§1. Neutronics Investigation into a Test Blanket Module with Li and V alloys

Muroga, T., Tanaka, T.

Technical discussion on ITER-Test Blanket Modules (TBM) has been made in Test Blanket Working Group (TBWG)[1]. The discussion is based on the concepts of breeding blankets to be developed for DEMO. The present concepts of lithium self-cooled blanket for DEMO are categorized into "No beryllium (Li/V)" and "With beryllium (Li/Be/V)" concepts. The former and the latter systems use neutron reaction of ^{7}Li (n,nα)T and ^{9}Be(n,2n)^{2}He for enhancing the Tritium Breeding Ratio, respectively. A Design Description Document was presented from Russia based on Li/Be/V blanket concept. However, the document based on Li/V concept has not been presented to TBWG yet.

The Li/V concept has some advantages over Li/Be/V concept; (1) the blanket structure can be simplified, (2) the system is free from the issues of natural resource limit and handling safety concerning beryllium, (3) no periodic replacement of blanket because of the lifetime of Be is necessary. The present study is the initial effort of investigating Li/V TBM from the neutronics aspects. In this report, the neutron energy spectrum and tritium production rate have been calculated using MCNP code with JENDL-3.2 database to characterize the Li/V test modules to be installed as ITER-TBM.

The primary purpose of the module test was defined as validation of the tritium production rate predicted based on the neutron transport calculation. For this purpose the module was designed to be composed of sectioned thick boxes which accommodate slow Li flow. The schematic view and cross section of the module is given in figure 1. This system enables to measure the tritium production rate as a function of the distance from the first wall. The size of the four boxes was limited (~0.027m^{3}) so as to satisfy the introduction limit of liquid lithium into the ITER test port. In Figure 1, there is a thin Li layer behind the first wall where Li is flowing with relatively high rate. The purpose of the layer is to cool the first wall and test MHD effect. The use of Li in this layer is, however, optional.

Spectral control is necessary for the module to simulate fusion DEMO blanket conditions. For this purpose, the module is covered with a B_4C layer to shield thermal neutrons. Figure 2 shows the result of calculation for tritium production in the module for the cases with and without the B_4C cover of 7.5 mm thick. With the cover, tritium production rate decreases but the contribution of ^{7}Li reaction to the overall tritium production increases significantly.

The contribution of ^{7}Li reaction to overall tritium production can be a parameter showing the spectral effects in the blanket area. The calculation implies that with coverage of B_4C layer of 2~5mm, the tritium production reaction from Li in the module is similar to that in the Li/V blanket. In the module experiment, the thickness of the B_4C cover can be a parameter for verifying the neutron transportation calculation.

Reference

1) V.A. Chuyanov, "ITER Test Blanket Working Group activities: a summary, recommendation and conclu-sions", Fus. Eng. and Design **61-62,** 273 (2002).

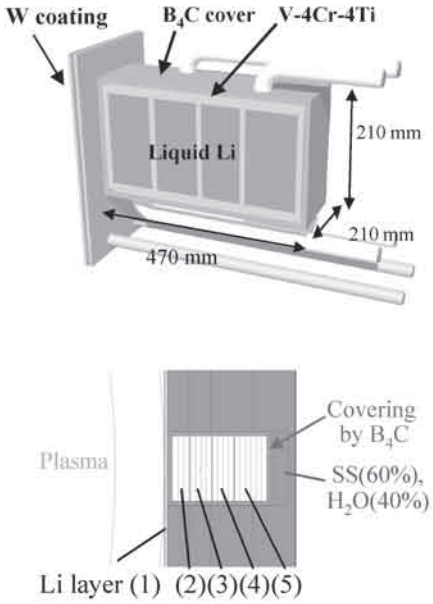

Fig. 1 The schematic view and cross section of the Li/V test module.

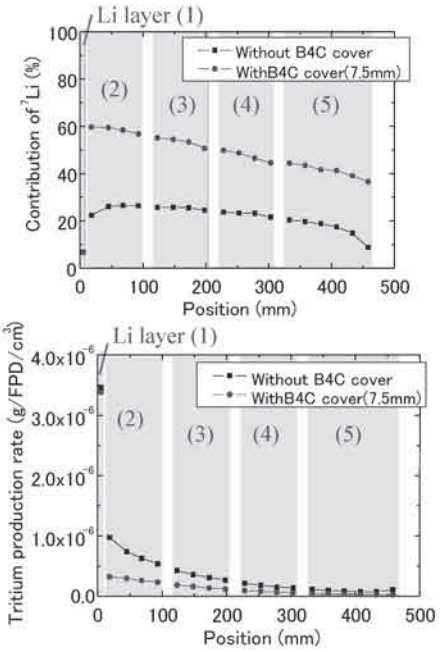

Fig. 2 Tritium production rate (upper Fig.) and contribution of ^{7}Li (n,nα)T reaction to overall tritium production (lower Fig.) as a function of the position in the Li/V test module.