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Progress and Strategy of ITER Liquid-type TBM Development

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1. Introduction

One of the main engineering performance goals of the ITER is to test and validate the design concepts of the tritium breeding blankets relevant to a power producing reactor. The tests will focus on modules including a demonstration of the breeding capability that will lead to a tritium self sufficiency and extraction of heat suitable for electricity generation. Korea has developed a Helium Cooled Molten Lithium (HCML) Test Blanket Module (TBM) and Helium Cooled Solid Breeder (HCSB) TBM to be tested in the ITER. Recently, solid-type HCSB TBM was decided as a leading concept in National Fusion Committee and the other is developing as the breeding blanket for DEMO. The name of the solid type TBM was changed to a Helium Cooled Ceramic Reflector (HCCR) considering the unique concept of using the graphite reflector [1-6].

For the liquid type TBM, the research scope was reduced only for investigating the international R&D status and making a strategy for developing a liquid breeder blanket for a fusion reactor in Korea in the scope of the ITER, which is being supported by one of the projects on the ITER non-procurement key technology development by the National Fusion Research Institute (NFRI). The present paper shows the developed strategy and current R&D status.

2. DB construction and R&D strategy development

By reviewing the liquid breeder blanket technology from journal papers, meeting materials, related domestic data such as Gen. IV reactor program, and other international programs, a research strategy was established with the following procedures:

(1) Technical/research/journal papers, including conference and workshop presentation materials, were obtained and reviewed. A DB of the references was constructed. (Fig. 1)
(2) The references were divided into two categories and the categories were re-sorted into three sub-categories. (Fig. 2)
(3) Based on the DB, domestic/abroad status of the liquid breeder blanket technologies was investigated and non-secured key technologies in Korea were determined.
(4) From the analysis of the key technologies, a strategy for achievement of the key technologies was established and a technical report was published. (Fig. 3)

3. Tritium permeation sensor development

According to the developed strategy, one of the basic R&D items, tritium permeation sensor development, was selected and has started to be developed.

There are several researches for developing the sensors in the ITER participants, and especially, EU has developed permeation sensors trying to select materials with low Sievert's constant and high hydrogen diffusivity coefficient. When it comes to the geometry, cylindrical- and annulus- shape of permeable sensors were invented to measure the hydrogen concentration in the liquid metal breeder. The annulus type was finally chosen to reduce the time necessary to measure the concentration. However, this response time is still too long at about several hours to measure the tritium in the online system [7-8].

To solve this problem, we designed and fabricated several sensors with various materials and plate types. A test was performed.

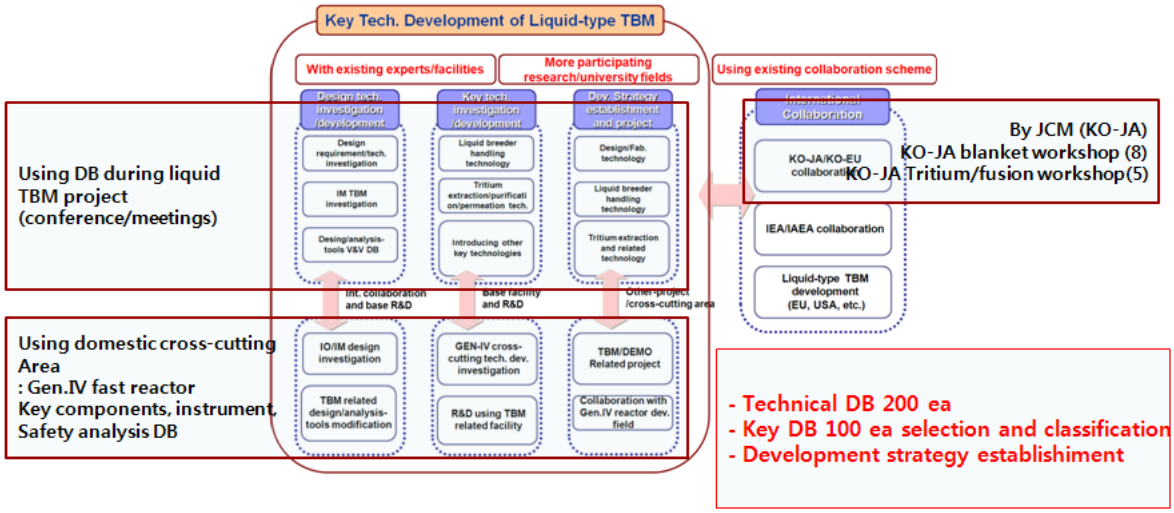

Fig. 1 Schematic of the literature survey and DB construction of the liquid breeder blanket development

Fig. 2 Classification of the constructed DB

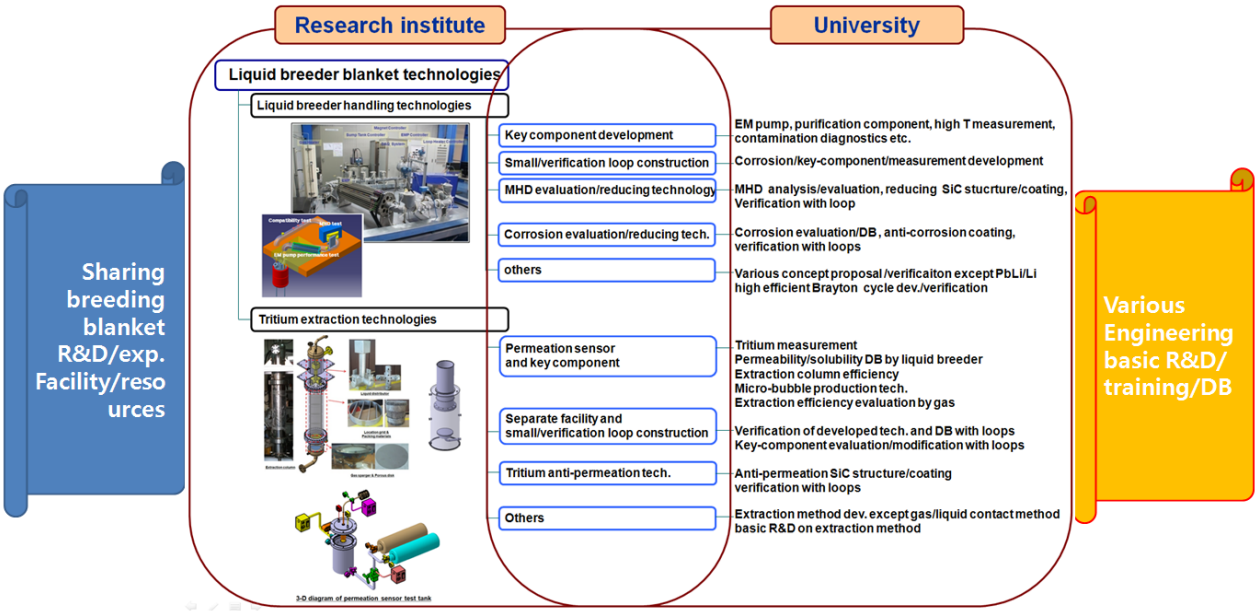

Fig. 3 R&D strategy for liquid breeder blanket in Korea

4. Conclusion

To develop an R&D strategy on a liquid-type TBM in the ITER, the DB was constructed which was collected from the technical, research, and journal papers, including conference and workshop presentation materials, were obtained and reviewed. A DB of the references was constructed. They were divided into two categories and these were resorted into three sub-categories. From the analysis of the key technologies, a strategy for an achievement of the key technologies was established, and a technical report was published. Among the key R&D items, the tritium permeation sensor development was selected and has started to be developed in this project.

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