Integrity Assessment of Bare Basket for Pre-packing Type B Radwaste

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1. Introduction

ITER radwaste will be generated in various ITER buildings such as Tokamak, a hot cell building, personnel assess control building, and a tritium plant building during the machine operation and maintenance periods. ITER radwaste is classified into Type B waste and purely tritiated waste which are at an intermediate level waste; Type A waste which is a low level solid; and liquid waste, and TFA waste which is a very low level. Among these radwaste types, Type B waste and purely tritiated waste are expected to generate about 1,200 and 43 tons, respectively[1]. Type B radwaste is to be transferred to the hot cell basement, treated (cutting & tritium removal), characterized and measured, pre-packed, characterized, and stored in the low-level radwaste building for 6 months, and then transferred to the extension located next to the hot cell building and stored for about 20 years.

Since an enormous amount of Type B radwaste will be generated compared to other waste types, it is important to select its pre-packaging method to store effectively and safely in the hot cell. In this study, among the various basket types, the stress analysis was performed to find the optimized side and bottom wall thicknesses for the bare basket.

2. Stress Analysis Results of the Bare Basket

The bare basket is made of a frame and a plate to reduce cost and basket weight. Its outer dimension is 1.4 m x 1.4 m x 1.4 m and it weighs about 6.4 ton (in case of side wall thickness: 0.075 m and bottom wall thickness: 0.4 m) [2]. The maximum loading weight of the bare basket is about 7.5 tons and it can store an average of 3.5 tons. In this study, a stress analysis was conducted on the condition of the maximum loading weight being 7.5 tons for a conservative analysis.

(1) Stacking

The normal operation for handling baskets is defined as they are stacked in the hot cell. The bare baskets are stacked in 3 levels in the hot cell, and the height of the piled baskets is 4.2 m. When the bare basket is stacked, bare baskets in the first level take 2 times the total weight of it. Therefore, the bare basket must sustain the structural integrity for that weight. Fig. 1(a) shows the maximum stress contour with respect to the side and bottom wall variations. The maximum stress in the bare basket is about 100 MPa and the maximum stresses in the matrix of the side and bottom wall thickness satisfies the normal operation stress criteria (138 MPa).

(2) Vertical drop

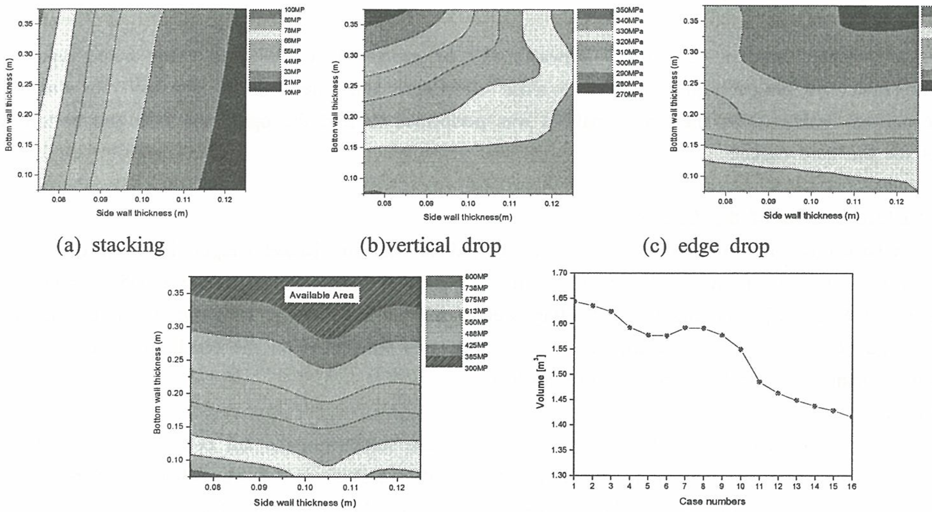
In the vertical drop simulation, it is necessary to know the velocity just before the impact as an initial condition. In this case, the velocity of the basket just before the impact is 9.1 m/sec. In this simulation it is assumed that the ground is not deformable and the waste in the basket is uniformly distributed. Fig. 1(b) shows the maximum stress contour for the matrix of the side wall thickness (0.075 m～0.125 m) and bottom wall thickness (0.075 m ～ 0.4 m). As shown in Figure 8, the maximum stresses in the matrix of the side and bottom wall thickness satisfies the accident stress criteria (<385 MPa). Therefore in only vertical drop case, the optimized side wall and bottom thicknesses to maximize the inner volume of the bare basket are 0.075 m and 0.075 m, respectively.

(3) Edge drop

The edge drop is one of the accident conditions of a basket and it is defined that the basket's bottom edge line is hitting on the ground. Fig. 1(c) shows the maximum stress contour with respect to the side wall thickness (0.075 m ～ 0.125 m) and bottom wall thickness (0.075 m ～ 0.4 m) variations. In this figure, the maximum stress trends to increase as the side and bottom wall thicknesses decrease. On the contrary, the maximum stress trends to decrease as they increase. And also the maximum stresses in the matrix of the side and bottom wall thickness satisfies the accident stress criteria (<385 MPa).

(4) Corner drop

The corner drop is the most severe case in the accident conditions. The corner drop is defined as the corner point of a basket collides with the ground. Generally the less the contact area is small, the more increases the stress there. Therefore in this case the maximum stress might be more increased than other cases. Fig. 1(d) shows the maximum stress contour with respect to the side wall thickness (0.075 m ~ 0.125 m) and bottom wall thickness (0.075 m ~ 0.4 m) variations. The hitched area means the side and bottom areas satisfy the stress limit of the accident condition. In order to determine optimized side and wall thickness for the accident condition, the inner volumes were calculated along with the stress limit board line (red line in Fig. 1(d)). Fig. 1(e) shows the inner volume variation along with the board line. In this figure, the optimized side and bottom wall thicknesses are 0.075 m and 0.348 m, respectively. It is found that the maximized inner volume is 1.644 m3 and its weight is 6.56 tons.



(a) stacking (b)vertical drop (c) edge drop

(d) corner drop (e) volume variation plot

Fig. 1. Contour of maximum stress for various drop cases

3. Conclusion

In this study we performed the stress analysis to find the optimized side and bottom wall thickness for the bare basket. According to the stress analysis results, it needs 0.075 m thickness of side wall and 0.348 m thickness of bottom wall thickness to satisfy the all drop conditions. However if ITER takes risks such as a vertical, edge and a corner drop accidents, the cost and space for prepackaging Type B waste can be dramatically reduced.

Reference

[1] Updated Layout of the Type B Radioactive Waste Treatment and Storage System in the Hot Cell Building, ITER_D_27XYVR(V1.1), 2008

[2] Functional Analysis of the Radioactive Waste Process and Storage Equipment in Hot Cell Building and Analysis of its Design Impact, COMEX NUCLEAIRE, 2008