§14. Measures to Radioactive Waste Arising from Fusion Reactor Operation

Yanagihara, S. (Univ. Fukui), Matsuda, S. (Tokyo Inst. Tech.), Masuzaki, S.

A large amount of radioactive wastes are produced by operating a fusion reactor in its plant life cycle including the decommissioning phase. These wastes should be properly managed to minimize the volume for final disposal. Considering proper waste management, conceptual design of the hot-cell for radioactive materials and the plant life cycle were discussed in this study.

Background

Four principles are described as the basic policy of radioactive waste management in the Framework for Nuclear Energy Policy published by Japan Atomic Energy Commission 2005, October as follows;

- 1) The liability of generators,
- 2) Minimization of radioactive waste,
- 3) Rational treatment and disposal, and
- 4) Implementation based on mutual understanding with public

Although the principles were prepared for the wastes arising from operation of fission reactors, radio-isotope utilization and so on, it should be necessary to consider the principles to design a fusion reactor. A research group was established consisting of specialists in such areas as safety evaluation, waste management, facility design of fission reactors and fusion research. The major discussion by the group was on radiological characterization of a fusion reactor facility, design concept of hot-cell for component maintenance and the plant life cycle from the viewpoints of safety and proper management of radioactive materials.

Plant life cycle management

It is necessary to study a plant life cycle of a fusion reactor. Followings are major focus points in the study;

- Radioactive waste: evaluation of the total amount of radioactive waste throughout the plant life cycle
- Reusing/recycling: possibility of radioactive materials for reusing/recycling
- Hot-cell facility: design concept of the facilities for treatment and maintenance of radioactive components.
- Plant life cycle: schedule of operation, maintenance and surveillances

A plant operation schedule was set up for estimating radiation levels of components as shown in Fig.1.The time schedule of the process in one cycle was outlined as follows in terms of blanket (B), and diverter (D).

- · Operation:220 days
- · Cooling :30 days
- Maintenance :60 days(B) and 40days(D)
- Inspection: 60 days(B) and 30days(D)

In the maintenance process, components taken out of the core are classified into recyclable/reusable and non-usable ones. The components which should be replaced periodically in operation are back-plate, diverter, blanket module, etc. The back-plate and the part of diverter is possibly reused, vacuum vessel, TF/PF/CS coil and cryostat will be disposed of as radioactive wastes.



Fig.1 An example of plant operation schedule

Radioactive wastes

The wastes arising during the plant life cycle (20 years in total) was estimated by changing output powers to be 70.01, 77.41, 95.50, 104.0 (10^3 tons) with 0.9, 1.35, 1.81, 2.26 (GW) in output power, respectively in case of no-reusing/recycling scenario¹). The amount of waste decreased in case of components reusing as shown in Fig.2. However it will be necessary to take some cooling period for stabilization and encapsulation of the wastes.

Although the amount of radioactive wastes arising increased with output powers, it should be considered that the power generation cost increases with decreasing the output power. In addition, utilization of components is effective for decreasing radioactive waste arising, but it should be required to enlarge the size of hot-cell for storage and maintenance of radioactive materials. A study on optimization is necessary for suitable designing of the facility.



Fig.2 Radioactive waste produced in total plant life

Concluding Remarks

The principles of radioactive waste management indicate that the responsibility of the waste disposal is belonging to the owner of the facility and the wastes should be disposed of under social consensus. Therefore it must be a necessary process to form social consensus on construction of a fusion reactor for realizing energy generation by fusion reaction. It is also important to discuss optimization of facility designing and plant life cycle considering proper radioactive waste management.

1) Someya, Y, et.al., Management strategy of radioactive waste in the fusion DEMO reactor, Plasma 2014