Development of a Train Simulator for Diesel-hybrid Railway Vehicles

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For the purpose of energy saving, countermeasures for exhaust gas, etc. of diesel railway vehicles, development and introduction of Diesel-hybrid Railway Vehicles have been in progress. At the development of hybrid railway vehicles, it is necessary to precisely evaluate the running performance, energy-saving effect, exhaust gas reduction effect, etc. of railway vehicles for various equipment configurations and equipment specifications. As the evaluation method, RTRI developed the Train Simulator for Diesel-hybrid Railway Vehicles capable of drawing up train performance curves and calculation of energy consumption, a discharge amount of exhaust gas, etc. associated with running of hybrid railway vehicles.

The main features of the simulator are shown below.

(1) It can draw up train performance curves and calculate fuel consumption, the SOC (State of Charge), the discharge amount of exhaust gas (NOx, PM, CO, HC, and so on), etc. associated with running of railway vehicles.

(2) It has a high degree of versatility and is applicable to the equipment configuration of various hybrid railway vehicles in the series type and the parallel type.

(3) User interface functions are enhanced to enable setting of the equipment configuration and setting of the operating conditions (operating modes) of equipment which change depending on speed and the SOC.

The overall configuration of the simulator is shown in Fig. 1. The simulator includes the user interface, a calculation part for train performance curves, and a calculation part for vehicle models. The train performance curve preparation system "Speedy", which has been widely used in Japan, is adopted for the calculation part for train performance curves and the related user interface. The calculation part for vehicle models receives a notch, speed, etc. as information of the running condition from the calculation part for train performance curves, then determines operating modes of individual equipments such as an engine and motor, responding to the running condition, and returns tractive force as well as braking force after calculating them to the calculation part for train performance curves. The calculation part for train performance curves calculates the speed, notch, etc. at the next step using the tractive force and the braking force. A train performance curve is drawn up by repeating the calculation successively. At this time, the calculation part for vehicle models calculates the instantaneous fuel consumption successively, and it then calculates the total fuel consumption by integrating a summation of the instantaneous fuel consumption calculations.

When carrying out a simulation, it is necessary to input many pieces of data for setting the equipment configuration and operating modes of hybrid railway vehicles. Accordingly, user interface functions are enhanced to facilitate such works in the simulator. For example, setting of the equipment configuration can be easily performed by selecting the necessary equipment from the block diagram on the operating screen by click operation, as shown in Fig. 2.

An example of the simulation result using the simulator is shown in Fig. 3. Further, it has been already confirmed that simulation results and actual measured values on actual vehicle tests almost coincide to each other.

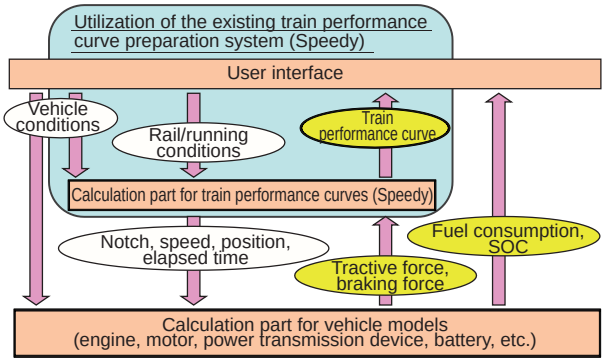

Fig. 1 Overall configuration of the simulator

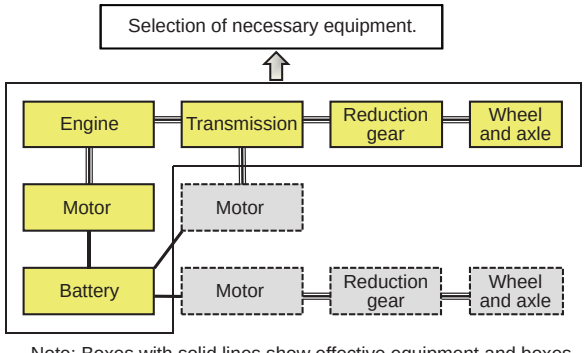

Fig. 2 Screen for setting the equipment configuration

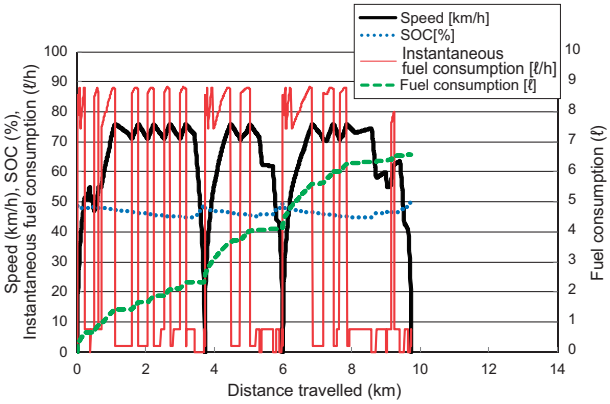

Fig. 3 Example of the results from simulation