Keeping electric vehicles safe and cool

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Making a contribution to global CO$_2$ emission goals

- The battery represents one of the 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
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
- $\text{H}_2/\text{O}_2$ 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 (H₂) 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 H₂ evolution tendency.
- Lowering the electrical conductivity in the glycol/water system results in significantly lower H₂ evolution tendency.

Minimize threat of critical H₂ evolution by lowering the coolant’s electrical conductivity.
Design challenge: low electrical conductivity coolant

Typical coolant composition:
- Water
- Glycol
- Solvents (high polarity and good ion solvation)
- Inhibitors
- Stabilizers
- Antifoam
- Dye
- Others

Corrosion inhibitors:
- Ionic components
  - SiO$_3^{2-}$, PO$_4^{3-}$, NO$_3^-$, etc.

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
Optimization for a low electrical conductivity coolant

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

- Use of corrosion inhibitors with low contribution to electrical conductivity
- Less polar solvents help to increase corrosion inhibitor content
Fully functional coolant with safety benefit

Conventional coolant

- Electrical conductivity
- Flammability
- Viscosity
- Thermal conductivity
- Thermal capacity
- Material compatibility

40 µS/cm coolant

- Electrical conductivity
- Flammability
- Viscosity
- Thermal conductivity
- Thermal capacity
- Material compatibility

Optimization of additives and solvent

Corrosion test
BASF battery coolants – next steps
Our contribution to sustainable mobility

2021
Technology push:
Launch of GLYSANTIN®
Electrified™ product family

2022
Addition of further low electrical conductivity coolants to the portfolio

2023
OEM approvals for low electrical conductivity coolants