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筐体内冷却管破断を考慮した耐圧性を有する核融合炉ブランケット
Fusion blanket with pressure resistance against in-blanket LOCA

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1. Introduction

In view of efficient power generation in fusion reactor, water-cooled ceramic breeder (WCCB) blanket with a coolant pressure of 15 MPa or over is being developed in QST. Higher pressure of coolant leads to thicker wall of pressure resistant parts in the blanket. To consider a coolant pipe break in the blanket, thickness of the blanket wall is decided by the coolant pressure to have pressure resistance. This increase in the wall thickness results in reduction of tritium breeding capability. Recently cylindrical blanket is studied because of its geometric advantage in necessary wall thickness. In this study, relationship between structural integrity and tritium breeding capability was studied for both box-shaped and cylindrical blankets.

2. Analysis

The structural integrity of box-shaped and cylindrical blankets is evaluated by theoretical calculation based on JIS B8280 and numerical calculation by a commercial finite analysis method code ANSYS ver19.1. The coolant pressure of 17.2 MPa was considered as a mechanical load. Tritium breeding ratio (TBR) in the modules was calculated by Monte Carlo N-Particle code (MCNP). Breeder material of Li_2O and neutron multiplier of Be were considered. Figure 1 shows calculation models, and dashed lines shows reflecting boundaries. Cross sectional area in the boundaries is defined as “evaluation area” and it is the same for both models.

3. Results and discussion

For the different evaluation areas, wall thicknesses of t1 and t2 were calculated to have pressure resistance for box-shaped and cylindrical blankets, respectively. For the box-shaped blanket, evaluation area contains 1/2 t1 as the reflecting boundary was taken into account. And then, TBRs for the blankets were calculated. Calculated values are exhibited in fig.2. The TBR is monotonically increased with increasing evaluation area for both blankets. The TBR and its increasing ratio of cylindrical blanket are higher than those of box-shaped blanket. For the same evaluation areas, the cylindrical blanket has a thinner thickness, larger breeder/multiplier zone and higher TBR than box-shaped one. It is implied that the cylindrical blanket could exhibit better balance of pressure resistance and tritium breeding capability even though it inevitably has a gap around the blanket. The details of evaluation procedure and additional discussions will be presented on the poster.

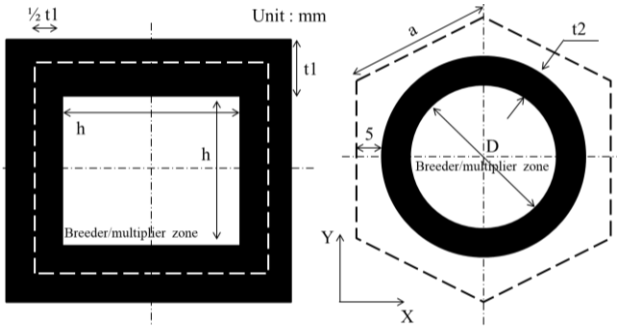

Fig. 1 Cut-view of box-shape and cylindrical blanket (Blanket wall is shown in black)

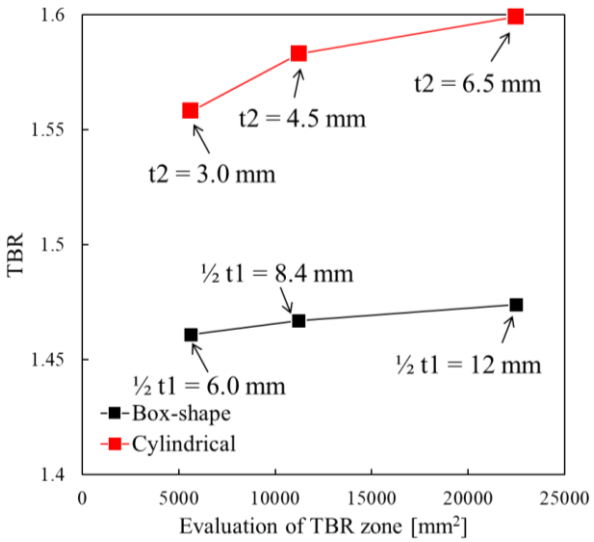

Fig. 2 Relationship between the TBR and evaluation area