Application of high Tc superconductors for advance of fusion reactor

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Abstract

The AC losses in HTSC coils was simulated under plasma disruption by the coupling analyses of heat transform and shieding current distribution in HTSC coil. The Stability of the HTSC coils was verified by the simulation results.

Introduction

Application of high Tc superconductors (HTSCs) to a fusion reactor has been studied by means of the excellent electromagnetic behavior which is inherent in HTSCs. The concrete this research in this year is stability analysis of a tokamak plasma by using a high Tc superconducting coil.

Simulation Results

Fig.1 shows the poloidally cross section of the ITER configulation selected as the example of the analysis, and the location of the HTSCs. A coupled analysis between the equilibrium calculation of the plasma based on the modified inductance method and the calculation of the superconducting shielding current based on the flux-flow-creep model was carried out in the configuration. The displacement of the reference point on the plasma separatrix was reduced within 22 cm at most, even if the most serious disturbance ($\delta\beta_p = -0.2, \delta l_i = -0.1$) which was supposed in the design of ITER was applied into the plasma. Consequently, it was confirmed that the plasma was stabilized enough by the effect of the HTSCs.

Based on this result, the electromagnetic analysis coupled with thermal one was developed, and the distribution of the shielding current in the superconducting coil and the calculation of the temperature variation caused by the AC loss were estimated (Fig.2). Consequently, it was proved that the AC loss can be neglected if the magnetic disturbance was lower than 0.1 T during the event of the plasma positional instability. As the result of the reseach, it was verified that the improvement of the plasma instability was possible by applying HTSCs which has been developed until now.

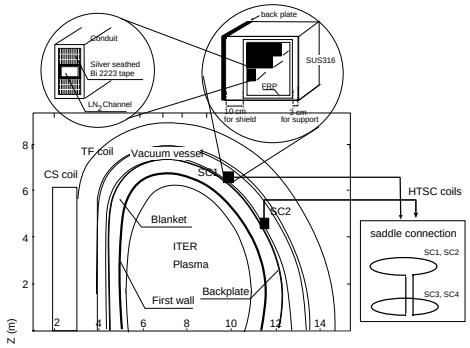

Fig 1. The location of the high Tc superconductors in the ITER configulation.

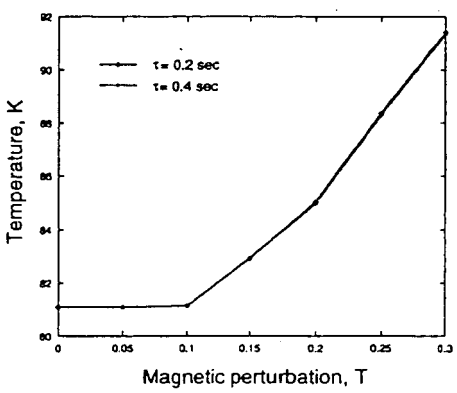

Fig 2. The relation between maximum temperature in an HTSC coil and magnetic disturbance