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# Development of a thermal management system for a new BEV

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In conventional battery electric vehicles (BEVs), cabin heating typically relies on positive temperature coefficient (PTC) electric heaters, and battery thermal management is commonly based on air cooling or simple water cooling systems. However, such independent thermal systems tend to increase power consumption during heating and degrade fast charging performance. This study aims to integrate the thermal systems of the cabin, battery, and powertrain and to make effective use of limited thermal energy, thereby achieving both comfort and high energy efficiency.

In the thermal management system of the new BEV, the powertrain cooling circuit and the battery thermal management circuit are connected via a four-way valve, and further configured so that heat exchange with the cabin refrigerant circuit is possible through a chiller. By switching and coordinating these circuits according to driving conditions and thermal demands, the system enables optimal distribution of thermal energy at the vehicle level. Specifically, by repurposing heat loss from the electric powertrain and the on-board charger (OBC) as heat sources for cabin heating and battery thermal management, the system achieves higher energy efficiency than conventional systems.

In addition, the new BEV is equipped with a navigation-linked battery thermal management function. Based on information such as road gradient, speed profile, and the location and output of fast chargers along the driving route, the system predicts the future battery usage state (heat generation and required charging) and pre-controls the battery to an optimal temperature. Before fast charging, the automatic preheating function calculates an optimal target temperature from the predicted state of charge (SOC) at arrival and the charger output, and optimizes the preheating timing so as to maximize energy obtained from fast charging.

For battery cooling, the system predicts battery heat generation and natural cooling capacity from driving load and ambient temperature, and selects a “mild cooling mode” that switches from chiller-based cooling to radiator-based cooling when sufficient cooling is expected. This enables battery cooling without using the air conditioning compressor, and by prioritizing mild cooling in segments where navigation-based route information indicates that low load will continue, the system improves energy efficiency. Furthermore, when sufficient battery cooling is expected along the post-charging route, a control is introduced that temporarily reduces the temperature margin during fast charging and relaxes the limitation on accepted charging power, thereby increasing the total charged energy.

In summary, the integrated thermal management system efficiently links thermal energy flows among the cabin, battery, and powertrain, and by combining heat loss recovery with navigation-linked control, it simultaneously achieves reduced power consumption for cabin heating in winter, enhances fast charging performance, and improves overall driving energy efficiency. These technologies enable the realization of an electric vehicle that “anyone can drive with confidence,” offering both extended driving range and high driving energy efficiency under a wide range of operating conditions, including cold and hot climates.

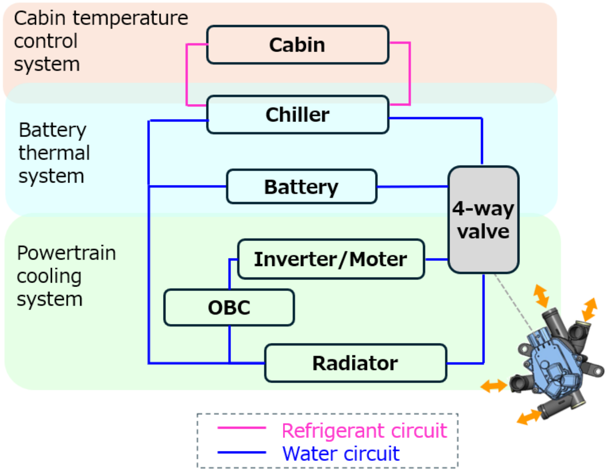


Fig.1 Circuit diagram of thermal control system of new BEV


Fig.2 Battery temperature control linked with navigation