

Analysis of fuel efficiency improvement technologies for hybrid vehicles using real road driving

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KEY WORDS: EV and HV systems, energy control system, energy management, Real driving emissions, Fuel economy (A3)

In Japan, development efforts are underway with the goal of making electrified vehicles account for 100% of sales by 2035, however Battery Electric Vehicles (BEVs) face numerous challenges, resulting in a high sales share for Hybrid Electric Vehicles (HEVs).

This study conducted on real road tests using three drivers and a series-parallel HV (Test Vehicle A)—a representative compact passenger car in Japan. We analyzed technologies for improving fuel efficiency in urban, rural, and highway driving by comparing the results with those from the previous model of the same vehicle (Test Vehicle B) and a different series HEV (Test Vehicle C), both tested in the previous fiscal year. The findings are as follows:

With the AC(Air Conditioner) turned off, Test Vehicle A demonstrated fuel efficiency improvements over Test Vehicle B of approximately 30.5% in urban driving, 15.5% in rural driving, and 2.6% in highway driving, with an overall average improvement of 16.2%.

In urban and rural driving, it was found that while Test Vehicle B operated by varying engine speed while keeping engine torque nearly constant, Test Vehicle A operated with both engine speed and torque held nearly constant, functioning as a dedicated power-generation engine for the series HV system.

Test Vehicle A exhibited a higher EV driving ratio than Test Vehicle B. This is attributed to increased power generation—resulting from a roughly 24% increase in engine output and a 31% increase in motor output—which allowed surplus electricity to be stored in a battery with 2.1 times the total output capacity of the previous model. Additionally, the engine appears to have undergone specialized modifications for HV power generation, such as increased output and a shift to a three-cylinder configuration.

Test Vehicle A (a series-parallel HV) showed a higher EV driving ratio than Test Vehicle C (a series HV), with the gap widening as driving speed increased. This is believed to be because, at high speeds where regenerative energy is limited, the series-parallel HV offers superior energy transmission efficiency for driving the wheels compared to the series HV.

The differences in the rate of fuel economy degradation due to AC usage between test vehicles A and B at each representative vehicle speed are 1.5% for urban driving, 8.5% for rural driving, and 1.3% for highway driving. The rate of degradation is significantly higher in rural driving compared to urban and highway driving; this is attributed primarily to the improved fuel economy performance observed when the AC is turned off.

Regarding future improvements in HV fuel economy, further enhancements in engine thermal efficiency and the efficiency of components such as motors and inverters will be necessary..

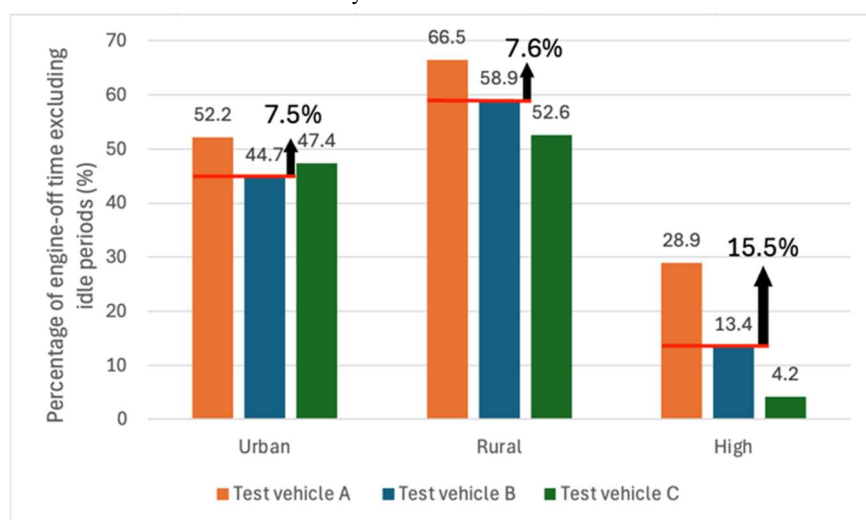


Fig.1 Comparison of EV driving ratio in urban, rural, and highway for driver A