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Improving Winter Driving Range of EVs with a Desiccant Device : Ceramic Humidity Regulator (CHR)

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With rapid growth of Electric Vehicles (EVs) in the market, challenges such as driving range, charging infrastructure, and reducing charging time needs to be addressed. Unlike traditional Internal combustion vehicles, EVs have limited heating sources and primarily uses electricity from the running battery, which reduces driving range. Additionally, during winter operation, it is necessary to prevent window fogging to ensure better visibility, which requires introducing cold outside air into the cabin. This significantly increases the energy consumption for heating and the driving range can be reduced to half of the normal range. This study introduces the Ceramic Humidity Regulator (CHR), a compact and energy-efficient device developed to address driving range improvement. The CHR uses a desiccant system to dehumidify the cabin, which can prevent window fogging without introducing cold outside air, thereby reducing heating energy consumption. CHR is based on desiccant dehumidification technology. Unlike conventional desiccant rotors, it features an integrated structure that combines the desiccant material with a honeycomb-type Positive Temperature Coefficient (PTC) heater. This enables highly efficient direct heating regeneration and a compact design optimized for EVs installation.

In this study, the heating power reduction effect of the CHR was evaluated under a low-temperature condition of −7℃. A vehicle equipped with advanced energy-saving HVAC technologies was used to assess energy efficiency when CHR was integrated into a system combining a humidity monitoring function that dynamically controls ventilation based on cabin conditions and a dual-layer air system capable of reducing ventilation volume. Compared with the reference Auto control mode, a maximum heating power reduction of 17% was confirmed by the CHR, and no window fogging was observed. These results confirm that dehumidification using the CHR enables a reduction in heating power consumption while maintaining anti-fogging performance.

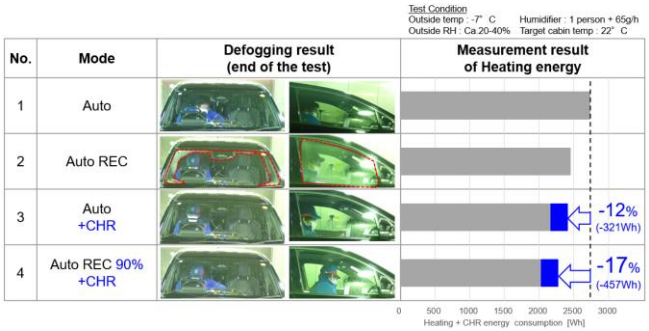

Fig.1 Defogging and heating energy results

Furthermore, a vehicle driving test from full to empty battery charge was conducted to evaluate whether the heating power reduction affects driving range. The outside air temperature was −20 ℃, and the CLTC driving cycle was used. A vehicle equipped with a cabin air recirculation control system based on a humidity sensor was used. Compared with the Auto mode, the CHR improved the driving range by 13%, while significantly reducing window fogging.

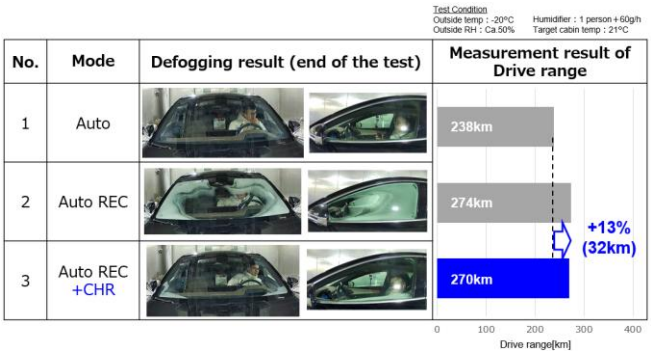

Fig.2 Defogging and drive range results

These results demonstrate the practical effectiveness of the humidity control device under real driving conditions, indicating that the device enables efficient dehumidification and serves as a practical and effective solution for improving winter driving range in EVs.