



Dielectric fluids
for safer, cooler, greener
high performance EV batteries.



THE FUTURE OF ELECTRIC VEHICLES

The adoption of Electric Vehicles (EVs) is dependent on satisfying consumer expectations.

It is estimated that there will be over 21 million EVs on the road globally by 2030. In order for the transition to EVs to be as smooth as possible in-line with customer expectations, a number of concerns need to be addressed by EV and battery OEMs, namely:

1. **Range anxiety** - the number of miles covered by a single charge must be as high as possible.
2. **Performance** - EVs need to perform as well as their Internal Combustion Engine (ICE) counterparts. Charge times must also be reduced.



Thermal management of EV battery systems is key to unlocking the current issues surrounding the EV industry.

If battery system performance can be maximised, the anxieties faced by customers will be alleviated as:

- Power capacity will be higher
- Vehicle range will be increased
- Faster charging will be possible
- Battery life will be longer

Battery system performance can be maximised when cells are immersed in MIVOLT - a new range of liquids for the immersive cooling of battery cells. The unique chemistry of MIVOLT fluids allows them to act as a dielectric coolant, removing heat directly from all areas of a battery cell surface.

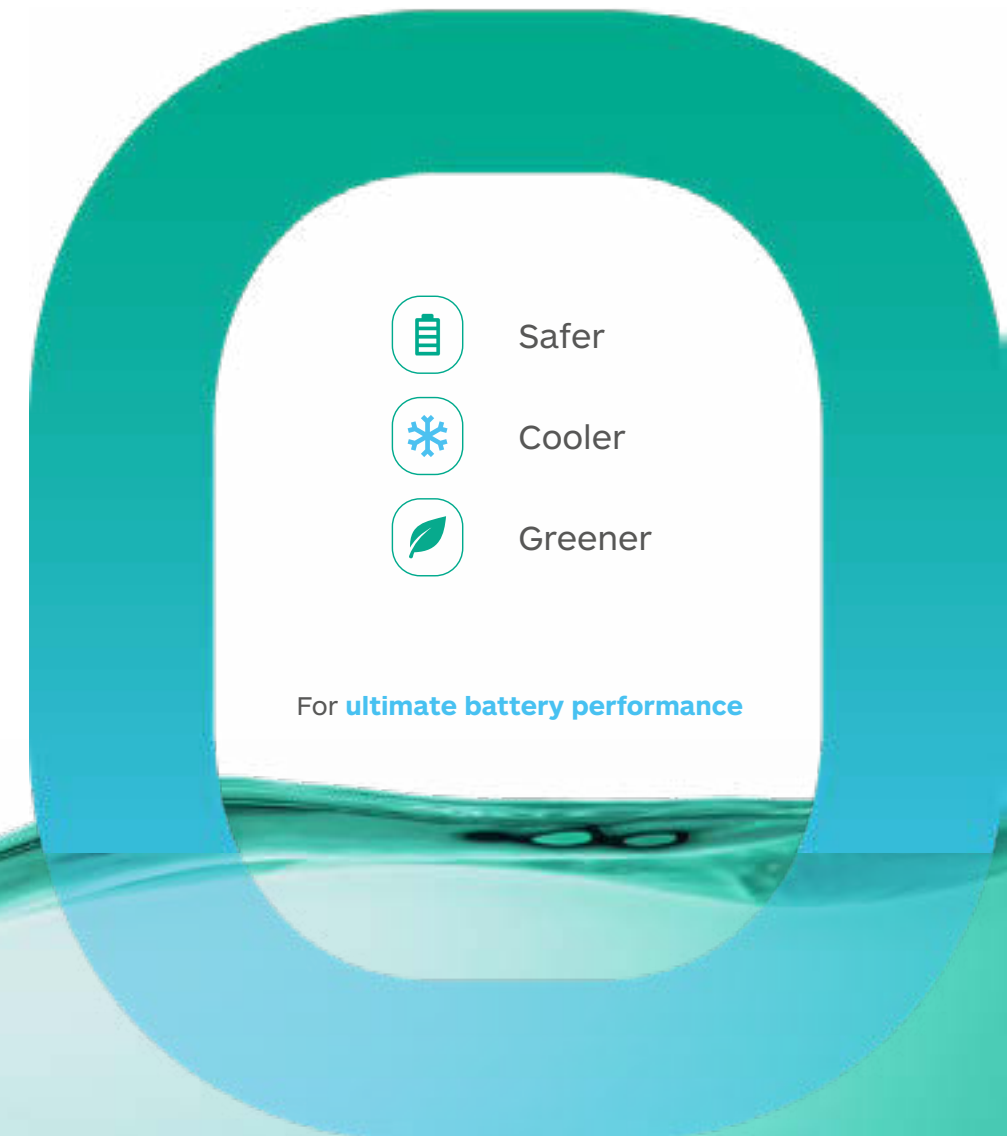
EV BATTERY COOLING WITH MIVOLT

Enabling the next generation of EV battery systems.

The MIVOLT range of dielectric fluids have been given a robust chemistry that makes the design and engineering of battery systems simpler, safer and more efficient. The unique properties within the formulas maximise thermal management performance to achieve efficient temperature control of battery packs. This allows not only a higher power to weight ratio, it makes starting up an EV in extremely cold climates possible and increases the lifespan of battery cells.

MIVOLT's dielectric fluids do not conduct and can therefore come into direct contact with battery packs. Direct liquid immersion cooling with MIVOLT means that heat transfer begins at the source with no reliance on a secondary indirect cooling system. Direct liquid immersion cooling inherently enables a simpler thermal management solution, negating the need for complex systems.

With its readily biodegradable characteristics, the MIVOLT range cools battery systems with minimal environmental impact.





READILY BIODEGRADABLE FLUIDS

The MIVOLT range
minimises health
and environmental
impacts.



MIVOLT PRODUCT SELECTOR

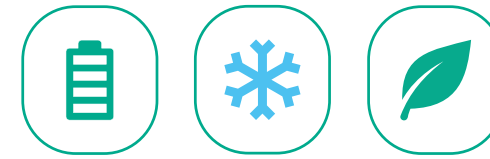
MIVOLT DF7 and DFK dielectric fluid properties.

The data presented in these tables are typical values.

MIVOLT[®] DF7

- + Low viscosity
- + Readily Biodegradable
- + Extremely low pour point -75°C
- + Non-volatile
- + Halogen free
- + Non-toxic

Thermal Properties	Units	Method	MIVOLT DF7
Density at 20°C	kg/m ³	ISO 3675	916
Specific Heat at 20°C	J/kg-K	ASTM E1269	1907
Kinematic Viscosity at 20°C	mm ² /s	ISO 3104	16.4
Thermal Conductivity at 20°C	W/m-K	ASTM D7896	0.129
Coefficient of Expansion at 20°C	1/K	ASTM D1903	0.00080
Cold Behaviour			
Kinematic Viscosity at -10°C	mm ² /s	ISO 3104	87.4
Kinematic Viscosity at -30°C	mm ² /s	ISO 3104	534
Pour Point	°C	ISO 3016	-75
Fire Safety			
Flash Point	°C	ISO 2719	194
Fire Point	°C	ISO 2592	218
Auto-Ignition Temperature	°C	ASTM E659	385
Environmental Impact			
Biodegradability		OECD 301	Readily Biodegradable
Global Warming Potential	GWP		<1
Ozone Depleting Potential	ODP		0
Chemical Properties			
Neutralisation Value	mg KOH/g	IEC 62021-2	<0.03
Net Calorific Value	MJ/kg	ASTM D 240-02	33.5
Dielectric Properties			
AC Breakdown Voltage	kV	IEC 60156	>75
Volume Resistivity at 20°C	GΩ.m	IEC 60247	>90



Biodegradable dielectric fluids for direct immersion cooling of battery systems.

MIVOLT[®] DFK

- + High fire point (>300°C)
- + Readily biodegradable
- + Low pour point
- + Non-volatile
- + Halogen free
- + Non-toxic

Thermal Properties	Units	Method	MIVOLT DFK
Density at 20°C	kg/m ³	ISO 3675	968
Specific Heat at 20°C	J/kg-K	ASTM E1269	1902
Kinematic Viscosity at 20°C	mm ² /s	ISO 3104	75
Thermal Conductivity at 20°C	W/m-K	ASTM D7896	0.147
Coefficient of Expansion at 20°C	1/K	ASTM D1903	0.00075
Cold Behaviour			
Kinematic Viscosity at -10°C	mm ² /s	ISO 3104	572
Kinematic Viscosity at -30°C	mm ² /s	ISO 3104	4362
Pour Point	°C	ISO 3016	<-50
Fire Safety			
Flash Point	°C	ISO 2719	>250
Fire Point	°C	ISO 2592	>300
Auto-Ignition Temperature	°C	ASTM E659	>400
Environmental Impact			
Biodegradability		OECD 301	Readily Biodegradable
Global Warming Potential	GWP		<1
Ozone Depleting Potential	ODP		0
Chemical Properties			
Neutralisation Value	mg KOH/g	IEC 62021-2	<0.03
Net Calorific Value	MJ/kg	ASTM D 240-02	30.8
Dielectric Properties			
AC Breakdown Voltage	kV	IEC 60156	>75
Volume Resistivity at 20°C	GΩ.m	IEC 60247	>90



**LIQUID
IMMERSION
COOLING**

**FOR ULTIMATE
BATTERY
PERFORMANCE**

A HERITAGE IN MATERIALS SCIENCE

MIVOLT is liquid engineered by M&I Materials Ltd.

M&I Materials is an independent, privately owned British company committed to developing specialised materials for challenging applications, and whose roots can be traced back to 1901.

Having started out manufacturing 'Micanite' products for electrical insulation, the company has reinvested in its capabilities throughout its history, having engineered its first dielectric fluid range over 40 years ago.

With the MIVOLT range of immersion cooling fluids, M&I Materials continues to grow its portfolio, building on a reputation for innovative products and superior technical knowledge.



TRUSTED BY LEADING ORGANISATIONS

Material innovations for demanding applications.

Globally, M&I Materials supplies to a wide range of sectors, from power and aerospace, to nuclear medicine and high-performance motorsports.

From its Trafford Park headquarters in the UK, M&I Materials exports its specialist products to 60+ countries around the globe.

This is made possible by the company's growing network of production facilities and commercial premises across the Americas, Africa, Middle East, Europe and Asia Pacific.

Offices

- UK
- USA
- India
- China
- South Africa

Manufacturing Locations

- UK
- USA
- India
- South Africa



MIVOLT®

IMMERSION COOLING LIQUIDS

a product of  **M&I MATERIALS**

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