Development of WSP System for Freight Trains —Best Paper Award in Rolling Stock Sessions, WCRR 2006

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The most commonly used equipment of a freight railroad business is freight cars, and much of the maintenance of freight cars is concentrated on the wheel-sets. It is therefore important for a freight railroad operator to decrease wheel-set maintenance. Wheel locking in freight cars results in wheel flat, which causes various other problems. For these reasons, we developed a new, practical Wheel Slide Prevention (WSP) system for freight cars (see Fig. 1). The main advantages of this WSP system (also called ABS "Antilock Brake System") are long life, reduced maintenance, low cost, and high reliability. And, in order to solve other problems seen in conventional equipment, we also developed a low power dump valve, a long life electric double layer capacitor (EDLC) for freight cars, and other devices.

(1) Long life EDLC for freight cars

We developed the first-of-its-kind electric double layer capacitor (diluted sulfuric acid solution-based electrolyte, 24V, 5 F; see Fig. 2, left). By sealing 28 cells in an oblong ceramic vessel, we were able to achieve high reliability, long life and high voltage under varying outdoor temperature conditions. Homogenous cells are stacked in the form of sheets to eliminate the need for a cell balancing circuit and thus cut EDLC production cost. The results of accelerated durability tests show that the EDLC life cycle is much longer than the development target, which was 8 years, and is now actually estimated at more than 30 years.

(2) Energy-saving dump valve for freight cars

Two effective ways to cut freight train WSP costs are to significantly reduce the power requirement and capacity of both power supply and charge units. Reducing the power consumption of the dump valve is the most effective method. We therefore developed a new energy-saving control method and a new valve structure (Fig. 2, right). We reduced power consumption of the dump valve to 2.2 W per set. This is much lower than the development target, which was 1/10 that of a conventional valve - actual power consumption is 1/60 that of a conventional valve. This ensures a maintenance-free period of eight years, which was our development target. (Reference: Development of a WSP System for Freight Trains: WCRR 2006 Proceedings, Montréal, June 2006)

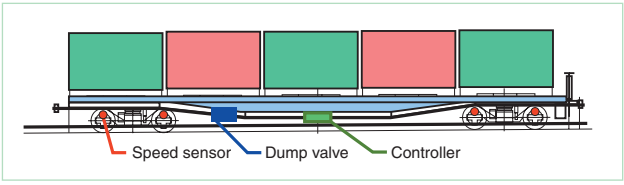

Figure 1. Wheel Slide Prevention (WSP) system mounted on a container freight car

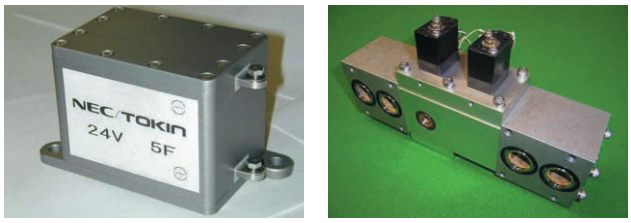

Figure 2. Electric double layer capacitor (EDLC, left) and dump valve

A Feasibility Design and its Evaluation of Fuel Cell Powered Train

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The paper has three main parts. First: The electrical characteristics of a proton exchange membrane type fuel cell (PEMFC), and results obtained during motive bogie operation with induction motors . In the case of the PEMFC, output voltage varies widely with the load current, and its operating points during output current surges and declines are along the same characteristic curve . Thus the PEMFC can be regarded as a normal linear power source characterized by wide output voltage fluctuations. Second: Results of feasibility design work for fuel cell powered vehicles (FC trains). I show FC and super capacitor (SC) specifications for regenerative brake energy accumulation, and estimate the weight and required space for equipment needed for this type of train. Figure shows a rough sketch of a proposed FC commuter train. Equipment configuration for a FC train is feasible. Third: Evaluation of FC train characteristics, including fuel cell stack price and energy efficiency. Calculations of the energy efficiency of fuel cells do not generally take into account the energy used to produce the hydrogen. An FC train equipped with a DC-DC chopper circuit system has many semiconductor switches, so it is also important to improve the energy conversion efficiency of traction equipment on board. We believe it is more important for an FC train to have greater total conversion efficiency than a conventional electrical train, and any discussion of FC train energy efficiency should also include consideration of the hydrogen generation process.