§5. Improvement of TBR and Activation Analysis of Blanket in FFHR

Wu, Y. (Institute of Plasma Physics, CAS, China),
Yamanishi, H., Muroga, T., Sagara, A.

Based on the blanket design of FFHR (Force Free Helical Reactor) [1], neutronics optimization have been carried out to improve the local Tritium Breeding Ratio (TBR) and activation calculations have been done to check the effects of low activation vanadium-alloy as structure material.

We calculated the local TBR using the 3D Monte Carlo Neutron/Photon Transport Code MCNP4B with the latest version of FENDL-2(Fusion Evaluated Nuclear Data Library) cross section library provided by the IAEA(Inter. Atomic Energy Agency)[2], calculated the flux spatial distribution using the 1D Discrete Ordinate Transport Code ANISN with the UW library[3] and calculated the activities and BHP(Biological Hazard Potential) of FFHR blanket using the improved activation analysis code AFDKR[4].

The previously estimated local TBR (1.18) for the reference design of FFHR was very marginal [5] and improvement is still required. Both previous and current calculations showed the increase of Be amount in the Be-Flibe zone improved the TBR. Particularly in current analysis, we noted the adoption of carbon reflector apparently increased the margin on the local TBR and the shielding efficiency for fast neutron (>0.1MeV) and gamma-ray, which is the ratio of the flux at the front to outer of the blanket, does not deteriorate much with the thickness of 20cm of carbon reflector (thickness of B_4C shielding zone accordingly reduced 20cm to keep the total thickness of 100cm of blanket) as in Fig.1. In addition, as an alternative option for requirement of much higher TBR, enrichment of Li-6 has been examined as shown in Fig.2. There is the maximum TBR of 1.4 at 50% enrichment of Li-6.

Activation calculations for FFHR have shown that V-alloy (V-4Cr-4Ti) instead of JLT-1 stainless steel as structure material influenced the overall activation level, especially, the long-term toxicity of radioactive wastes as shown in Fig.3. Therefore, V-alloy may be considered as an option of structure material of FFHR.

References

[1] Sagara A et al. Fusion Techn., Vol.39, No.2, Part 2 (2001) 753-757.
[2] IAEA Nuclear Data Section, IAEA-NDS-CD-6, Version Jan. 14 (1999).
[3] W.W. Engle, "A User's Manual for ANISN". USAEC Report K-1693 (1967).
[4] AFDKR user manual. ASIPP internal report.
[5] Y. Asaoka et al., Fusion Techn., 30,853 (1996).

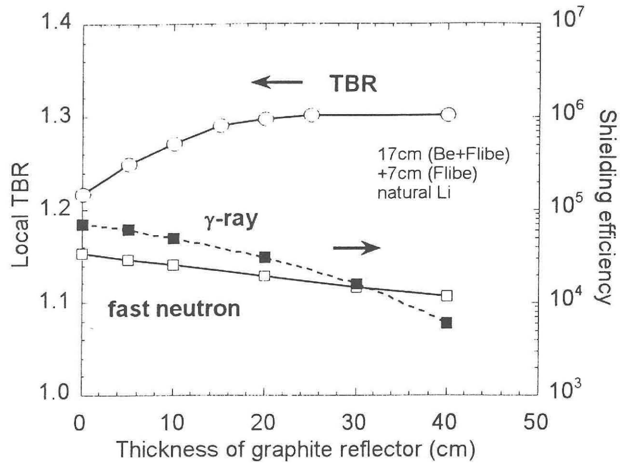

Fig.1 The local TBR and shielding efficiency as a function of carbon reflector thickness.

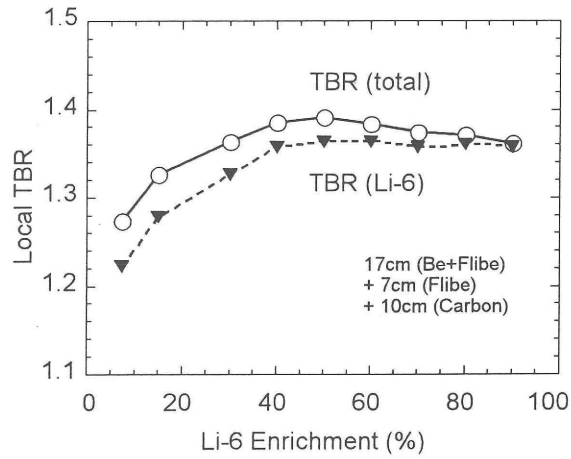

Fig.2 Dependence of the local TBR on enrichment of Li-6.

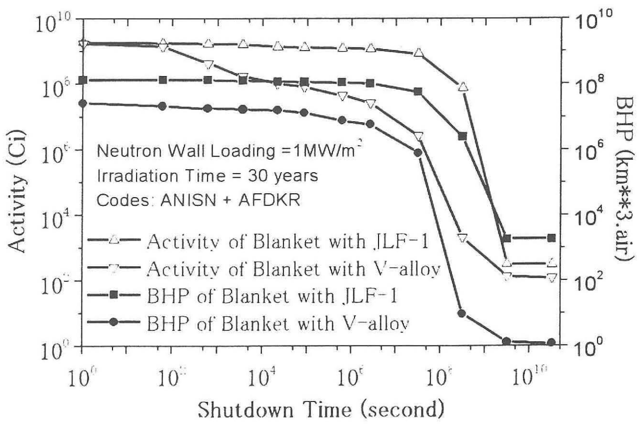

Fig.3 Effect of V-alloy instead of JLT-1 on Activation of Blanket