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# Development of low conductivity coolant for battery electric vehicle

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$CO_2$ emissions reduction from vehicles is an urgent issue for preventing global warming, and vehicle manufacturers are making various efforts to achieve carbon neutrality by 2050. In recent years, BEVs have been attracting significant attention as carbon neutral vehicles that can reduce $CO_2$ emissions to zero through the use of clean energy.

Key elements required for BEVs include sufficient cruising distance regardless of the season, long-term battery capacity retention, and fast charging. The battery cooling system plays a major role in these elements. Water-cooling is widely used as a battery cooling system for BEVs. In the water-cooled system, the coolant used in engine vehicles can be used for BEVs as a heat transfer medium during cooling. This coolant contains a large amount of additives, therefore it has a high conductivity such as sea water.

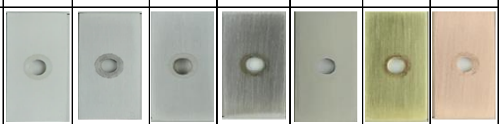
If such coolant leaks in the event of a car accident or cooling system failure, it may cause a short circuit in the battery, afterwards it could lead to abnormal overheating. In this study, we have developed the low-conductivity coolant for BEVs that helps prevent abnormal overheating of the battery even in the event of coolant leakage.

Coolant for engine vehicles must have the following functions: cooling performance, anti-corrosion performance, and anti-freeze performance. The one for BEVs is required to have both high anti-corrosion performance and low conductivity due to additives. Based on the above, the following four development goals were defined and studied in this development.(1) Low conductivity, (2) Anti-corrosion performance, (3) Compatibility with cooling system parts, and (4) Cooling performance and antifreeze properties.

Ethylene glycol is used in coolants for engine vehicles from the viewpoints of parts compatibility, cooling performance, and antifreeze properties. The same concept was used for the low conductivity coolant, where ethylene glycol solution was selected as the base material, and additives were used to suppress ionic leachate from the parts, which is the cause of increased conductivity. Ionic additives are generally used as additives. However, reduction of ionic components is essential for low conductivity. The coolant design concept was to use mainly non-ionic corrosion inhibitors, supplemented by a small amount of ionic corrosion inhibitors.

Ion elution from metal parts, rubber parts, and flux (a manufacturing aid for aluminum parts) must be suppressed. Additives were examined comprehensively for each of these and the corrosion inhibitor recipe was optimized. The initial conductivity was 45 μS/cm, and the anti-corrosion performance was equal to conventional coolants as evaluated by ASTM standard tests (Fig. 1).

We successfully achieved both high anti-corrosion performance and low conductivity by optimally blending a non-ionic corrosion inhibitor and the minimum required amount of ionic corrosion inhibitor. The use of low conductivity coolant helps to prevent abnormal overheating of batteries even in the event of coolant leakage. We believe that this will contribute to the spread of safer BEVs.

| Metal material | Al | | | Fe | | Cu | |
|---|---|---|---|---|---|---|---|
| | A3003 | ADC12 | AC2A | SPCC | SUS304 | C2680 | C1100 |
| Appearance |  | | | | | | |
| weight loss by corrosion mg/specimen | -0.2 | ±0.0 | -0.2 | +1.0 | -0.3 | +0.7 | +0.9 |
| ASTM draft requirement | ○ | | | ○※ | ○ | | ○ |
| Original standard | | ○ | ○ | ○ | | ○ | |

※This requirement is currently exeptional

Fig.1 Metal corrosion test by low conductivity coolant

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