§4. Study on Large-Scale Conductor Stabilized by Active Control of Current Distribution

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1. Purpose of study

Scales of superconductors for a next generation LHD need to scale up by about one order of magnitude compared with the conductors for the present LHD. However, scaling-up of conductors causes many problems.

We have proposed a parallel superconductor concept to clear those problems, 1). In this concept, a main conductor is divided in subconductors, each of which is electrically insulated from other subconductors and connected to an individual power supply. Current of each subconductor can be controlled individually. With this method, a large scale conductor can be easily realized by bundling smaller scale subconductors, because the most intriguing issue of a large scale conductor, inhomogeneous current distribution in the conductor cross-section, is cleared by active control of the currents of the subconductors. Moreover, the conductor is actively stabilized by quick transferring a current of a quenched subconductor to other subconductors.

We are focusing our effort to the active stabilization. We have already demonstrated that a coil of two parallel wires could be actively stabilized by quick control of the current of the parallel wires, 2). In this study, we study the current control algorithm for a coil of four parallel wires.

2. Summary of studies of this year.

We made a test coil wound of four insulated parallel subwires 1~4 (54mm turner bore and 100 mm length) and studied the control algorithm by simulation study. Fig.1 is a schematic control circuit. In normal operation, the current control unit produces current references of subwires i_{r1}~i_{r4} which are equal values and total of which is equal to the coil current reference i_{or}. When one of four subwires is quenched, the quench detector detects the quench and identifies the quenched subwire. The quench signal is sent to the current control unit and the current control unit produces subwire current references so that the current of the quenched subwire is reduced below the recovering current by transferring the current of the quenched subwire to other subwires evenly. During the current transferring, the total of the subwire currents is controlled to be always equal to i_{or}

Fig 2 shows the simulation results where subwire1 is quenched. Parameters of the test coil are used in the simulation. The subwire current i_1 is transferred to other subwires 2~4. As seen in Fig.2, the currents are transferred quickly with small voltage applied to the subwires, while the total of the subwire currents are kept constant.

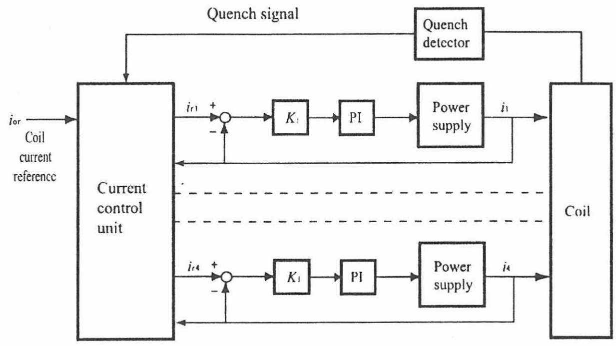

Fig.1 Schematic control circuit of parallel wire coil

3. Plan in next step

We are now constructing the current control unit using a digital computer and A/D and D/A units. After some tests to proof the functions of the current control unit, we conduct an experiment to demonstrate the parallel superconductor concept using the small-scale test coil.

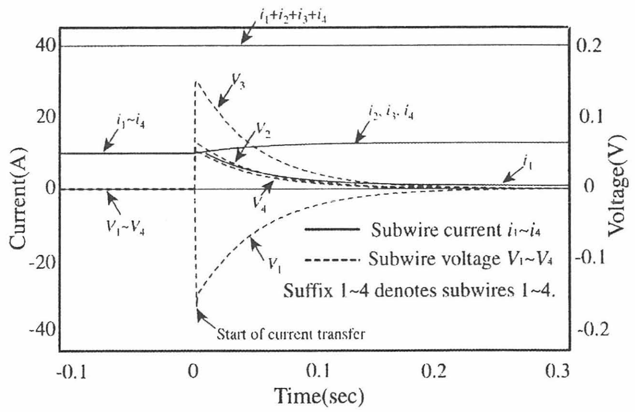

Fig.2 Simulation results

References

1. W-K.Yoo, O.Tsukamoto and N.Amemiya, Advances in Cryogenic Eng., Vol.39, p293-300, 1994
2. O.Tsukamoto, K.Yamagishi,T.Wada and W.L.Zhu Proc. ICEC17: Superconductivity, Section 12, p579-582, 1998