



High Performance Immersion Crypto Mining **BitCool® Dielectric Coolant**

Single-phase, Liquid Immersion Cooling for ASIC Miners

Gary Testa, President & CEO

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Engineered Fluids, Inc.

Specialized developer of Single-phase Liquid Immersion Cooling Solutions

High-Performance Biodegradable, Non-Toxic, Non-Corrosive Dielectric Coolants



AmpCool®- Dielectric Immersion Coolants for Batteries, Electric Motors and Hydraulics

- Electric motors & motor controllers
- Hydraulic power transmission and actuator systems
- Aquatic applications for pressure compensating, insulating, and lubrication
- Battery and Fuel Cell cooling & Thermal Runaway Protection in hybrid and electric vehicles



BitCool®- Dielectric Immersion Coolants designed specifically for ASIC based miners

- BitMain, MicroBT, Auradine, Innosilicon, GMO, Canaan, Ebang
- And many other miners in testing
- See our Complete [Miner Compatibility Testing](#)



ElectroCool®- Dielectric Immersion Coolants for Semiconductors and Servers

- Server / CPU / GPU / SSD / DRAM
- Lasers / LEDs / RF Amplifiers / Tubes / Processors / RADAR
- Battery / Fuel Cell cooling for Power Generation (Solar / Wind / Conventional) in stationary electrical storage applications



SubmergeDeep®- Dielectric Immersion Coolants and Lubricants, Water Intrusion Protection, and Pressure Compensation for Subsea equipment

- Pressure compensation and lubrication for Remote Operated Vehicles, Submarines, Undersea oil / gas equipment
- Water intrusion protection and pressure compensation for subsea LEDs, Lighting, Electronic Controls, and Electric Motors, and general electronic systems
- Pressure compensation and immersion cooling for Battery, Fuel Cells, Charging Systems, and Pumps



VoltCool® Additives – Specialty Maintenance and Protective Additives for use in Power and Distribution Transformers

- Highly concentrated (1:100) direct mix requires no removal or reprocessing of transformer oil to treat Power, Distribution Transformers, & Switch Gear
- Antioxidant and Corrosive Sulfur Stop Transformer Treatments provide immediate long-lasting protection
- Simple field deployment eliminates the costly downtime required by traditional polishing and crystal additives.

Engineered Fluids vs. the Competition

Our Dielectric Coolants are the safest and most effective on the market

Characteristic	EF ElectroCool™	3M Novec™	Organic Esters	Silicone Oil	Shell GTL Base Oil
Dielectric Strength (ASTM 1816)	60kV	40kV	75kV ⁽²⁾	35kV	25kV
Relative Heat Capacity (Air = 1)	1,610	1,360	1,470	1,105	1,170
Environmental Impacts ¹	GWP=0	GWP=9,000	GWP=1	GWP=0	GWP=0
10+ year Operating Life (Guaranteed)	Yes	No	No	No	No
Health and Safety (Food Grade Certification)	Yes	No	No	No	No
Biodegradable and Non-toxic	Yes	No	Yes	No	No ⁽⁵⁾
Non-corrosive to Metals	Yes	Micro-cavitation	No ⁽³⁾	Yes	Corrosive Sulfur
Material Compatibility with Electronics	Yes	No	No ⁽⁴⁾	Yes	No
Hydrophobic and Water Displacing	Yes	Highly Hydroscopic	Highly Hydroscopic	Yes	Hydroscopic
Easy to Clean / Remove from Devices	Yes	Evaporates	Yes	No	No
Purpose-Built, Tested and Guaranteed	Yes	No	No	No	No
Material Compatibility Guarantee	Yes	No	No	No	No
Immersion Device Warranty Available	Yes	No	No	No	No
5yr and 10yr Characteristic Warranties Available	Yes	No	No	No	No
Cooling Systems are Simple, Quiet, and Clean	Yes	No	Yes	No	No

Competitive Notes

- 1) GWP – Global Warming Potential. GWP is a measure of how long a product once it evaporates remains in the atmosphere and acts as a green house gas. For reference, carbon dioxide possesses a GWP of 1, and the GWP of methane is 36.
- 2) Natural Ester - The published value of dielectric strength of 75kV is technically possible, however based on actual testing of product samples provided to us by customers it averages <50kV from sealed original containers, and then quickly degrades to stabilize at ~35kV. This is due to the absorption of moisture from the surrounding air due to the highly hydroscopic nature of esters. Esters used as dielectric cooling fluids (such as power transformers) always require a fully sealed system where the ester is protected from moisture and air by the use of noble gas or nitrogen “blankets” where the gas blanket displaces the air in the system. This is a costly maintenance feature generally presents the use of open containers with esters.
- 3) Natural Ester – Esters are not a stable final reaction product; they are a mid-point reaction product that is not inherently stable, and esters are prone to a process called “hydrolytic instability” in which the molecule unzips in the presence of heat and water. Esters are highly hydroscopic, meaning that they readily absorb moisture and will hold large amounts (>500ppm vs less than 60ppm for EF) of water in suspension. This moisture combined with heat over 50C can cause the chemical reaction to revert to the base Acids and Alcohols that form the building blocks of an Ester. The acids formed, such as Heptanoic acids, are corrosive to common light metals such as tin, solders, copper, aluminum, etc. The alcohols will evaporate off thereby increasing the concentration of acids further accelerating the breakdown of the ester. In addition, copper acts a catalyst for these reactions.
- 4) Natural Ester – Esters are used in the manufacture of plastics and rubbers to soften them and provide flexibility. The same properties that provide this beneficial characteristic cause plastics and rubbers to become overly soft, gummy, and break down when immersed in esters. This is a particularly damaging to plastic connectors which lose their structural integrity and to electrolytic capacitors. Rubber plugs are used in all electrolytic capacitors (they keep the electrolyte in the capacitor), esters cause the plugs in electrolytic capacitors to degrade, thereby leaking the electrolyte out of the capacitor, this then causes catastrophic device failures, most typically in power supplies and power ICs. It may take 9-12mths before failure, but the process cannot be reversed. The only way to protect against this type of damage is similar to the process required with Novec which is that the entire circuit board and components must be coated with a protective material to prevent the ester from coming into contact with the plastics and rubbers. Such conformal coatings are expensive, time consuming, and also negatively impact the thermal performance of the components.
- 5) Mineral oils contain sulfur and phosphates which can cause sever allergic reactions including skin dermatitis and respiratory distress due to skin contact with the fluid and the evaporation of the oil into the air. Shell products in particular have a high rate of allergenic reactions.

BitCool® Coolants vs other Dielectrics

Dangers of Mineral Oil and White Oils when used as a Dielectric Fluid

Mineral Oil is highly flammable and subject to hazardous material storage requirements

The flashpoint of mineral oil is 135C and is considered a flammable and hazardous material subject to all Occupational Health and Safety regulations including maximum storable quantities, building codes, handling regulations and state and local permits for use and storage.

Mineral Oil is toxic and a known carcinogen in humans

The National Toxicology Program: *"Untreated and mildly treated mineral oils are known to be human carcinogens based on sufficient evidence of carcinogenicity from studies in humans."*

Mineral Oil is not biodegradable and must be handled and disposed of as a toxic material under OSHA regulations and the EPA.

"Thirty days before any person burns mineral oil dielectric fluid in the boiler, the person gives written notice to the EPA Regional Administrator for the EPA Region in which the boiler is located"

Mineral Oils contain sulfur, phosphates, and other impurities which are highly allergic

Direct skin contact with mineral oils can cause sever skin reactions including skin dermatitis other skin rashes. Evaporated mineral oil can also cause respiratory distress through allergenic reactions of the bronchial tract.

Mineral Oils contain sulfur which turns to copper salts through corrosion and can short circuit electronics

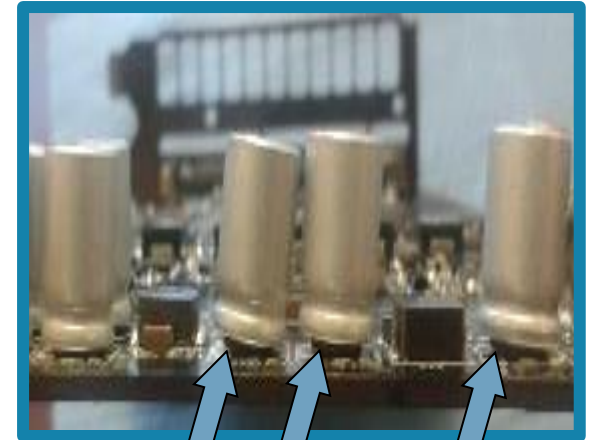
Mineral oils undergo little if any processing after refining. Sulfur is a naturally occurring substance in hydrocarbons and is not removed during refining. This sulfur is activated by heat in the presence of copper and zinc and eats away at these metals while also forming copper salts. The copper salts are deposited on board traces and cause shorting and device failures.

Mineral Oil is not guaranteed to meet any operational characteristics

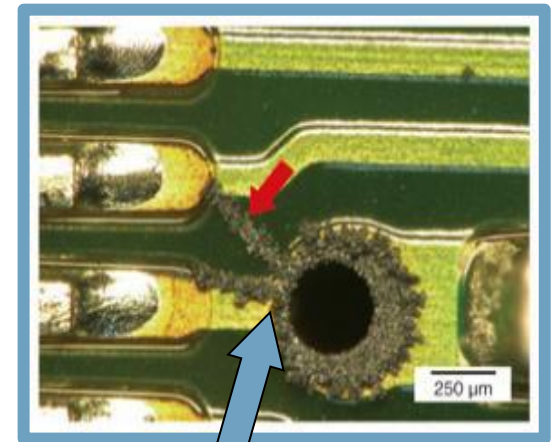
Mineral oils are commodities made by many oil refineries. Their compatibility profiles differ widely from one brand to another, and operational characteristics differ from batch to batch. They are sold without any guarantee of critical dielectric characteristics.

Mineral Oil is incompatible with some common semiconductors components and materials

This board was immersed in mineral oil for about 4mths. Material incompatibility caused swelling of rubber gasket material in the capacitors on this Nvidia Tesla K80 GPU. This swelling caused the boards to fail due to the capacitors breaking off the board.



Failed Capacitors due to Material Compatibility Issues



Copper Salt Buildup on Metal Circuits Leading to Catastrophic Device Failure

SLICTank Crypto Immersion Module



2x SLICTank Module – 675kW Total Module Capacity



Module achieves a PUE of <1.05 year-round.



For more information...

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