Development of Low Cost Long Life Antilock Brake System for Freight Trains

Kiyoshi KAWAGUCHI
Senior Researcher, Traction Control, Vehicle Control Technology Division

1. Reasons for our freight train ABS development

Because freight train brake systems must be able to operate without an electric power source, freight trains normally use low-cost automatic air brakes that meet international standards. Freight trains in Japan run on the same track as passenger express trains, so they must have brake systems whose response and deceleration are higher than those of freight trains anywhere else in the world. However, this means that the wheels of high-speed container trains in Japan are susceptible to wheel slide damage, similar to that of the wheels of electric passenger trains.

Therefore, Japanese freight trains with no electric power source have long presented significant problems, the two most important being: (i) a rise in noise levels due to vibrations caused by wheel-flat; and (ii) an increase in maintenance costs for wheels and bearings.

To permit maintenance savings for high-speed container trains, as well as lower costs for operating high-quality freight services, we recently developed a new type of Antilock Brake System (ABS; also called Wheel Slide Prevention [WSP]).

2. Configuration of ABS for freight trains

The newly developed ABS for freight trains has the following features.

(1) Since the freight train has no electric power source, a small generator is installed on the axle end, to generate electricity while the train is running (Fig. 1).

(2) The generated electricity is stored in a special electric double-layer capacitor (EDLC), which is barely affected by outdoor temperatures (Fig. 2).

(3) In order to reduce generator and EDLC costs, anti-skid valve power consumption is minimized.

The configuration of the ABS for freight trains is shown in Fig. 2.

3. Key development points

3.1 Long life EDLC for freight trains

We developed the first-of-its-kind EDLC (diluted sulfuric acid solution-based electrolyte, 24V, 5 F; see Fig. 3). By sealing 28 cells in an oblong ceramic vessel, we were able to achieve high reliability, long life and high voltage (24V) 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. Exterior dimensions are 72×148×84 mm, and the weight is 1.6 kg including the vessel. 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 (calculated after even considering operating temperatures below -20°C and above +65°C).

For reference purposes, a conventional EDLC uses an organic electrolyte and is enclosed in a cylinder made from aluminum sheeting. Its life cycle is only several years under outdoor conditions.

3.2 Energy-saving antiskid valve

Two effective ways to cut freight train ABS costs are to significantly reduce the power requirement and capacity of both power supply and charge units. Reducing the power consumption of the antiskid valve is the most effective method.

We therefore developed a new energy-saving control method (Fig. 4) and a new valve structure (Fig. 5). We reduced power consumption of the anti-skid valve to 2.2 W per set. This is much lower than the development target, which was 1/10th that of a conventional valve - actual power consumption is 1/60th that of a conventional valve.

The air inlet and outlet are covered with dust filters, and the valve structure has no parts susceptible to friction, to reduce wear and tear. This ensures a maintenance-free period of eight years, which was our development target.

4. Future plans

The results of various tests show that the freight train ABS has attained most development targets, including a cost reduction to one-half that of conventional models. Tests will be continued for some time, with a view to putting the new ABS into practical use for next-generation container trains.

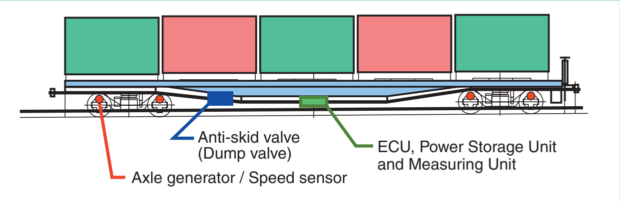

Figure 1. New ABS mounted on container freight car.

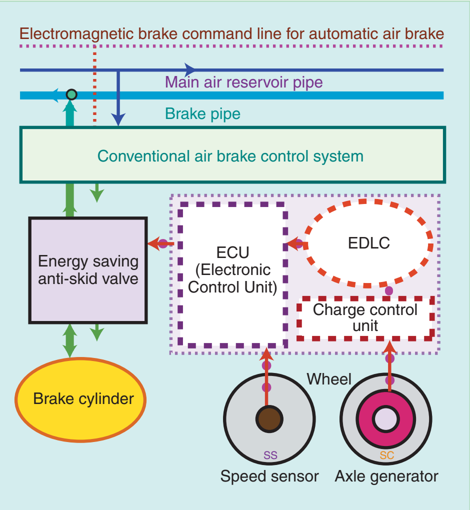

Figure 2. ABS configuration for freight trains (example).

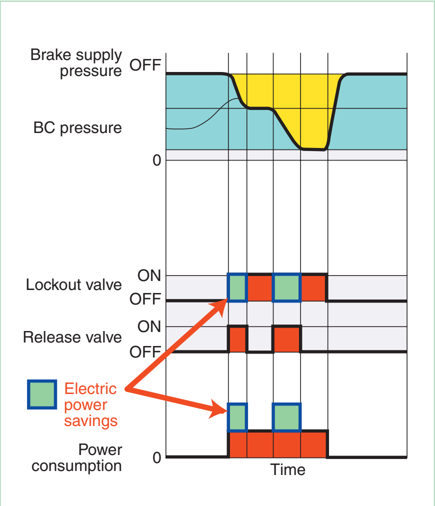

Figure 4. Energy-saving control method used by anti-skid valve

Figure 3. Long-life EDLC for freight trains

Figure 5. Energy saving anti-skid valve