DESIGN OF A TF COIL FOR TOKAMAK FUSION POWER REACTORS WITH YBCO TAPE SUPERCONDUCTORS

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The maximum field within the toroidal field (TF) coil winding for tokamak fusion power reactors such as A-SSTR2, VECTOR has been designed to be about 20 T from an economical point view. The generation of 25 T has been already achieved on the small coil using high Tc suerconductor, BSCCO. The 20 T level superconducting coil is translated into reality. On the other hand, the development of YBCO that is more excellent performance, namely the ability of using at higher temperature attractive on low cost operation, than BSCCO is rapidly progressed. A long length type of YBCO with over 100 m has been fabricated with very high current density of 4000 A/mm^2 at 20 T and 30 K. YBCO tape is expected sufficiently to be commercial superconductor in the near future. In this paper the applicability of YBCO tape to the TF coil of the tokomak fusion reactor is considered.

The most important issue on the application of the YBCO tape to coils is to take a measure against magnetic instability due to flux jump. The value of the first flux jump field (B_{fj}) increases as temperature increases. B_{fj} at 30 K is estimated as about 7 T. Therefore, to avoid the occurrence of the flux jump, YBCO type coil is used in the high field region of more than 14 T on 20 T coil. The YBCO type coil is firstly kept in normal state until the low field region coil is operated up to 14 T and then it is cooled down to 30 K. The YBCO type coil generates 6 T under the background field of 14 T. By this operation system the YBCO tape coil can be stably operated without flux jump instability. A 40-kA, 20-T conductor for the TF coil of VECTOR is designed using YBCO tape. The conductor consists of two YBCO units and one reinforced strip. The YBCO units are composed of two YBCO tapes attached to both surfaces of a copper sheet as quench protection. The YBCO tapes are a three layers structure with hastelloy, YBCO material and silver. The total thickness YBCO material in the conductor is 40 μm.