§37. Feasibility Study of LiPb-He-SiC High Temperature Blanket Concept

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1. Introduction

Blanket is one of the most important technical issue of the fusion technology to utilize the fusion energy to convert from fast neutron to commercial form. High temperature blanket for efficient and attractive energy conversion is one of the most important subjects in fusion technology. Concepts with Lithium-Lead eutectic is expected as a liquid blanket material for future fusion reactors that is possible to initiate test as a Test Blanket Module in ITER, and also eventually expected to be an advanced blanket to be operated at high temperature encompassing 900 degree C. We propose the concept of the high temperature advanced blanket with the combination of liquid LiPb, SiC composite material, and helium coolant. Under this LHD collaborative study, fundamental issues of LiPb-SiC blanket system such as tritium solubility and permeability on LiPb and SiC, compatibility of the matrial with LiPb are investigated. .

2. Outline of the study

The figure 1 shows the concept of the blanket we propose. The outer vessel is made of ferritic/martensitic steel cooling panel with proven technology. The tritium breeder and multiplier is LiPb eutectic to be slowly circulated to recover the fusion heat at the temperature as high as 900 degree C. SiC cooling panel made of the NITE composite developed by the Kyoto university works as an insulation to maintain the temperature of the outer vessel below 550 degree. The research activities in our laboratory on this concept covers wide range of the technical subjects such as;

1) design and numerical calculation on neutronics and thermal hydraulics,
2) material compatibility
3) MHD effect measurement
4) hydrogen behavior and control in SiC-LiPb system,
5) LiPb loop technology.

In this section, some of the recent results are presented.

Figure 2 shows the typical thermal design of the blanket module. The breeder is designed to generate sufficient tritium at the ratio TBR>1.2 that can be designed with the neutronics code. In this case, 1D transport code ANISN was used to evaluate the tritium production from the neutron comes from the left side. Heat generation is at the same time obtained, and the figure 2 shows the temperature distribution calculated as the result of the nuclear heat and its removal by the helium flow so that cooling in the SiC channel will maintain the left side at 550 degree C that is below the limit for ferritic steel material..

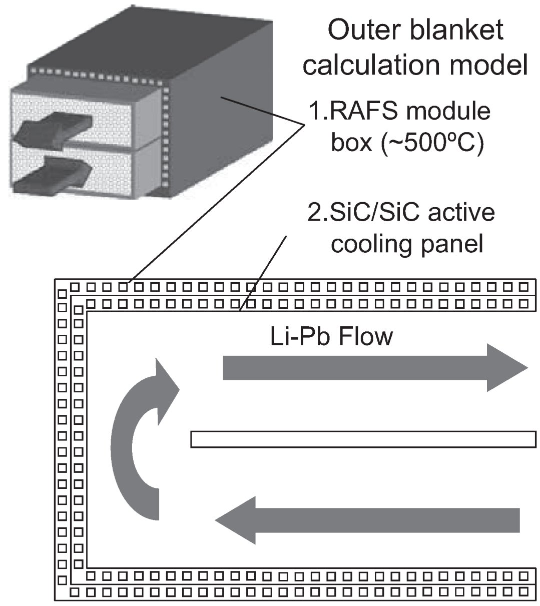

Fig.1 Cylindrical IECF device with energy spectrum analysis system.

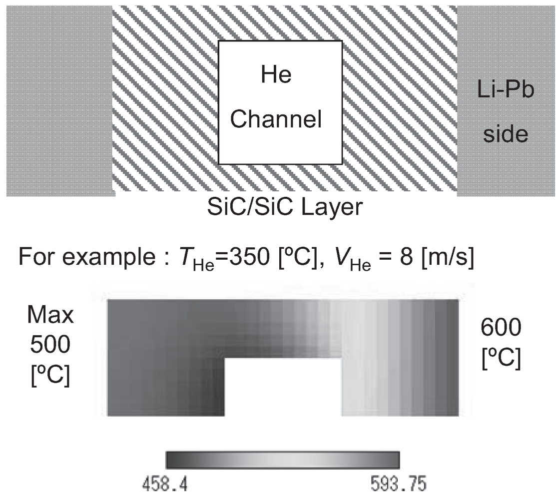

Fig.2 Temperature distribution in the SiC cooling panel. The right side faces 900 degree LiPb while the left is maintained below 550 degee.

Tritium permeation is one of the important issue, and we started the measurement of hydrogen permeation through advanced materials. Compatibility between LiPb and SiC and F82H is also being measured.

3. Conclusion

The entire research program is progressing toward the evaluation of feasibility of the concept. Current emphasis is on compatibility and LiPb-H chemistry, and corrosion and isotherm are measured with attention on purity and the effect of atmosphere.