Power Storage at Substations

Konishi, Takeshi
Researcher, Power Supply Systems, Power Supply Technology Division

Application of a power storage system to electric railways will cut the contact demands, power consumption and electric charges at substations, effectively utilize power regenerated to save energy, and relieve the voltage drop of overhead lines. This study aims at establishing specifications for the power storage system for electric railways.

OUTLINE OF POWER STORAGE SYSTEM

We had an eye to electric double layer capacitors (EDLCs) as a medium to store power for electric railways for the reason that it features a long life without requiring frequent maintenance and has quick charge/discharge characteristics better than those of secondary batteries. These features suit electric railways under large fluctuations in workloads. A high-efficiency step-up and -down chopper is promising as a power converter to control the charging/discharging operation without relying on the EDLC voltage. Based on the above discussions, we had a mini-model of a DC 400 V power storage system manufactured by using an EDLC and a step-up and -down chopper. Table 1 indicates the specifications for EDLCs. Since the voltage per cell of an EDLC is 2 V, we increased the voltage and capacity of the model by connecting cells in series and parallel, respectively. The energy capacity of the model was about 80 kW available for five seconds. The voltage on the EDLC side was increased or dropped by the chopper to transfer energy to and from a DC 400 V feeding system. Figure 1 shows the major components of the mini-model, which has a rectifier, a power source and resistance/inductance to simulate a substation, a railway vehicle and the impedance of overhead lines, respectively, in addition to a power storage system. Figure 2 gives the test results of the mini-model. When the powering current is large, the voltage of the railway vehicle drops. Since the EDLC discharges, however, the current supplied by the substation is suppressed. This in turn suppresses the voltage drop that would occur when an EDLC is not used. As the EDLC absorbs the power regenerated during regenerating operation, the voltage of the railway vehicle does not increase. As a result, we were able to confirm that the EDLC would contribute to the stability of the power supply system for electric railways. As a revised version of the mini-model, we are now discussing a power storage system that combines an EDLC and a high-capacity lead storage battery. We are also performing an accelerated degradation test of a DC 100 V power storage system to verify the life of the EDLC.

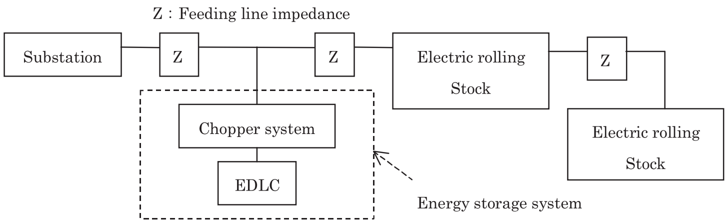


Figure 1. Main circuit of mini-model.

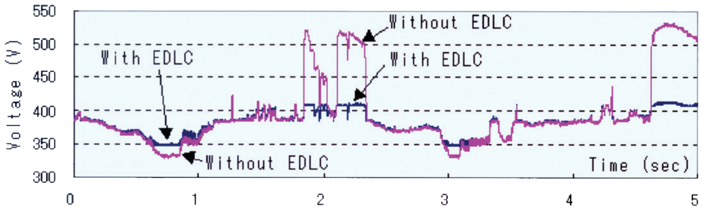


Figure 2. Test results.

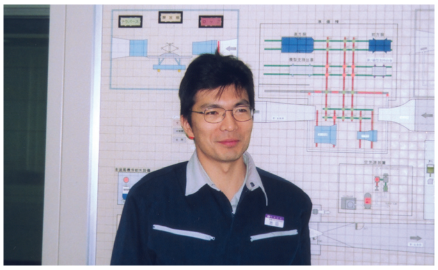
Table 1. Specifications for EDLCs

Item	Unit	Block	Module
Constitution	46-Cell series	8-Unit parallel	3-Block series
Voltage	93 V	93 V	280 V
Current	50 A	400 A	400 A
Capacity	12 F	97 F	32 F
Resistance	0.44 Ω	0.05 Ω	0.16 Ω
Dimension	D, 340 mm	D, 431 mm	D, 1000 mm
	W, 340 mm	W, 465 mm	W, 900 mm
	H, 50 mm	H, 537 mm	H, 2300 mm
Weight	7.2 kg	74.5 kg	715 kg

FUTURE SCHEDULE

We will simulate a power storage system to establish specifications optimized for optional electric railway sections, and promote researches to test a power storage system that will be applied to actual service lines.

Precise Contact Force Measuring Method for Current Collection System



Ikeda, Mitsuru
Senior Researcher, Current Collection, Railway Dynamics Division

The current collection system is subject to vibration due to the interaction between catenary and pantograph through the contact force in between. This requires precise measurement of the contact force, which is an essential factor in evaluating the performance of current collection. At the Railway Technical Research Institute, we have promoted researches on the method to measure the contact force and succeeded in substantially expanding the range of measurable frequencies as explained below.

METHOD TO MEASURE THE CONTACT FORCE

We first set a control volume on the pan as shown in Fig. 1 and considered the equilibrium between the forces acting thereon. The contact force is then expressed as the sum of the force F_a on the cross section A, the force F_b on the cross section B, and the inertia force acting on the part sandwiched between these sections. F_a and F_b are measured with load sensors fixed at the pan. Types