§74. Nuclear Calculations on the Flibe Blanket in FFHR

Yamanishi, H., Sagara, A., Motojima, O.,
Uda, T.
Noda, T. (National Research Institute for Metals)
Tanaka, S., Terai, T. (University of Tokyo)
and FFHR Group

In the reference design of FFHR-1, since the reactor size is large with the major radius R=20 m and the plasma minor radius a=2 m, the space for blanket and shield is as wide as 1 m between the last closed flux surface (LCFS) and the plasma-facing surface of helical coil. This space is divided into 5 zones, those are, the plasma scrape-off zone, the protection zone, the tritium breeding zone, the radiation and thermal shielding zone, and the vacuum and tritium boundary zone. For the blanket structural material the low radioactivation ferritic steel JLF-1 has been selected as the first candidate. The neutron multiplier Be has been adopted, because Be is expected to reduce the severely corrosive molecule TF in FLiBe by producing T_2. The shielding zone consists of B_4C and JLF-1.

The blanket design for FFHR is improved by one-dimensional neutron transport analyses which are performed for an infinite cylindrical system with P5-S8 ANISN code by using the FUSION-40 nuclear data set. This calculation gives neutron and gamma-ray flux in the blanket of FFHR. Using these flux data, nuclear properties including TBR, nuclear heating and induced radioactivity are evaluated.

From viewpoints of TBR and nuclear heating, the 28 cm breeding zone is divided into three layers as shown in Fig. 1. The first layer is consisted of FLiBe 100% layer for cooling the first wall and transfer thermal energy efficiently. The second layer is a Be pebble layer which is filled up with Be pebbles in order to increase TBR and the interactive surface area to reduce the amount of corrosive TF molecules. And the third layer is a FLiBe 100% layer. Partitions between layers are applied with plates that have many holes for FLiBe going through. In the improved blanket, TBR is 1.2 and the energy deposited in FLiBe is calculated as 55 % of the total nuclear heating.

The TBR is compared between the design of Be pebble layer and that of uniform distributed Be. Figure 2 shows the TBRs when the thickness of Be pebble layer is changed to 5cm, 10cm and 15cm. In this figure, the TBR, when the same quantity of Be is uniformly distributed in the breeding zone, is also correspondingly indicated. When the Be pebble layer has a thickness of about 12 cm, the TBR becomes 1.2.

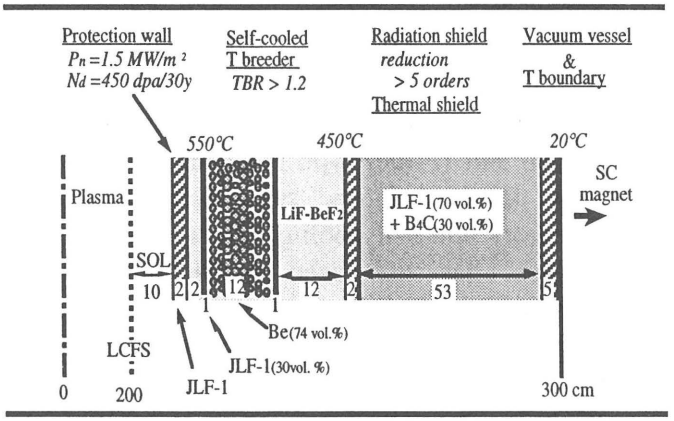

Fig. 1 The blanket and shielding stracture in FFHR

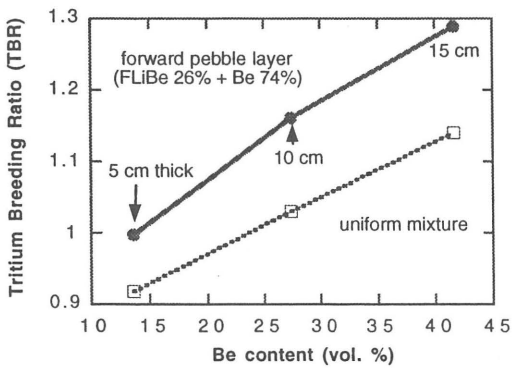

Fig. 2 Comparison of TBR between forward Be pebble and uniform mixture.