

§20. Operation Test of 100kW Class DEMO SMES

Chikaraishi, H., Hemmi, T., Mito, T.,
Abe, R. (Shibuya Co., Ltd.)

The operation test using 100kJ SMES and the power converters are performed. The test circuit is shown in Figure 1. To show the large power operation of this test system, the regenerating power is circulated to the electrical utility network. In the experimental room, there is no 400V line for test, we made a test line using step up transformer.

In the preliminary operation design, the exciter will be turned off while the system supply the power to the facility. This exciter is based on the switching regulator and the dc side circuit is simple diode rectifier and the circuit to circulate dc current can be kept. Therefore, we changed the control sequence that the exciter is not turned off even if the SMES supplies power.

The electrical line used in this test supplies many utilities in the Superconducting Magnet Lab. and a hard power change in short time may makes problem to other utilities. Therefore, we limit ramp up rate of the power to 1.5 MW per second. Previous experiments show that the superconducting coil has enough operation margin and the power converters made with rating of 140kW for short time operation. Therefore we discharge at the maximum rate of 140kW to show the temperature rising in the coil clear.

Figure 2 and Figure 3 show the test results. Dc line voltage, the coil voltage and current are shown in Figure 2. The discharge started at $t=1000\text{ms}$ and stopped at $t=1720\text{ms}$. To check the operation of the chopper, the discharge operation was continued until coil current became zero. The available power is limited by coil current and dc voltage. In this system, dc voltage is 300V and 150kW output is possible while coil current is larger than 500A. At the beginning of the operation, disturbance was observed in dc current and coil voltage. The coupling between inverter control and chopper control caused this disturbance. In the next 1MW class system, a computer controller is used and decoupled control will be installed. Figure 3 shows the stored energy in the coil, power flowing dc link. The dc power is kept constant as 150kW while $1000\text{ms} < t < 1440\text{ms}$. After this operation, the temperature of coil increased 1K and it is smaller than the designed value. In this test operation, the capacity of the utility line used in this test was about 20kVA and is smaller than SMES output of 150kW then the line voltage raised about 30%. In the actual system line capacity and SMES capacity are balanced and the voltage change will not be occurred.

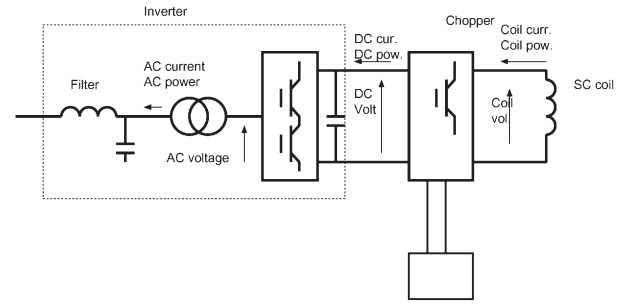


Figure 1. Test circuit diagram

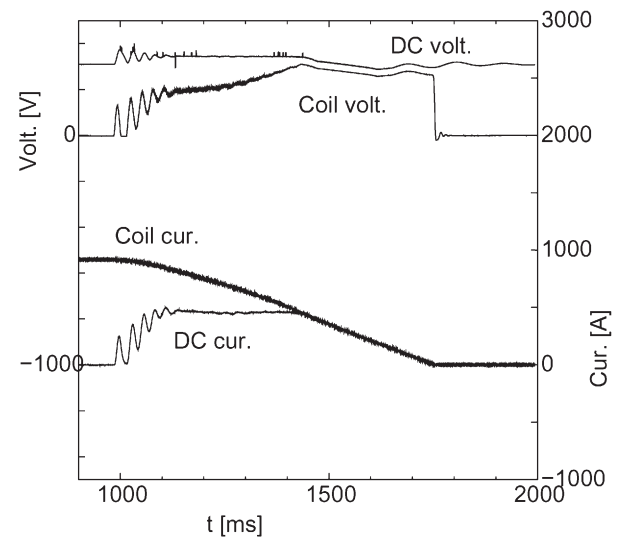


Figure 2. Coil voltage and current for 150kW discharge operation

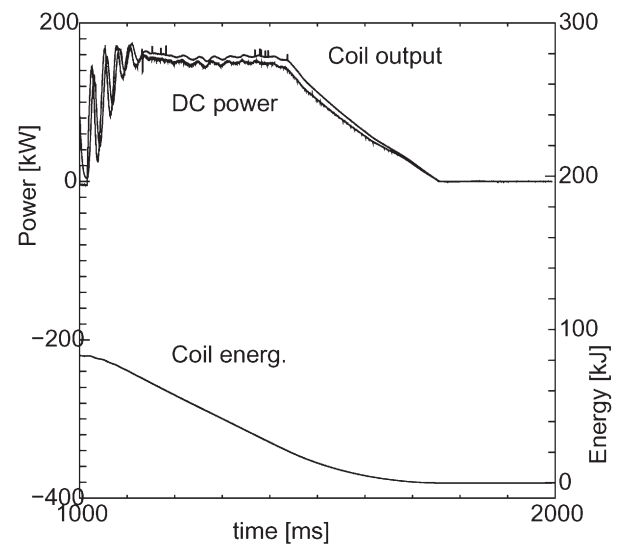


Figure 3. Stored energy and power flow