The Design Windows and Economical Potential of Heliotron Reactors

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Heliotron reactors are characterized by a pair of helical coils with large major radius but moderate aspect ratio, which give us different approaches for power plants from tokamak reactors. Based on the recent experiment results of LHD and the technology-cost basis of magnets developed for LHD and ITER construction, the design window analysis has been carried out. We found that the Heliotron reactors have the technically and economically attractive design windows, where the major radius is increased as large as for the sufficient blanket space, but the magnetic stored energy is decreased to reasonable level because of lower magnetic field with the convenient physics basis of H factor near 1.1 and β of 5%.

For searching design windows of Heliotron reactors and for discussing their potential as power plants, we have developed a mass-cost estimating model linked with system design code- HeliCos. The major relationships between plasma parameters and reactor parameters are identified. The main calculation flows and issues to be considered are shown in Fig. 1.

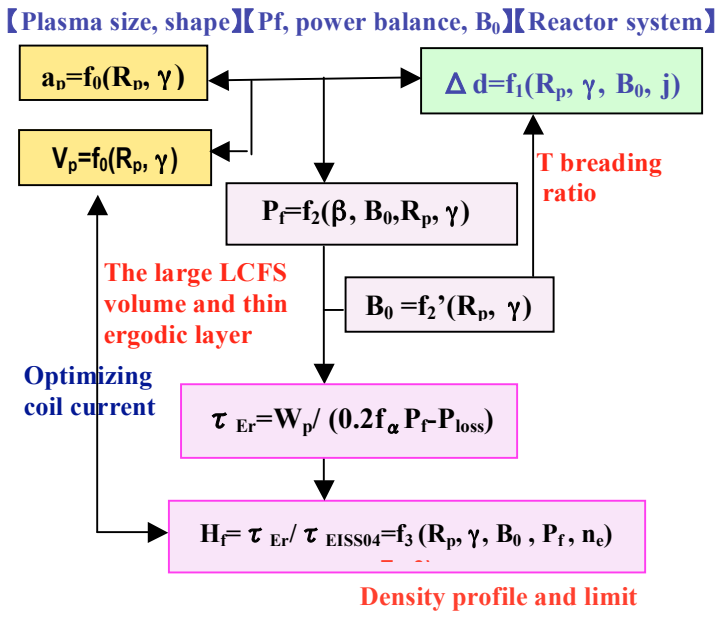

Fig.1 The major design parameters and calculation flows.

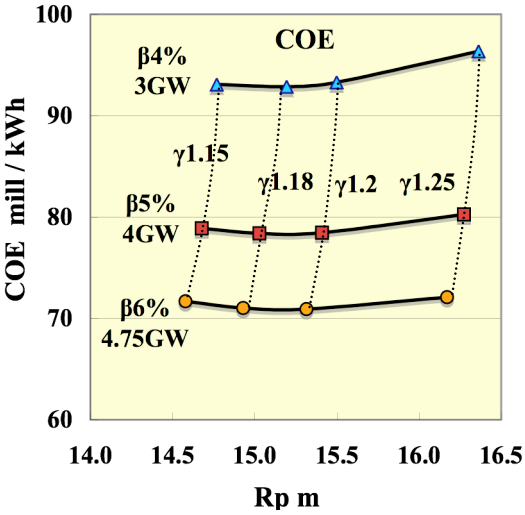

Fig.2 The COEs of Heliotron reactors, which depend on plasma major radius R_p, coil pitch parameter γ and β, show the bottom near R_p=15~15.5m with blanket space condition Δd=1.1m.

Figure 2 show the COEs (cost of electricity) of Heliotron reactors which are strongly depend on γ and β. The results of analysis show the Heliotron reactors have the economically attractive design windows in rather large plasma major radius of 15~16m, with the sufficient blanket space and the reasonable magnetic stored energy of 120~140 GJ [1]. As the LCFS (last closed flux surface) volume is very sensitive not only to the required magnetic field but to the blanket space and reactor size, the effect of increasing the LCFS volume with optimizing the coil current was discussed.

[1] Y. Kozaki *et al.*, 22nd IAEA Fusion Energy conf., FT/P3-18 (2008).