

Development of battery technology for powerful driving performance of premium minivans

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Nissan has expanded its 100% electric-drive hybrid system, e-POWER, from compact cars to minivans. For application to a large 4WD premium minivan, the battery system had to meet the highest output demand in e-POWER history while preserving cabin spaciousness, cost competitiveness, vehicle weight, and durability. Therefore, the development target was to improve output without increasing pack volume, module count, or cell count.

The battery pack is installed under the front seats. To achieve higher output within the existing pack case and module configuration, increasing voltage and reducing cell resistance were compared. Considering durability, manufacturability, and cost, this development selected cell resistance reduction, because its durability impact could be controlled through targeted cell-design countermeasures.

Cell resistance was decomposed into ohmic resistance from terminals and current collectors, and resistance/capacitance components associated with the positive electrode, electrolyte, separator, and negative electrode. Based on contribution, manufacturability, and cost, the selected measures were active-material improvement, separator improvement, and electrode improvement. For the active-material improvement, the particle size of the active material was reduced to increase the electrochemically active surface area per unit volume, thereby improving current input/output capability and reducing cell resistance. However, the increased reaction area can promote side reactions with the electrolyte, which can form a high-resistance surface film that inhibits lithium-ion insertion and extraction, resulting in increased DCR during aging. Therefore, durability countermeasures were indispensable. The newly developed electrolyte additive forms protective reaction products on the active-material surface. Storage testing confirmed that the combination of the new electrode and new electrolyte suppressed DCR increase to a level comparable with the current cell.

Cooling performance was improved while retaining the current pack structure because higher output increases heat generation during charge and discharge. Cabin air is drawn through intake ducts by the cooling fan and supplied to the inter-cell flow paths. Fan-speed variation in mass-produced parts was reassessed, and the permissible fan speed was reset based on in-vehicle noise and vibration sensory evaluation. This increased heat rejection by 18% while maintaining cabin quietness.

By combining cell resistance-reduction technology and cooling-performance improvement under strict layout constraints, the premium-minivan e-POWER battery achieved a 15% increase in system output compared with the current system while securing cell durability. The resulting high-output battery system meets the highest output requirement of the e-POWER system without changing the pack structure, enabling powerful driving performance in a large 4WD premium minivan.

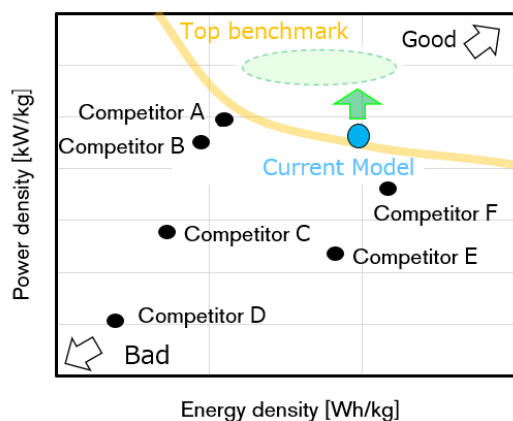


Fig. 1 Acceleration Battery Power Density Requirement

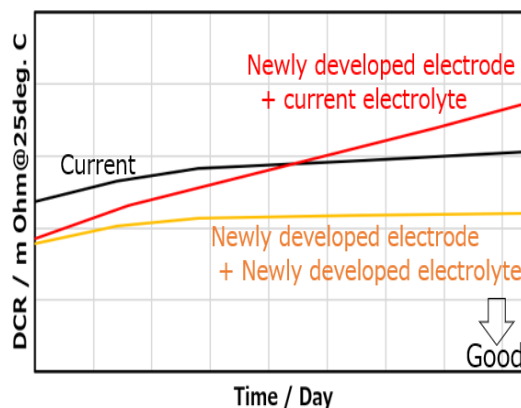


Fig. 2 Storage Duration and DCR Increase Rate