

Development Scenario of Tokamak Reactor for Early Demonstration of Electric Generation

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The development scenario of the tokamak reactor by three stages (i.e. the experimental reactor such as ITER, a demonstration reactor, and a commercial reactor) is recently being discussed.

In order to construct the feasible development road map, it is necessary to evaluate which component of reactor technologies and to what extent should be developed. From the viewpoint of the future electric supplier, we proposed the conceptual design of a commercial reactor, CREST[1] and a demonstration reactor, Demo-CREST [2,3]. On the other hand, the project of the experimental reactor ITER is underway, and its experimental plan and R&D activities are almost completed. Hence, it is most important and reasonable to investigate the demonstration reactor on the track of ITER in order to show a specific development scenario of the tokamak reactor. In this paper, a specific development scenario by three devices, ITER, Demo-CREST and CREST, is constructed, in which early demonstration of net electric generation at demo phase is focused.

In the Demo-CREST operation[2,3], the improvement of plant performance is steadily explored through the following two phases, (i) the demonstration phase, and (ii) the development phase. In the demonstration phase, a net electric power of 500MW is achieved based on the results from the ITER project. In the following development phase, a net electric power of 1000MW is feasible by the advanced plasma operation and reactor technology (reversed shear plasma operation, thermal efficiency more than 40%, and so on) applied to CREST. Accordingly, the demonstration of the key technology required for improving economic performance in Demo-CREST leads to the reactor technology required for CREST.

In the Demo-CREST design, the large blanket module system for aiming at TBR~1.1 in the demonstration phase is applied to demonstrate tritium self-sufficiency, and its replacement method that enables to shorten the maintenance period is proposed. Consequently, the tritium self-sufficiency and maintainability is ensured in Demo-CREST, which leads to the reliable operation indispensable to the demonstration reactor. The priority of development issue and its objective parameter for each development stage of the scenario are also assessed.

[1] K.Okano, et al., Nucl. Fusion 40(2000)635

[2] Y.Asaoka, et al., "Conceptual design of a demonstration reactor for electric power generation", Proc. 20th IAEA Fusion Energy Conf.(Vilamoura, November 2004), IAEA-CN-116-FT/P7/4.

[3] R.Hiwatari, et al., Nucl. Fusion45(2005)96

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