§7. Tritium Production Rate Measurement in Li/V-alloy Assembly with 14 MeV Neutron Irradiation

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Neutronics investigations for the Li/Vanadium alloy (V-alloy) blanket system without Be neutron multiplier have been performed as one of alternatives in the design activity of the helical type reactor FFHR2. To examine the accuracy of the neutronics calculations for the combination of Li and V-alloy, tritium production rates in a Li/V-alloy assembly with a 14 MeV neutron irradiation have been measured at the Fusion Neutronics Source (FNS) facility of JAEA.

The Li/V-alloy assembly was constructed with small solid Li blocks and V-4Cr-4Ti vanadium alloy blocks as shown in Fig. 1. The dimensions of the assembly were ~46 x 51 x 51 cm^3. A V-alloy layer of ~23 x 24 x 5cm^3 was placed in the assembly at the position of ~15 cm from the front surface. On the central axis of the assembly, ^{6}Li enriched (^{6}Li: 95.5 %) and ^{7}Li enriched (^{7}Li: 99.94%) Li_2CO_3 pellets of 13 mmϕ x 1.9 mm were installed for a tritium production rate measurement. The generation rate of 14 MeV neutrons at the tritium target was ~8 x 10^{10} n/s and the total irradiation time was ~13 hours. After the irradiation, the Li_2CO_3 pellets were dissolved in a HNO_3 + CH_3COOH solution and liquid scintillator was added. Tritium activity in the solution was measured with a liquid scintillation counter [1]. The maximum measurement error was 8 %. The measured tritium production rates were compared with those calculated using the MCNP5 code and JENDL-3.3 library.

Figure 2 shows the distribution of the tritium production rates measured with the Li_2CO_3 pellets. It is noted that more than 99 % of tritium was produced by the ^{7}Li(n,nα)T reaction (Threshold energy: 2.8 MeV) in the ^{7}Li enriched pellets. In the ^{6}Li enriched pellets, the contribution of ^{7}Li to the tritium production was < 5 % and most of tritium was produced by the ^{6}Li(n,α)T reaction with low energy neutrons. The distribution for the ^{6}Li enriched pellets shows the enhancement of ^{6}Li(n,α)T reaction around the V-alloy layer which is considered because of the elastic and inelastic scattering and (n,2n) reaction in the V-alloy layer. Comparison of the measured and calculated tritium production rates is shown in Fig. 3. The calculated/experimental (C/E) values for the ^{7}Li enriched pellets are 1.01-1.04 and those for the ^{6}Li enriched pellets are 1.02-1.08, respectively. The distribution shows a tendency of slight overestimation for the tritium production rates by the ^{6}Li(n,α)T reaction around the V-alloy layer.

The present result indicates that the measured and calculated tritium production rates in the Li/V-alloy assembly are consistent within 8 %. The impact of the present result to the neutronics investigations of the Li/V-alloy blanket is under study.

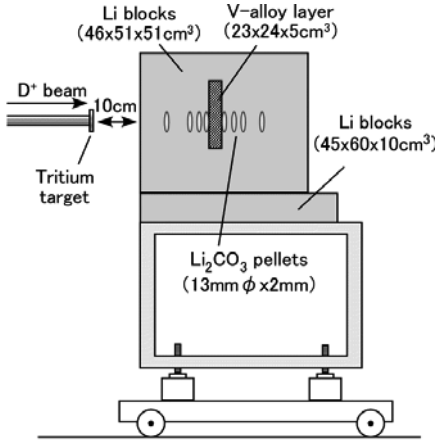

Fig. 1 Schematic drawing of tritium production rate measurement in a Li/V-alloy assembly.

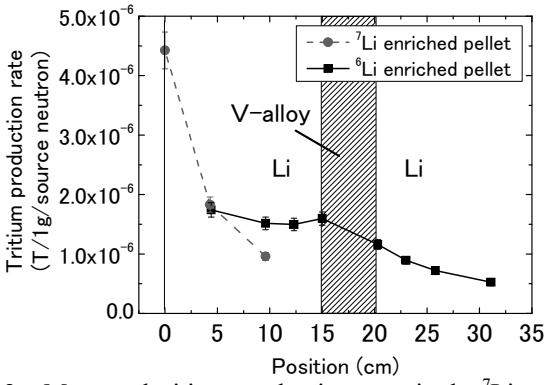

Fig. 2 Measured tritium production rates in the ^{7}Li enriched and ^{6}Li enriched Li_2CO_3 pellets.

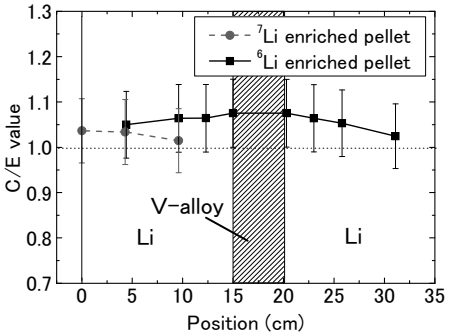

Fig. 3 C/E for the tritium production rates in the Li/V-alloy assembly.

1) Y. M. Verzilov et al., JAERI-Research 2004-015.