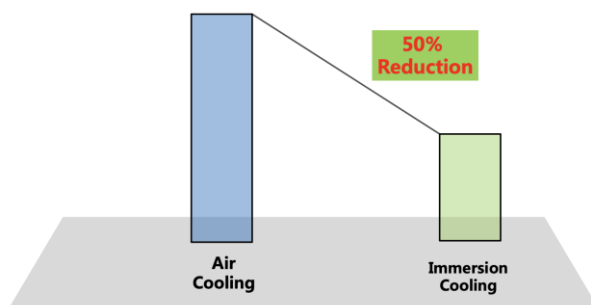
36% Energy savings have been documented in large scale deployments.

50% reduction in HDD Failure rates have been documented.

Power consumption comparison
Air-cooling Vs immersion cooling



HDD Failure rate
Air-cooling Vs immersion cooling



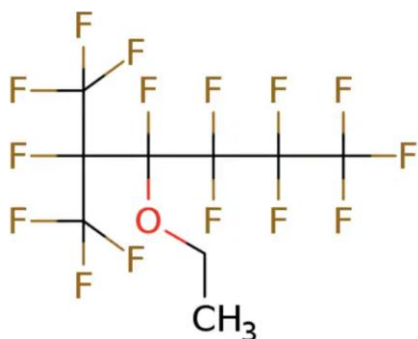
What Perfluorinated Fluids are optimized for Data Center immersion Cooling?

Hydrofluoroethers (HFE's)

Tyrell Chemical produces a line of Hydrofluoroethers optimized for AI Datacenter cooling.

Hydrofluoroethers (HFE's) are a class of synthetic organic compounds that contain carbon, hydrogen, fluorine, and oxygen atoms connected by ether linkages.

They are **not considered fully fluorinated** molecules as compared to PFPEs. They were primarily developed as environmentally friendlier replacements for ozone-depleting substances. They have high thermal stability, low toxicity, low global warming potential and zero Ozone depletion.



Fluorspar is the base material used when producing all Fluorinated Heat Transfer Flu



What does it take to do full immersion cooling?

Tyrell Chemical Full Immersion Cooling

Tyrell Chemical can fully optimize a full-immersion cooling solution for customer needs including hardware, software, tanks, plumbing and an optimized chemical formula for Super Compute or AI Datacenter.

Immersion cooling requires a system approach with regards to tanks, architecture, piping as well as monitoring and maintenance. While requiring a systems approach it can be done in small modular form in the data center or at the edge



Server architecture,
Tank sealing,
Maintainability,
Space utilization



Data center architecture
pipe layout



Monitoring and
Management system

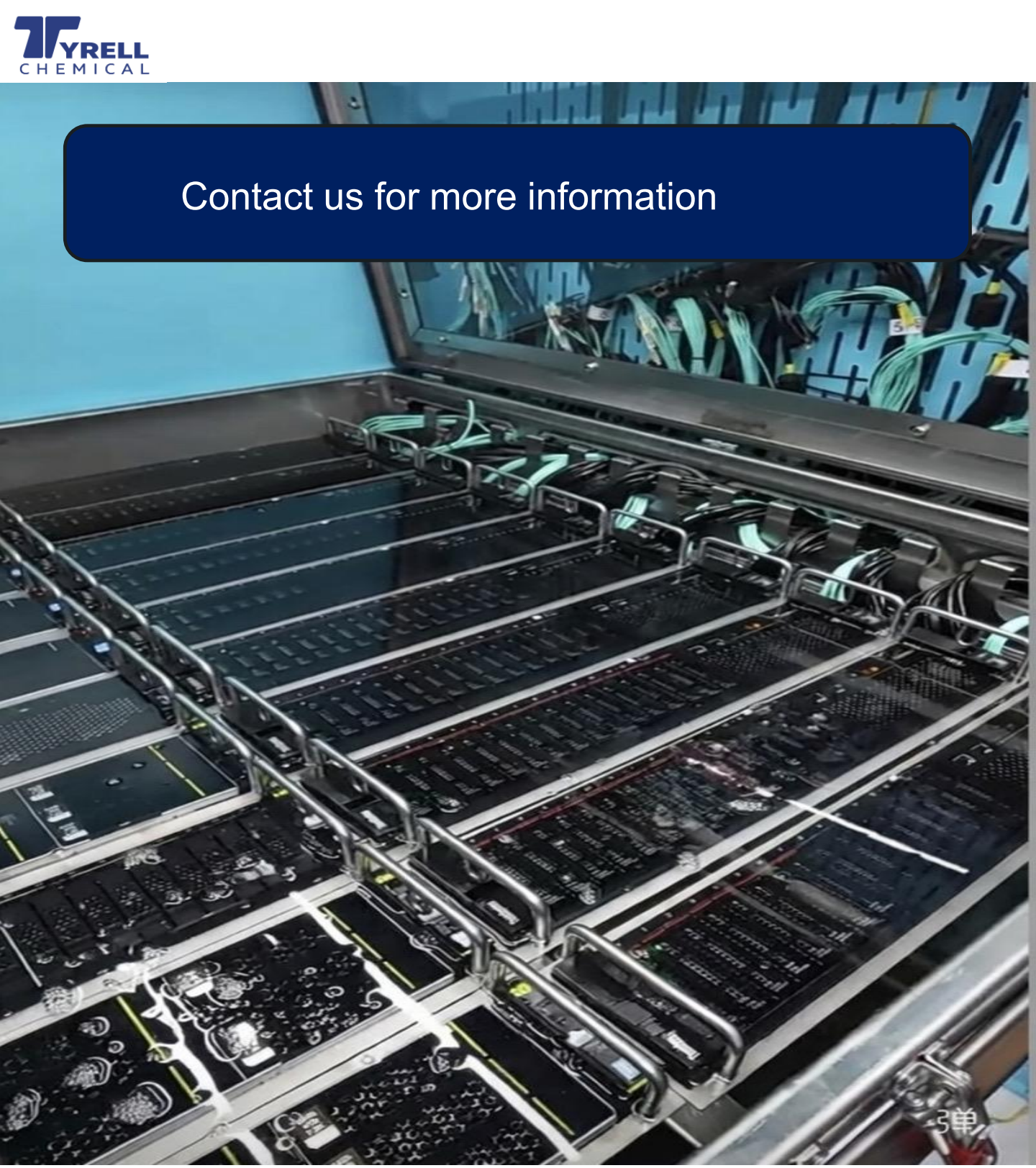
Which companies are working on immersion cooling?

Some firms that may be working on full immersion cooling are located on the graph on the right.



“Within five years, ten on the outside, there will be no alternative to immersion cooling.”

- Dr. Satoshi Matsuoka, Tokyo Institute of Technology



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