Development of sampling techniques for ITER Type B radwaste

Kwonpyo Hong [a*], Sunggeun Kim [a], Sanghee Jung [a], Wan-Ho Oh [a],
Myungchul Park [a], Heemoon Kim [a], Sang-Bok Ahn [a]
[a] *Korea Atomic Energy Research Institute, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, Korea*
[*] *Corresponding author: kp8452@gmail.com*

1. Introduction

Type B radwaste(Intermediate level and long lived radioactive waste) is generated from the vacuum vessel inner structure of ITER Tokamak building when its structural components are replaced for maintenance after operation. After being transported into the hot cell facility, the Type B radwaste which are mostly metallic components of vacuum vessel undergoes a series of treatment process in red zone of hot cell building.

Sampling which is one of the treatment processes is to obtain small pieces of samples from Type B radwaste in order to evaluate tritium inventory contained in Type B radwaste.[1]

There are several difficulties and limitation in sampling activities. As the Type B radwaste components are mostly metallic(mostly stainless steel) and bulk(~ 1 m in size and ~ 100 mm in thickness), it is difficult in taking samples from the surface of Type B radwaste by remote operation. But also, sampling should be performed without use of any liquid coolant to avoid the spread of contamination. And all sampling procedures are carried in the hot cell red zone with remote operation.

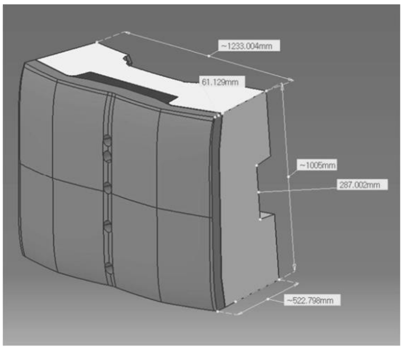

Fig. 1. Blanket module of Tokamak vacuum vessel which is a typical example of Type B radwaste of ITER.

Three candidate techniques of sampling are under development for ITER application, which are core sampling, chip sampling, and wedge sampling. The ITER materials used in sampling experiment are stainless steel (316L/316LN) or CuCrZr alloy.

2. Methods and Results

2.1 Core sampling

Core sampling is to take core samples from metallic thick materials by core drilling method. Coolant is not allowed. As the core drilling should penetrate the target materials to pick out the sample, the thickness of target material is limited. In the experiment the thickness of core drilling was 50 mm.

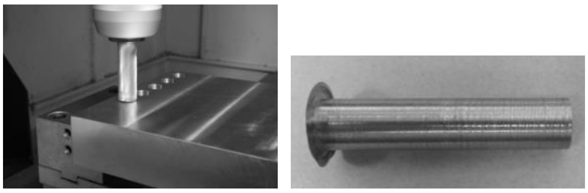

Fig. 2. Core drilling scene and an example of core sample. Target material in the figure was stainless steel and the obtained sample length is 50 mm.

The temperature increase during core drilling was also observed to check the possibility of hydrogen release by heat. Temperature at the center of core sample which was measured using a thermocouple was less than 44.5 ℃ for stainless steel and 32.8 ℃ for cu alloy.

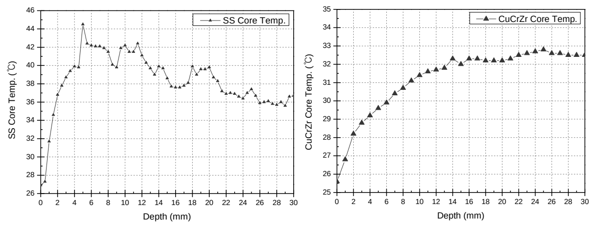

Fig. 3. Temperature increase measured at the center of core sample during drilling for stainless steel(left) and cu alloy(right).

2.2 Chip sampling and H loss evaluation

If the drill chips generated in usual drilling process can represent the target material from the view point of hydrogen concentration in material, chip sampling technique will be simple and convenient method for ITER Type B sampling. However the hydrogen loss during sampling procedure should be checked and evaluated in advance because the drilling heat and the mechanical stress on drill chips can affect the hydrogen contents.

In order to evaluate the hydrogen loss during sampling, the following experiment was designed. The idea of experiment is to measure the hydrogen amount in the drill chips and the remainder and to compare the hydrogen amount of initial specimen.

The procedure of experiment was as follows.

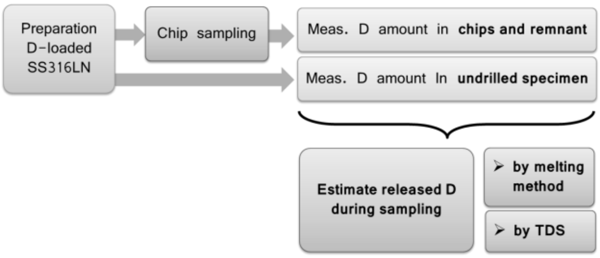

Fig. 4. Procedure of Chip sampling and deuterium measurement.

After the preparation of two groups of stainless steel specimens, the deuterium gas was loaded into specimens. The behavior of deuterium is expected to be more similar with tritium than hydrogen(protium).

One group of specimens undergoes chip sampling while the other group does not. Then deuterium concentration of each group were measured by using hydrogen determinator or TDS(Thermal Desorption Spectrometer).

Following figure shows an example of TDS result.

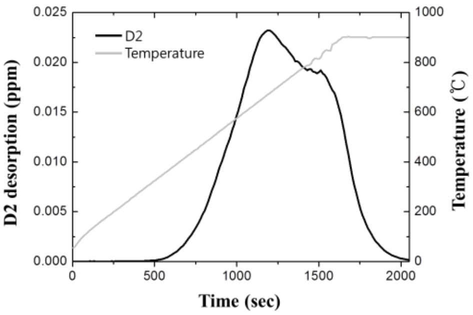

Fig. 5. An example of obtained TDS result. The amount of D2 in specimen can be evaluated from the black solid curve.

From these data deuterium loss during sampling process could be evaluated. This experiment is in progress. The overall result will come out in several months.

2.3 Wedge sampling

Wedge sampling is to take wedge type samples from the surface of metal block without using any coolant. The difficulties of Wedge sampling are slope cutting of hard material such as stainless steel with no use of coolant. Experiments to verify the availability of Wedge sampling have been performed.

Wedge sampling can be achieved by four times of vertical cuttings or slope cutting at a surface of metal block. Cutting tool used in the experiment was a HSS side milling cutter which has the dimension of 150 mm (dia.) x 2.0 mm (blade thick.) x 25.4 mm (blade length).

After cutting plan was set up, three times of vertical cutting and one time of slope cutting has performed.

The cut depth of each slope cutting were 35 mm for stainless steel and 42 mm for cu alloy as shown in Fig. 6.

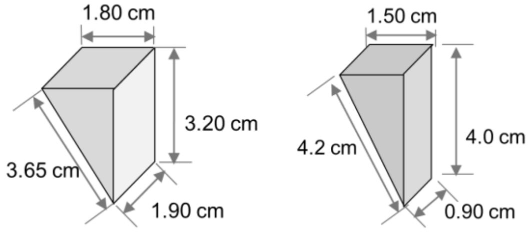

Fig. 6 Wedge samples taken from the surfaces of stainless steel block and cu-alloy block.

The experimental results obtained by this time shows that the real sampling system for ITER Type B radwaste is available cooling without using coolant and remote operation

3. Conclusions

Three kinds of sampling techniques are being developed. They are core sampling, chip sampling, and wedge sampling, which are the candidates of sampling techniques to be applied to ITER hot cell. Object materials for sampling are stainless steel or Cu alloy block in order to simulate ITER Type B radwaste.

The best sampling technique for ITER Type B radwaste among the three sampling techniques will be suggested in several months after finishing the related experiment.

REFERENCES

[1] D. Torcy et. al. Technical specification of Type B radwaste processing and treatment equipment development, EGVZ3J(ITER Document), 08 Jul. 2015.