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Synergistic Effects of Hybrid Electric Vehicle Conversion for Heavy-Duty Trucks and Dynamic Power Supply on Highways

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About the electrification of heavy-duty trucks, intermittent charging and power supply while driving on highways are being considered as a means of reducing battery capacity and infrastructure-related costs. The key challenge here is that the power line infrastructure must be sufficiently installed along the operational route for the system to function effectively, and that it takes a considerable amount of time to reach the operational stage.

Fig. 1 shows the power supply sources when power lines are installed on a gradient section and heavy-duty HEV trucks are driving. On downhill gradients, the electrical energy generated by the motor's electric braking is fed back into the power line. On uphill gradients, the motor is driven using electricity supplied from the power line in addition to engine power, thereby reducing the load on the engine and allowing it to operate at its optimal thermal efficiency. This allows the regenerative energy generated on downhill gradients to be effectively utilized. On flat roads, heavy-duty hybrid trucks drive primarily on engine power.

Fig. 3 shows a schematic diagram of the Chuo Highway, which features steep gradients among Japan's highways. The 25-ton truck has 68 kWh of potential energy at Point A, which is at an elevation of 1,000 meters. For Section B, a motor capable of generating 133 kW of regenerative power is required.

Next, we will describe a method for converting existing heavy-duty trucks with internal combustion engines into hybrid electric vehicles (HEVs) using in-wheel motors. Table 1 shows the specifications per unit for the 22.5-inch wheel-integrated in-wheel motor, and Fig. 4 shows its appearance. By mounting them on the left and right rear wheels, an output of 150 kW and 4,000 N·m is achievable.

Table 1. Specifications of 22.5-inch in-wheel motor.

Item	Specification
Max. Motor Power Output	75kW@350-460min^{-1}
Maximum Torque of Motor	2046N・m@0-350min^{-1}
Rated Motor Power Output	30kW@350-460min^{-1}
Weight	80kg
Cooling system	Air
Efficiency	89%@rated

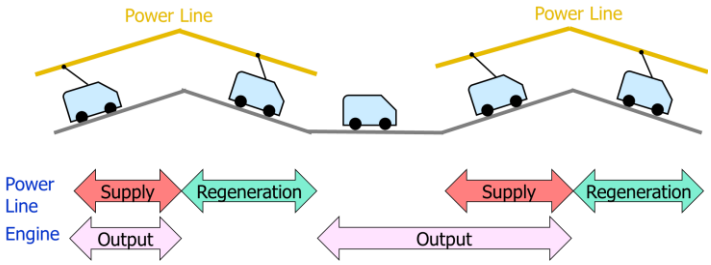

Fig.1 Power Source for HEV Heavy-Duty Trucks

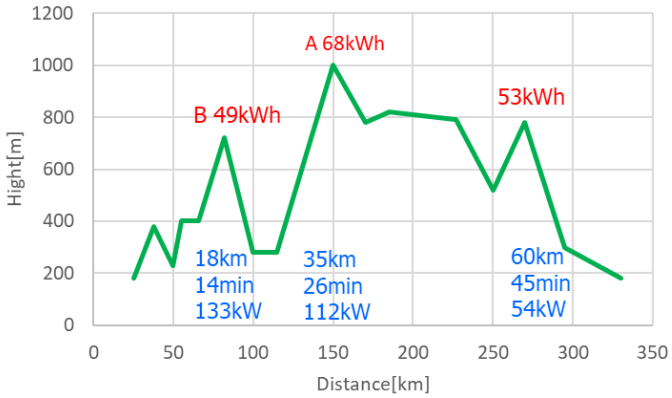

Fig.3 Potential Energy of the Chuo Highway

Fig.4 Outer rotor type 22.5-inch in-wheel motor.