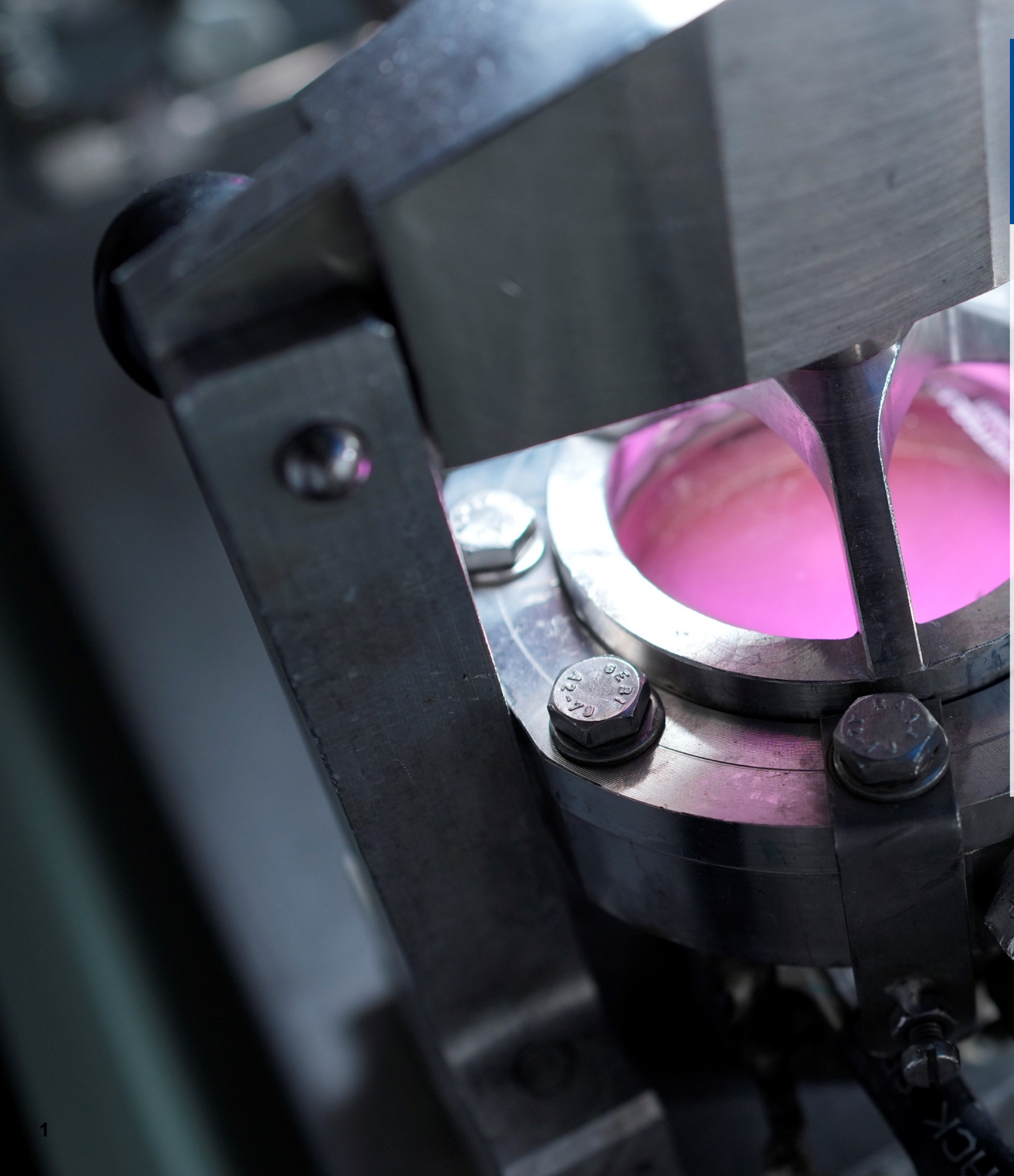

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on December 9, 2021

# Keeping electric vehicles safe and cool

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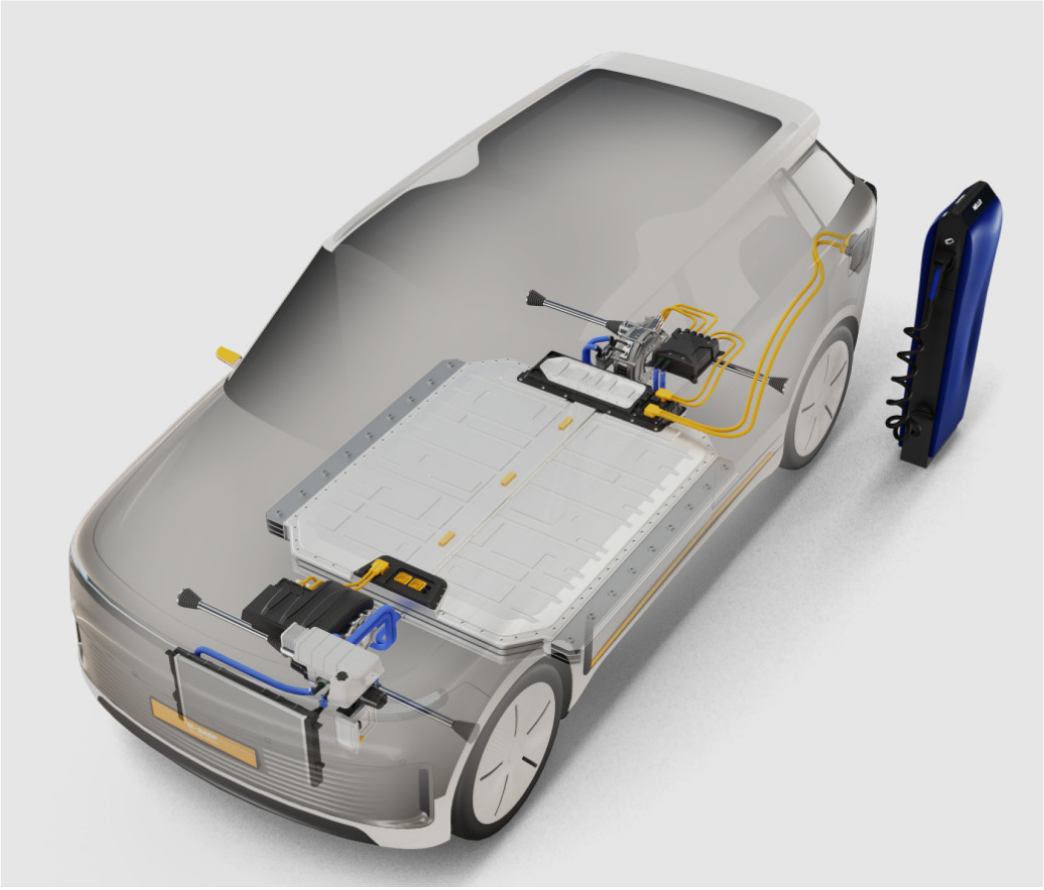
Senior Manager Technical Marketing
Automotive Fluids

# Making a contribution to global $CO_2$ emission goals

- The battery represents one the of highest value parts in the electric vehicle, in terms of financial as well as natural resources
- Longevity of the battery is key for a sustainable e-mobility future and depends on optimal thermal management
- Coolant technologies need to address additional requirements
  - Battery heating
  - Corrosion protection in a broader temperature window
  - Battery safety
  - Electrical conductivity



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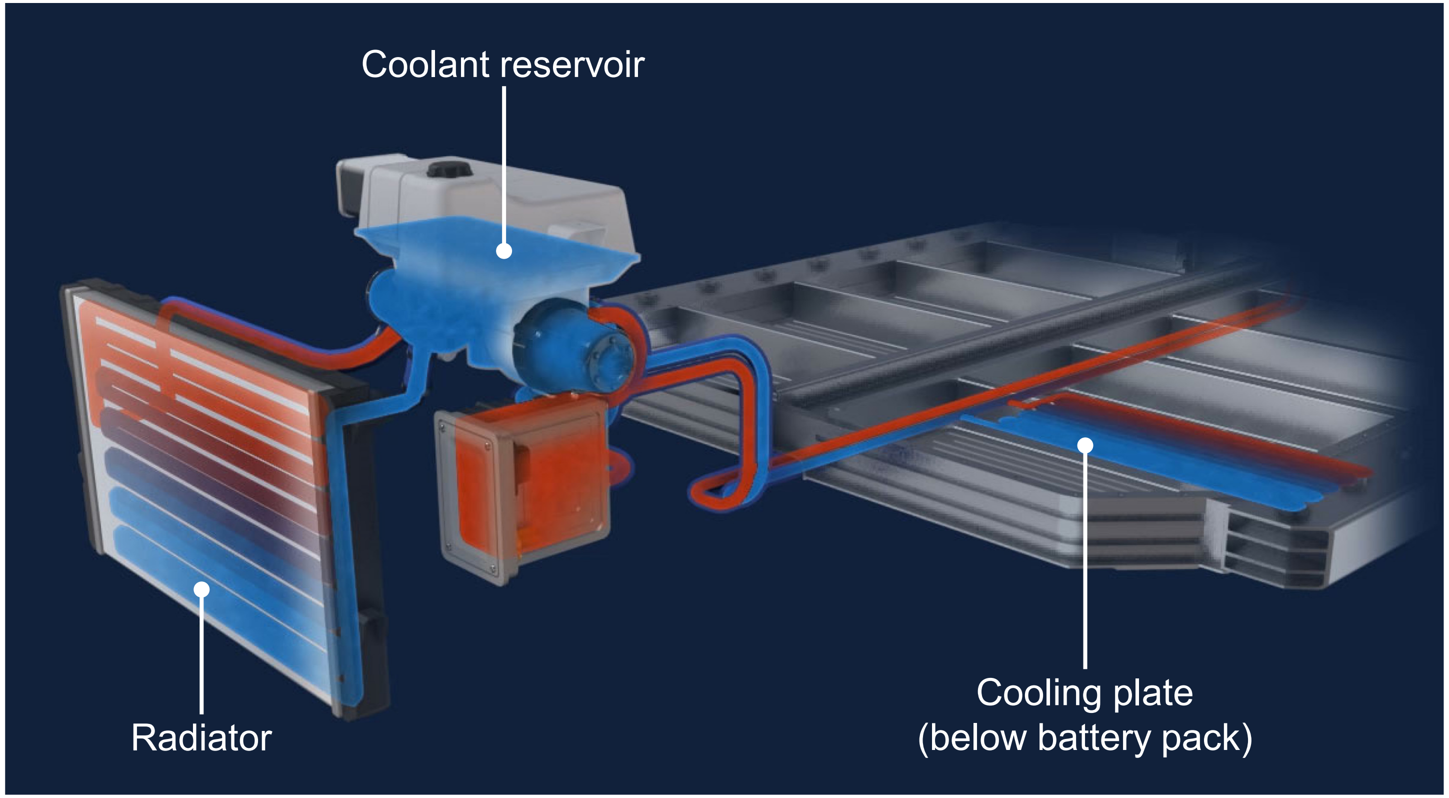
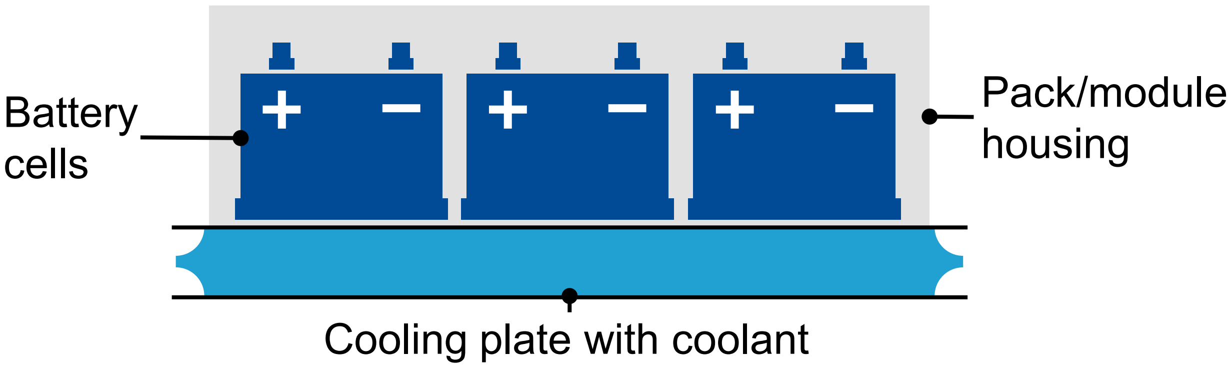
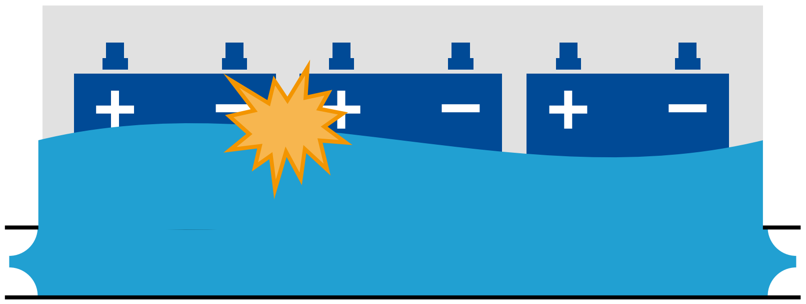
# Liquid cooling for thermal management of the battery

- Battery electric vehicles (BEVs) rely on a thermal management system (TMS) for optimal operating conditions
- Heat dissipation from the battery pack is typically achieved through cooling plates or pipes
- Glycol/water-based coolants represent the predominant fluid technology
- Coolant volume in BEVs is twice as high compared to internal combustion engines (ICE)



# Assessing safety aspects of indirect cooling



**Scenario:** Regular driving, parking, charging, etc.

- No direct contact between coolant and battery cell
- **Safe condition and operation**

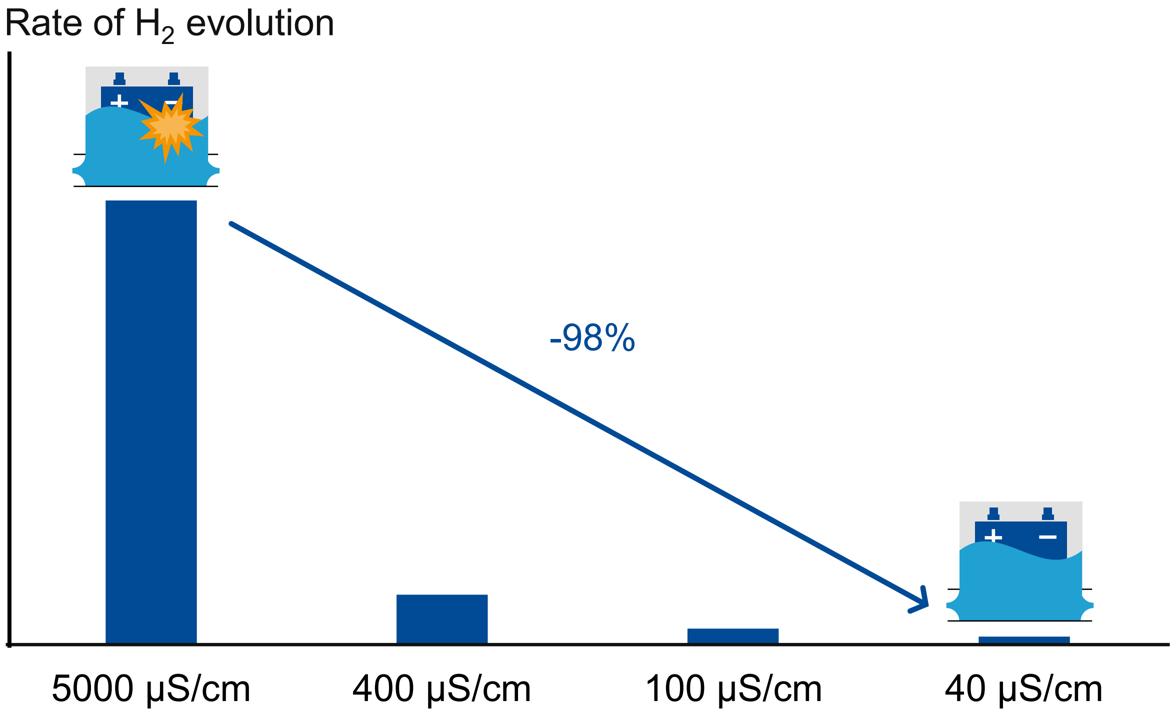
**Scenario:** Car crash, system failure

- Direct contact between coolant and battery cell
- $H_2/O_2$ generation in the presence of water and conducting fluid
- Self-discharge and leak currents
- **Worst case: overheating, fire, explosion**

# Towards safer indirect cooling

- The rate of electrochemical hydrogen ($H_2$) generation depends on the electrical conductivity of the coolant
- Conventional glycol/water coolants exhibit electrical conductivities of up to 5000 µS/cm, resulting in high $H_2$ evolution tendency
- Lowering the electrical conductivity in the glycol/water system results in significantly lower $H_2$ evolution tendency

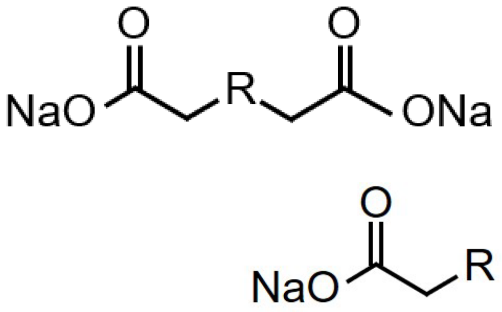
## Rate of $H_2$ evolution vs. coolant electrical conductivity




**Minimize threat of critical $H_2$ evolution by lowering the coolant's electrical conductivity**

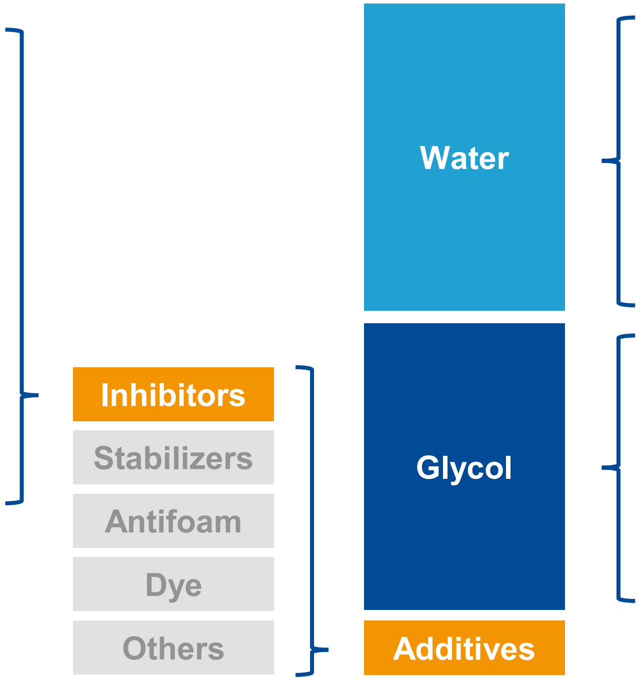
# Design challenge: low electrical conductivity coolant

**Corrosion inhibitors**
ionic components

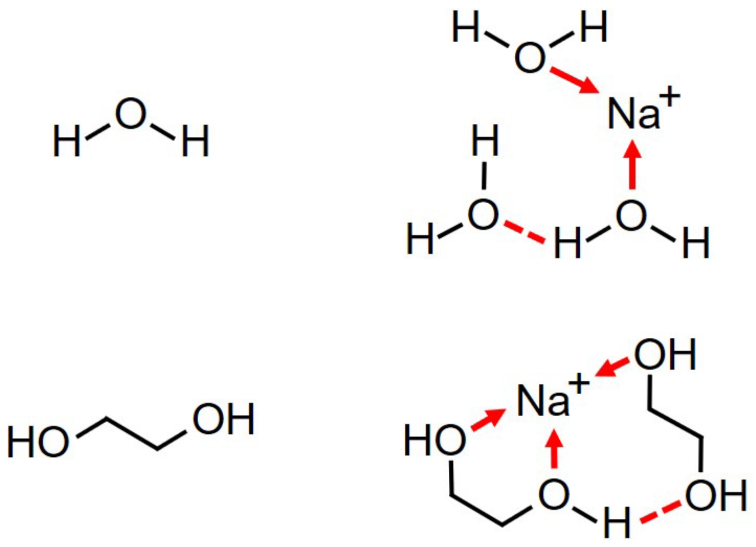



$SiO_3^{2-}$, $PO_4^{3-}$, $NO_3^{-}$, etc.

**Typical coolant composition**

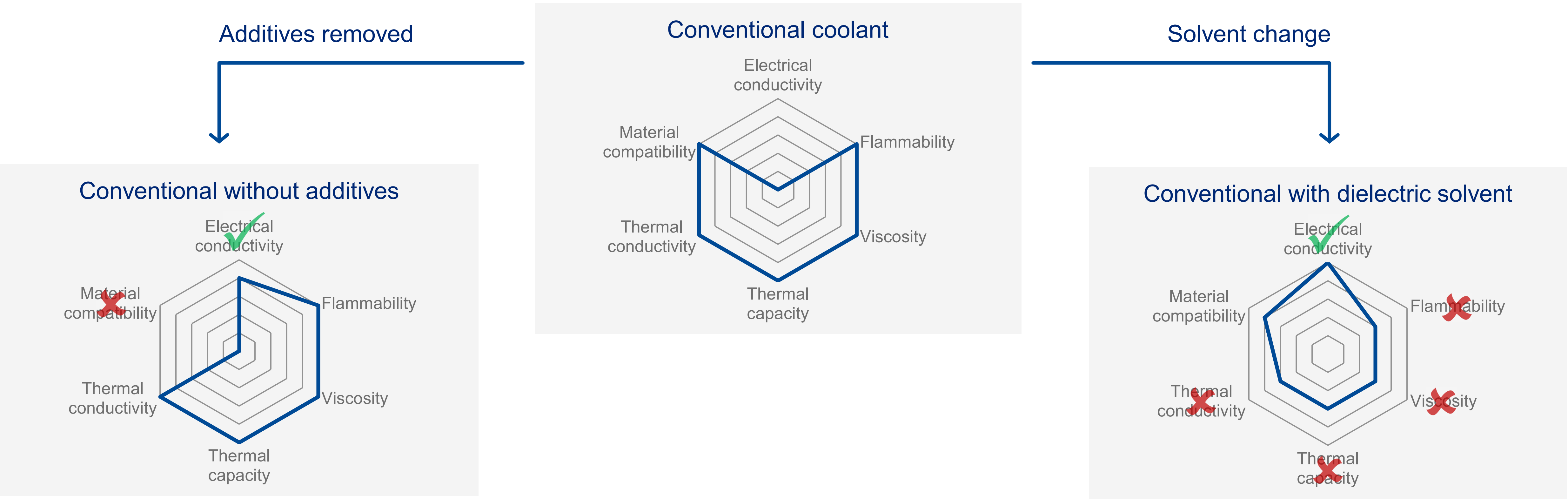



**Solvents**
high polarity and good ion solvation




## Typical coolant ingredients lead to high electrical conductivity

# Small changes to the coolant composition have big effects




## Performance parameters are interconnected, careful adjustment is key

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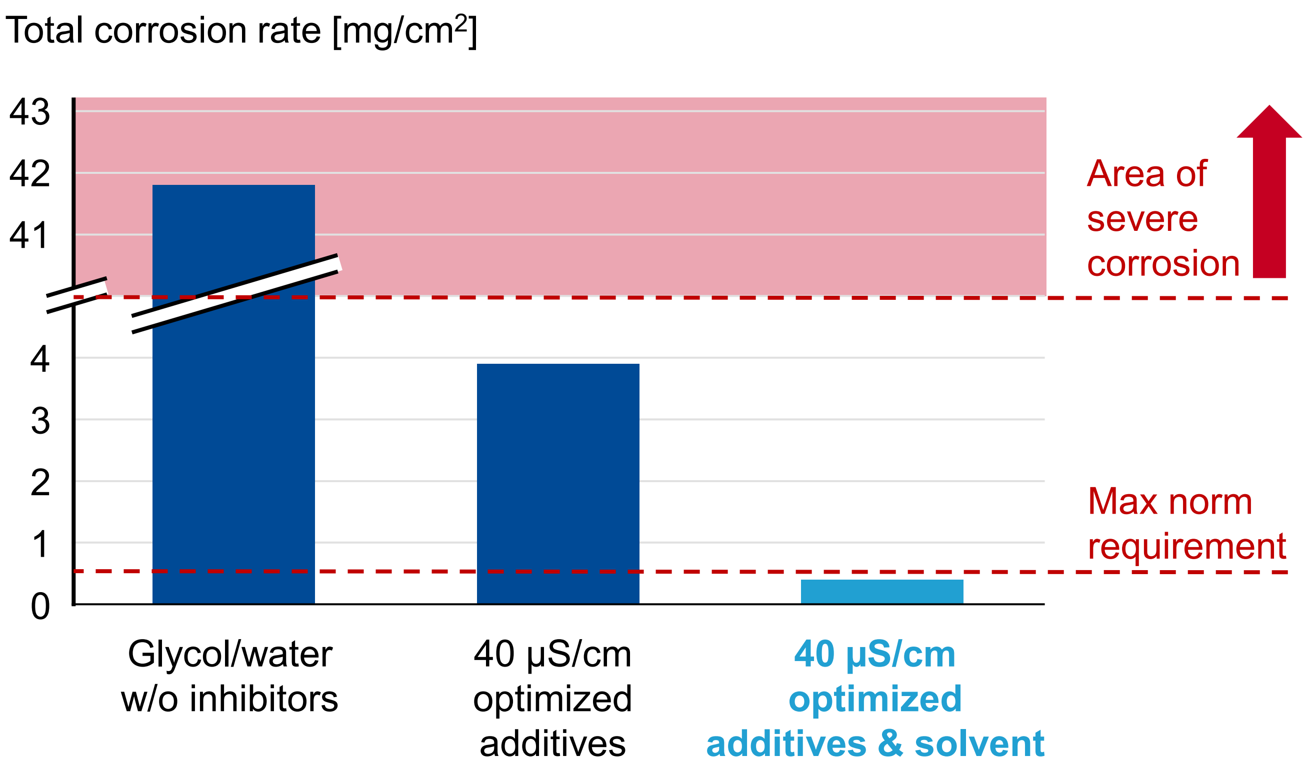
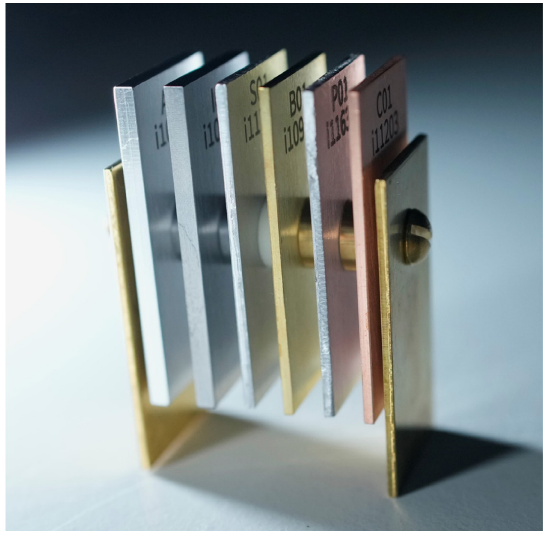
# Optimization for a low electrical conductivity coolant




- Use of corrosion inhibitors with low contribution to electrical conductivity
- Less polar solvents help to increase corrosion inhibitor content

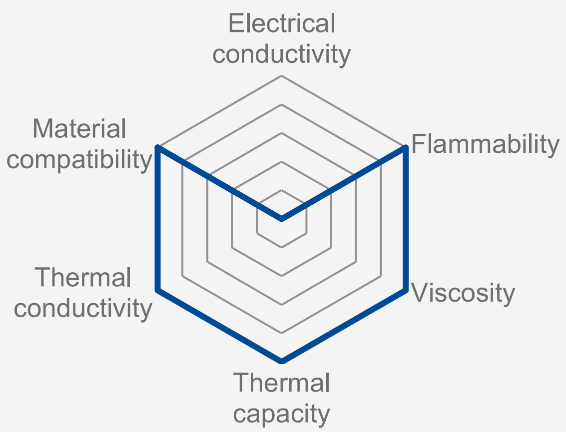


Corrosion test specimen

## Non-ionic additives and lower polarity solvent enable good corrosion protection at low electrical conductivity

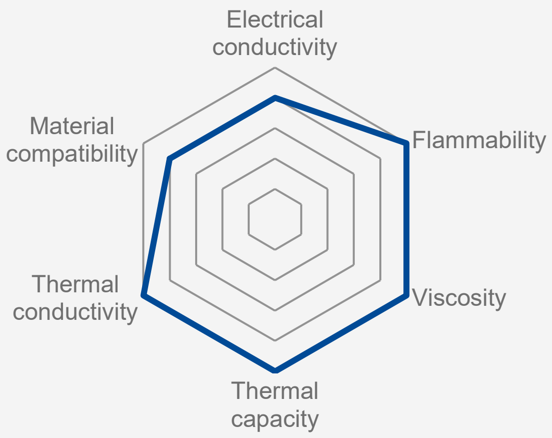
# Fully functional coolant with safety benefit

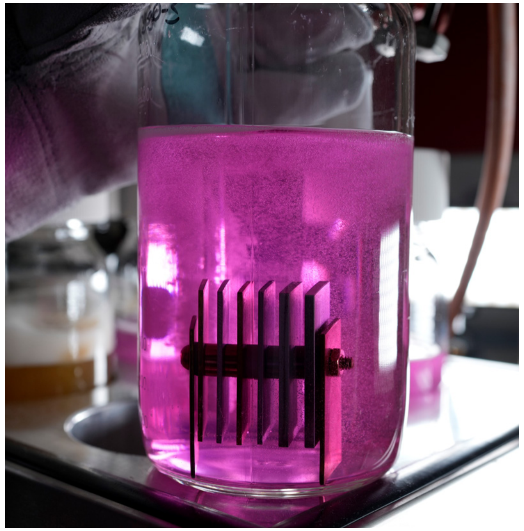
Conventional coolant




Optimization of additives and solvent

40 µS/cm coolant



Corrosion test

# BASF battery coolants – next steps

## Our contribution to sustainable mobility

**2021**

Technology push:
Launch of GLYSANTIN®
Electrified™ product family

Der Schutz-Garant.
GLYSANTIN® ELECTRIFIED™

**2022**

Addition of further low electrical conductivity coolants to the portfolio

**2023**

OEM approvals for low electrical conductivity coolants

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