Design study of the magnetic field coils and configuration for the Chinese First Quasi-axisymmetric Stellarator

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The Chinese First Quasi-axisymmetric Stellarator (CFQS) is a future quasi-axisymetric (QA) stellarator device, which will be constructed in Southwest Jiaotong University (SWJTU) in China. This is the international joint project of National Institute of Fusion Science in Japan and SWJTU, and its design work has been continued jointly. A QA stellarator has mainly axisymmetric magnetic field components in the special magnetic coordinates (Boozer coordinates), which determine the guiding centre orbit, therefore, the neoclassical properties of the QA stellarator are similar to tokamak although inductive current is not required. About ten years ago, CHS-qa, has been designed as a post CHS device, which is a low aspect ratio (~3.2) QA stellarator. Based on this design, new configuration for the CFQS is obtained. The present parameters of magnetic field strength, the major radius, the aspect ratio and the toroidal periodic number are 1.0 T, 1.0 m, 4.0, and 2 respectively. The 16 modular coil system is optimized by the NESCOIL code for this configuration. By using this coil system, the free boundary equilibrium calculation by the VMEC is conducted, and the Shafranov shift and bootstrap current are estimated. The bootstrap current reaches 30 kA at β~1.5 %, and the good QA properties are maintained up to this β. For the flexibility of the magnetic field configuration, 3 pairs of poloidal field coils are considered. The Shafranov shift is suppressed by the vertical field produced by those coils.