SIMPLIFICATION OF BLANKET SYSTEM FOR A SLIMCS FUSION DEMO REACTOR

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Conceptual design of a tritium-breeding blanket for SlimCS has been studied [1]. The SlimCS for a demonstrating fusion power plant is a conceptual tokamak reactor with low aspect ratio and a reduced-size central solenoid coil. The major parameters of SlimCS were a major radius of 5.5 m, an aspect ratio of 2.6 and a fusion power of 2.95 GW. Basic requirement for feasible reactor include net Tritium Breeding Ratio (TBR) ≥1.05. The conditions of coolant in the work were sub-critical water conditions of 23MPa and ΔT=70˚C (290-360˚C). The blanket for SlimCS was divided into the replaceable blanket from the permanent blanket by the conducting shell. The replaceable blanket of 0.45m in thickness was located in the forward blanket. It was found that the achievable local TBR of the replaceable blanket was 1.38 [1]. However, a structure of the blanket was complexity. On the other hand, reasonable structure of blanket is required to manufacture in the keeping self-sufficiency of the tritium. When the manufacture of the blanket would turn out to be difficult from the viewpoint of engineering, simplification of blanket system is necessary for SlimCS.

In this paper, the blanket system was analyzed to be as simply as possible without decreasing the net TBR below 1.05. The breeding area for simple blanket system was mixture of Li_4SiO_4 pebbles for the tritium breeding and $Be_{12}Ti$ pebbles for the neutron multiplication, as shown in figure 1. Both materials can be mixed in the blanket without surplus of partition, because of chemically-stabile materials. There diameters of the pebbles are 0.2 mm and 2.0 mm, respectively. In these conditions, packing fractions of mixed breeding zone were 65-80%. In the calculations of the neutronics and thermal analysis for the blanket system, ANIHEAT code with the nuclear data library FUSION-40 was used. Figure 2 shows preliminary results of the local TBR for the neutron wall load. The calculated conditions were the coolant of the sub-critical water, ^{6}Li enrichment of 90% and a breeding blanket of 0.45m in thickness. For a decrease in the neutron wall load from 5 to 1 MW/m^2, the local TBR was improved for the reduced water of coolant in the breeding blanket. Moreover, neutron wall load is changed along the poloidal direction. Taking accounts in the distribution of the neutron wall load, the suitable designs of the blanket were effective in the net TBR. Finally, the layout of suitable blanket designs along the poloidal direction is proposed in consideration of blanket coverage, and engineering problem such as maintenance and manufacture are discussed.

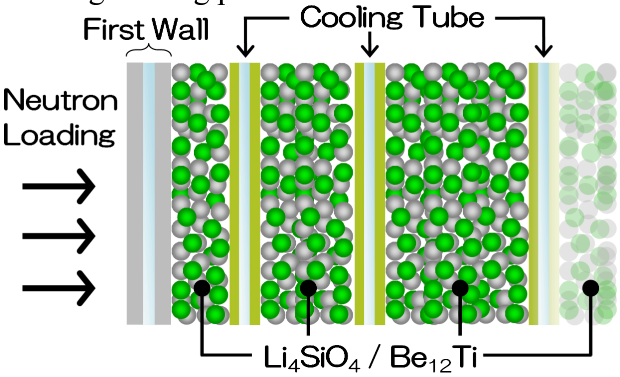

Fig. 1 1D-model of simple blanket system

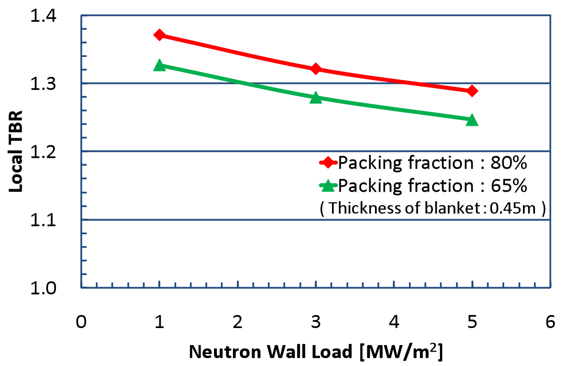

Fig. 2 Local TBR for neutron wall load

[1] K. Tobita et al., Nucl. Fusion, volume 49, (2009) 075029 (10pp)