§22. Measures to Radioactive Waste Arising from Fusion Reactor

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Introduction

Maintenances of highly radioactive components and management of radioactive wastes including reusing and recycling are important subjects to be studied for operating a fusion reactor. From these points of view, a scenario of work procedures and a layout of the hot-cell for maintenance were studied by reviewing experiences of present nuclear facilities. The design of ITER was referred in this study [1].

Maintenance of fusion reactor

A maintenance scenario assumed is such as replacement of blanket and diverter modules (sector) as one piece and disassembling of the sector, classification and storage of radioactive wastes in the hot-cell. Issues on the scenario were discussed which must be considered in the designing phase. Since the sector is highly radioactive and the temperature is high due to the decay heating as shown in Table 1[2], it is necessary to consider the long cooling term for reuse/recycle of the components. Also the proper layout plan of the hot-cell and drafting of the detailed procedure are indispensable for the effective maintenance work such as disassembling and decontamination.

Table 1 Component property after 2 years cooling
(3 GW power and 2years operation)

Components	Dose rate (Sv/h)	Temperature (℃)
Outer part of blanket	4.75×10^{3}	178
Inner part of blanket	3.21×10^{3}	281
Diverter	5.7×10^{2}	126

Disassembling and classification process

In the hot-cell, the components of the sector taken out of the core are disassembled and classified considering reuse/recycle and disposal as shown in Fig.1. Lithium and beryllium are reusable materials; those may be cooled down in around 10 years for reusing. The structural materials are also reusable after cooling of roughly 50 years. Non-reusable materials are disposed of by classifying them based on the radioactivity levels. For the effective maintenance described above, the hot-cell is segmented coping with each work activity. The segmented areas are categorized considering the work activity of disassembling, decontamination and storages. Some areas are requested to be highly air tightness conditions for prevention of spreading of tritium contamination.

In addition, it may be necessary to prepare a new framework of safety regulation for disposal of radioactive wastes.

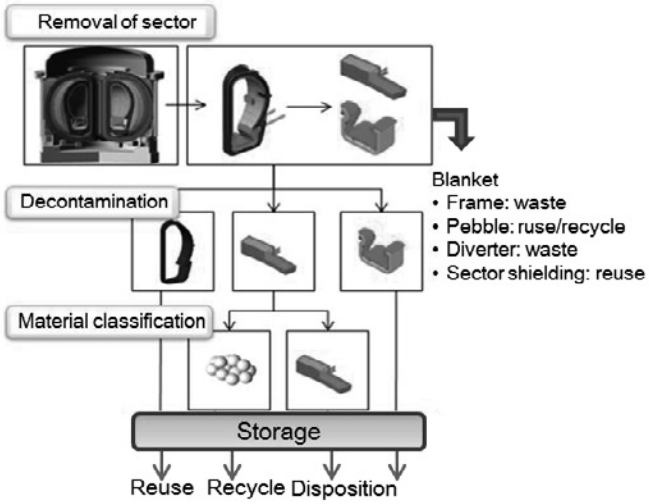

Fig.1 Flow of maintenance process

Plant life cycle

In the maintenance period, a new sector is installed into the core after one sector is removed one by one. This process is repeated until finishing one replacement cycle. Mutual use of sector components among several fusion reactors may be considered, since one cycle of the replacement of all sectors and cooling period for reue/recycle expects more than the life time of a fusion reactor. The storage area of the sectors may be large enough for matching long time operation of the fusion reactor. Optimization for the effective sector replacement cycle is important for the practical reuse/recycle and disposal of the radioactive waste.

Remarks

The work process of sector maintenance and the layout of hot-cell for the work were discussed. Although reuse/recycle of components produced by disassembling sectors are indispensable options, it is hard to use the components in one single fusion reactor due to the long cooling period required. A proper plant life management including plant life time expectation should be studied to share the components among several fusion reactors.

1)Tsunodate, S: J. Plasma Fusion Res. Vol.87, Supple., (2011) 193
2) Someya, Y., Tobita, K., J. Plasma Fusion Res. Vol.7 (2012)