§14. Economic and Environmental Assessment of Helical and Tokamak Reactors

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Three reference 1-GWe D-T reactors; tokamak TR-1, spherical tokamak ST-1 and helical HR-1 reactors, are designed using PEC (Physics Engineering Cost) code, and their plasma behaviors with Internal Transport Barrier (ITB) operations are analyzed using TOTAL (Toroidal Transport Analysis Linkage) code, which clarifies the requirement of deep penetration of pellet fueling to realize steady-state advanced burning operation. In addition, economical and environmental assessments were performed using extended PEC code, which shows the advantage of high beta tokamak reactors in COE and the advantage of compact spherical tokamak in lifetime CO_2 emission reduction [1-3].

Comparing with other electric power generation system, the cost of fusion reactor is higher than that of fission reactor, but on the same level of oil thermal power system. The CO_2 reduction can be achieved in fusion reactors same as in the fission reactor. The EPR of high-beta tokamak reactor TR-1 could be higher than that of other systems including fission reactor. These systematic design and comparative simulation analyses on both tokamak and helical reactors can be done by the help of the above two codes.

For the engineering design of DT reactors, blanket thickness, maximum magnetic field strength and neutron wall loading are crucial for determining the reactor size. In the code, four blanket designs; Li/V, Flibe/FS(Ferritic Steel), LiPb/SiC, FF(Fission-Fusion) Hybrid, can be evaluated in three type reactors. In the present analysis, high-thermal-efficiency LiPb/SiC blanket is mainly considered. Other blanket designs are evaluated and published somewhere in the future. Economic and environmental assessments are performed evaluating cost, CO2 emission and energy investment on several tens of reactor components using the input-output table method. The obtained beta dependences of COE, CO2 emission and EPR are shown in Fig.1 for 1 GWe power reactors with high heat efficiency (50%) LiPb/SiC blanket system.

1) K. Yamazaki, S. Uemura, T. Oishi, J. Garcia, H. Arimoto and T. Shoji, Nuclear Fusion 49 (2009) 055017 (6pp)
2) S. Uemura, K. Yamazaki, H. Arimoto, T. Shoji, Transactions of the Atomic Energy Society of Japan. 8 (2009) 34 [in Japanese].
3) K. Yamazaki, S. Uemura, T. Oishi, The 7th General Scientific Assembly of the Asia Plasma and Fusion Association (APFA2009) and the Asia-Pacific Plasma Theory Conference (APPTC2009) Aomori, Japan, October 27-30 2009.

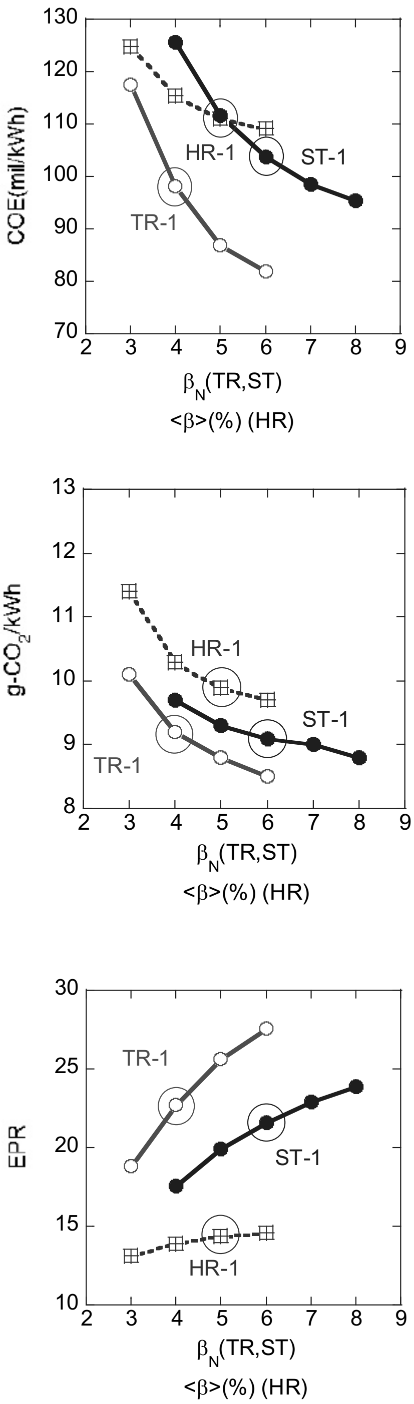

Fig.1 Comparisons on Cost of Electricity (COE) (upper figure), CO2 emmision ammounts (middle figure) and Energy Payback Ratio (EPR) (lower figure) for Tokamak reactors(TR), Helical reactors(HR) and Sperical Tokamak (ST) reactors.