Optimization of the heliotron configuration using split-type helical coils

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The optimization of the heliotron configuration is proposed using split-type helical coils. In the conventional design of stellarator/heliotron configurations, the optimization was done changing the modulation of winding law of helical coils. That is, parameters for the optimization are toroidal pitch, poloidal pole number, major and minor radii of coils. Since the helical field component is fixed by only helical coils, free parameters to change the field configuration are poloidal and toroidal field components using external coils. On the other hand, optimized stellarator configurations were proposed. In these configurations, most important characteristic of the optimization is the design using numerical codes. The optimization procedures are followings; (i) a reference configuration is prepared and optimized parameters, which are MHD equilibrium/stability, transport and so on, are decided, (ii) then the magnetic configuration satisfying optimized parameters is explored with numerical codes, (iii) finally, external coils to produce an optimized configuration is designed by an inverse problem. Usually, since magnetic field lines in the optimized stellarator are strongly modulated along the toroidal direction, the magnetic field is produced by modular coils. Conventional stellarator/helioron and optimized stellarator have advantages and disadvantages. The configuration space in the conventional stellarator/heliotron is not wide. However, since the coil system is simple, there is an advantage from the viewpoint of the engineering. For the optimized stellarator, the configuration space is wide but sophisticated coil system is a disadvantage.

In this study, using numerical codes to design the optimized stellarator, an L=2/M=10 heliotron configuration is optimized to keep good confinement and MHD properties. In the conventional L=2/M=10 heliotron, the preset magnetic axis for the vacuum field is an important parameter. For inward shifted configurations, transport properties are good but MHD properties are not good. On the other hand, for outward shifted configurations, those properties are opposite for inward shifted configurations. To improve the optimization, we adopt split-type helical coils. Split-type helical coils are already used to design the heliotron-type reactor. However, it was only study of the vacuum field configuration and effects of the plasma response were not included. In this study, the optimization including the plasma response is an important issue.