Energy-saving train operation

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Railways are environment-friendly transportation means, and are placed as important measures of modal shift promotion worldwide in these days when CO2 discharge reduction is a global problem. In this context, we have been introducing energy-saving train vehicles and have been taking measures for energy saving. In this paper, we introduce; operating methods aiming at energy-saving for the Shinkansen and the electric multiple units in the conventional lines; diesel train idling stops; the evaluation / inspection of them.

A basic policy of energy-saving train operation

The train-driving time is composed on the basis of the standard train-driving time (the driving time when a train runs at the maximum speed in an average driving situation between stations) which is established on every vehicle performance of each train in consideration of many conditions such as connection / shunting with the other train, and the extra time is added to the actual standard train-driving time. Energy-saving train operation is the operation that we take advantage of this extra time.

Energy-saving train operation for the Shinkansen

We compared the operating method of three patterns and an energy consumption (energy consumption by powering – energy by regenerative brake) in a section between Hakata and Kokura by an 8-car train of 700 series Shinkansen "Hikari Railstar" (maximum speed: 285km/h, the time required between Shin-Osaka and Hakata in Sanyo Shinkansen (distance: 644.0km): about 2.5 hours, configuration: 6M2T). The three patterns are, (a)performance in coasting operation from the maximum speed (the traditional energy-saving operation): 897.3kWh, (b)performance in accelerating in the latter part: 836.3kWh, (c)performance in coasting operation from the arbitrary speed less than maximum : 836.3kWh. Of these, (c) is the most superior in energy-saving effect, and is the operating method that is comfortable for passengers and easy of handling. In this driving method, we control energy consumption for powering and keeping the speed by not accelerating to the maximum speed through use of the extra time. Then, we aim at getting energy by regenerative brake to some extent. We confirmed that there were about 412kWh, approximately 4.4% energy reduction effect between Hakata and Shin-Osaka in Sanyo Shinkansen (distance: 644.0km) per a train (an 8-car train of 700 series Shinkansen) when we tried this operating method for about 10 months since 2002 and inspected the effect. We consider that this is because we could control energy consumption for powering and keeping the speed by not accelerating to the maximum speed, and also because we could reduce running resistance in proportion to the square of the speed.

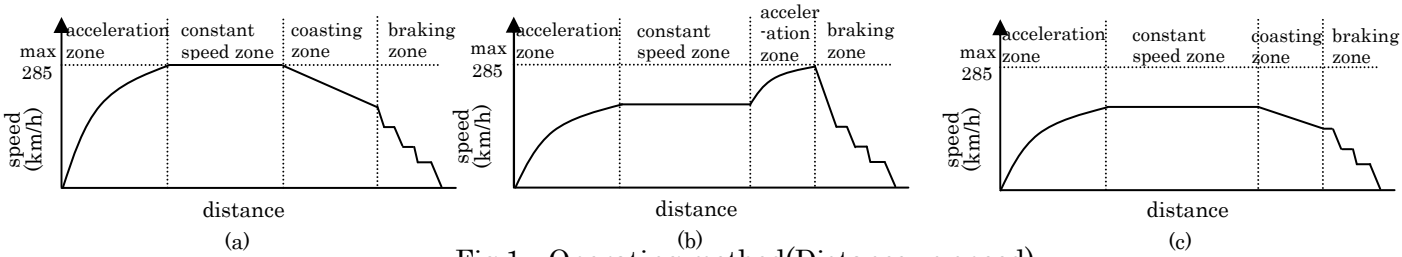

Fig.1 Operating method(Distance vs speed)

***Energy-saving train operation for the electric multiple units in the conventional lines ***

It is characteristic in comparison with the Shinkansen that the operating methods in the conventional lines repeat acceleration and stop in a short time. We compared the operating method of each driver and energy consumption (energy consumption by powering – energy by regenerative brake) in a 7-car train of 321 series electric commuter train (maximum speed: 120km/h, configuration: 6M1T). As a result, we confirmed that the power consumption by powering became a little when coasting speed was low, and that energy by regenerative brake when decelerating had little difference.

Also, we found that operating time remains the same in both cases when accelerating to the maximum speed and when decelerating efficiently keeping the coasting speed low. With these results, we made a standard operating table based on the operating method in which there was a little of energy consumption in fact and inspected the effect. Then we confirmed that there were about 100kWh, approximately 20% energy reduction effect between Nishi-Akashi and Osaka in Sanyo and Tokaido lines (distance: 55.9km, stations: 26) per a train (a 7-car train of 321 series electric commuter train). In regard to energy-saving operation in the conventional lines, too, we can conclude that it is effective not to unnecessarily accelerate to the maximum speed taking advantage of the extra time, and to control energy consumption for powering by keeping the coasting speed low.

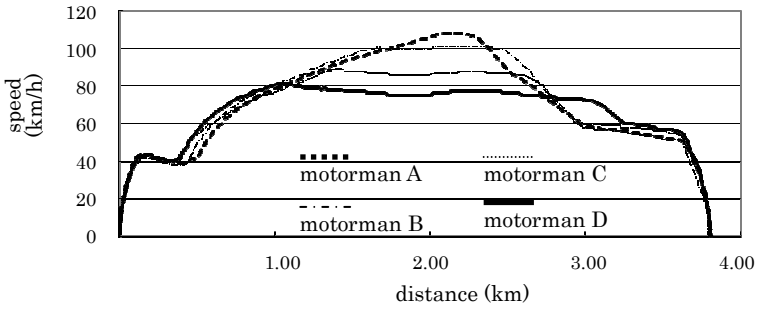

Fig.2 Operating method (Distance vs speed)

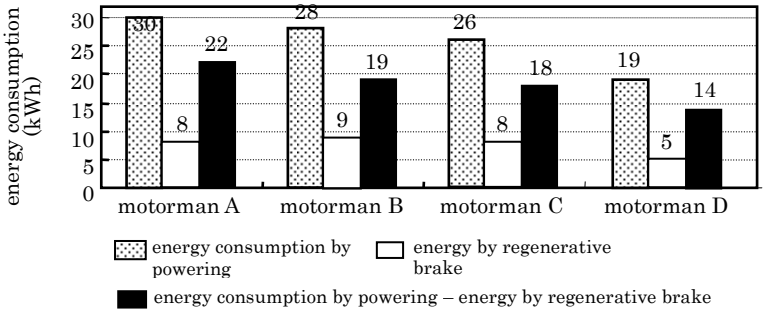

Fig.3 Result of measuring energy consumption in a section between Osaka and Shin-Osaka.