Radioactive waste management plan according to the replacement of the KSTAR device's Divertor

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1. Introduction

The tokamak device for the nuclear fusion experiment consists of various structures. In particular, the internal structure of the vacuum vessel is radiated by neutrons generated during the nuclear fusion reaction. Therefore, if it is disposed of, it should be treated as radioactive waste. In this paper, we intend to describe the management of waste following the replacement of the Low Divertor of the KSTAR device.

2. Estimation of the type and amount of radioactive waste

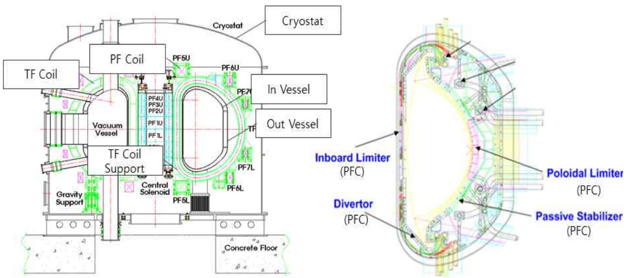

Figure 1 vertical section of KSTAR Device

The inside of the KSTAR vacuum vessel is covered with graphite tiles as a plasma-facing component(PFC). The vacuum vessel and cryostat SS316 stainless steel and superconducting coils are made of Nb3Sn and NbTi, both contain copper stabilizer conductor. The Nb3Sn coil contains Inconel 908. However, the replacement this time is a lower divertor, a type of PFC, and its components made of SS316.

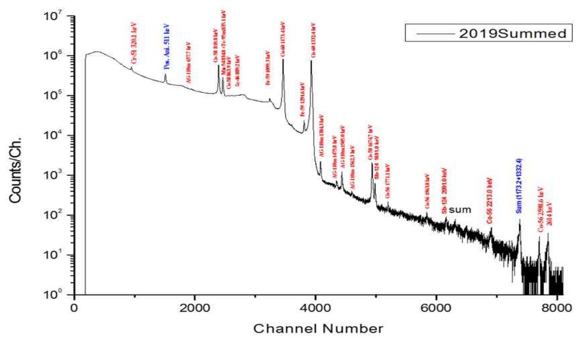

Figure2 Analysis of nuclides inside the vacuum vessel

Table 1 describes the main nuclides produced in each component as a result of radiation by neutrons. In the case of graphite tiles, the adsorption of tritium generated during deuterium fusion reaction is the cause.

Table I: Major nuclides by substance

Component	Material	Major Radioisotope
divertor tile	Graphite	Tritium
backplate	SS316L	Co-58, Co-60
manifold	SS316L	Co-58, Co-60

Table 2 below shows the types of waste generated when the KSTAR device's divertor and some limiters are replaced with a tungsten diverter.

Table2: Estimated amount of waste by location

Components		Material	Volume (mm^3)	Specfic gravity	Q'ty	Weight (kg)	
Divertor	Inboard divertor backplate	SA240-316LN	78,981,557	8	1	632	3,920
	Inboard divertor tile	Graphite	75,970,864	1.82	1	138	
	Central divertor backplate	SA240-316LN	121,249,802	8	1	970	
	Central divertor tile	Graphite	138,254,126	1.82	1	252	
	Outboard divertor backplate	SA240-316LN	137,965,743	8	1	1,104	
	Outboard divertor tile	Graphite	109,241,034	1.82	1	199	
	Top-bottom manifold	SA312-TP316L	78,191,613	8	1	626	
Inboard Limiter	Inboard Limiter tile	Graphite	54,318,862	1.82	1	99	99
Passive stabilizer	Upper-lower manifold	SA312-TP316L	44,247,897	8	1	354	354
Total weight (kg)							4,373

The figure shows the result of measuring by putting the measuring device inside the vacuum container after delaying the end of operation by about a month because the detector cannot be placed inside.
Therefore, nuclides with relatively long half-lives were measured.
As for nuclides with long half-lives, Co-58 and Co-60 are major nuclides due to radioactivity of SS316, which is the main component.

3. Divertor Tritium Measurement Method

The following method was used as a method for measuring the tritium of the divertor. The divertor was cut to an appropriate size and the tritium extracted from the vacuum furnace was collected using a bubbler. The collected tritium sample was prepared by removing salt and organic matter, and mixing the scintillator. The prepared sample was analyzed using LSC after minimizing physical quenching.

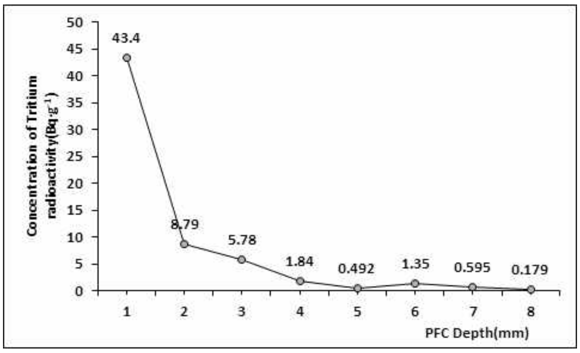

Figure3. ^{3}H concentration by PFC depth

Calculating from the results measured by this method, the average concentration of graphite tritium is 7.8Bq/g, which is less than 1/10 of the allowable concentration for self-disposal (100Bq/g), so it is a level that can be disposed of by itself, but it is possible to will be kept

4. Conclusions

The radioactive waste that can be generated from the fusion research device is SS316, which is the main structure of the device, and graphite material, which is PFC. The concentrations of nuclides or radioactive materials they contain are not of concern. However, it is expected that the concentration and amount of radioactive material will increase as the operating period of the device increases. Continuous monitoring is necessary for their disposal in the future.

5. REFERENCES

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