§1. Neutronics for Li/Vanadium-alloy and Flibe/Vanadium-alloy Blanket Systems

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Neutronics calculations were carried out to characterize self-cooled Li and Flibe blankets with vanadium alloy (V-4Cr-4Ti) structure, as advanced options for the Force Free Helical Reactor (FFHR-2). In the present paper, the parameter dependence of Tritium Breeding Ratio (TBR) and neutron shield performance was examined for a Li blanket (FFHR-LV) and a Flibe blanket (FFHR-FV). Calculations of neutron transport and of nuclear reactions were performed for FFHR-LV and FFHR-FV blankets by using the MCNP-4C code and JENDL 3.2 nuclear data. The modified FFHR-2 design, FFHR2m1, has a plasma major radius of 14.0 m and a minor radius of 1.73 m. The neutron wall load is 1.5 MW/m^2. In the present calculation, a simple torus was fully covered with uniform blanket layers consisting of self-cooled breeder channels and radiation shield.

The TBR was independent from the Flibe composition between 30 to 45 mol% of BeF_2 in the case of the FFHR-FV as shown in Fig. 1. Due to the increase in the temperature range of the coolant Flibe as a result of the change of the structural materials from JLF-1 (Low activation ferritic steel) to V-4Cr-4Ti, the fraction of BeF_2 can be changed from 43 mol% to 31 mol% without changing the margin to coagulation of Flibe and without changing TBR. The compositional change of Flibe resulted in a significant decrease in its viscosity as shown in Fig. 2.

The increase in the B_4C in the shielding material resulted in the decrease in the fast neutron flux at the superconducting magnet by 60-70% in both FFHR-LV and FFHR-FV, as shown in Fig. 3.

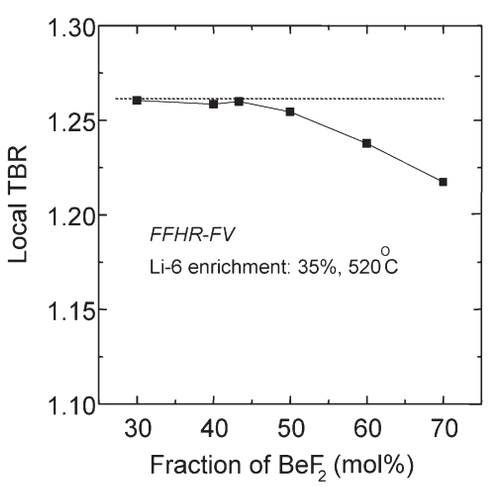

Fig.1 Local TBR as a function of the fraction of BeF_2 in Flibe for FFHR-FV. Blanket thickness : 60 cm, ^{6}Li enrichment : 35%, Temperature : 520 °C.

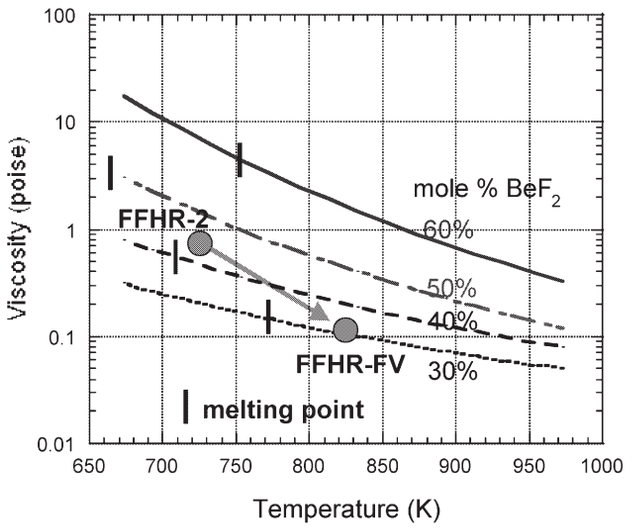

Fig.2 Viscosity of Flibe as a function of temperature and mole % of BeF_2. The conditions for the minimum temperature region of the blankets of FFHR-2 and FFHR-FV are shown in the Figure.

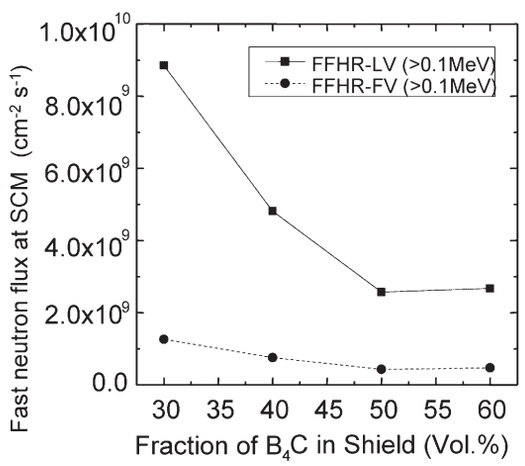

Fig.3 Fast neutron (E>0.1MeV) flux at superconducting magnet as a function of the fraction of B_4C in the shield for FFHR-LV and FFHR-FV.
Blanket thickness : 54 cm for FFHR-LV and 60 cm for FFHR-FV,
^{6}Li enrichment : 35%, Temperature : 520 °C.