EF-P042

Design Study of LAR Tokamak Reactor with a Self-consistent System Analysis Code

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The design of the blanket and shield play a key role in determining the size of a reactor since it has an impact on the various reactor components. The blanket should produce enough tritium for tritium self-sufficiency and the shield should provide sufficient protection for the superconducting TF coil. Neutronic optimization of the blanket and the shield is necessary, and we coupled the system analysis with a neutronic calculation to account for the interrelation of the blanket and shield with the plasma performance of a reactor system in a self-consistent manner.

By using the coupled system analysis code, the operational space for a low aspect ratio (LAR) tokamak reactor with a superconducting toroidal field (TF) coil is investigated with an aspect ratio in the range of 1.5 - 2.5. The minimum major radius which satisfies all the physics and engineering requirements increases with the magnetic field at the magnetic axis. A required inboard shield thickness is mainly determined by the requirement on the protection of the TF coil against radiation damage. It is shown that to have a fusion power bigger than 3,000 MW in the LAR tokamak with a superconducting TF coil, a major radius bigger than 4.0 m is required.