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IFMIFターゲットアセンブリの健全性評価の進め方
A Study on the Assessment Procedure for a Structural Integrity in IFMIF TA

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1. Introduction and Background

The International Fusion Materials Irradiation Facility (IFMIF) is a plant to test effects of neutron irradiation on candidate materials for fusion reactors. The lithium target facility provides a neutron field for testing the materials in the IFMIF plant, which consists of lithium target, i.e. Target Assembly (TA), and a lithium loop. One of the most critical components among the IFMIF in terms of reliability and availability is the Target Section [1]. Therefore, the structural integrity of TA should be ensured to obtain a safety operation of IFMIF. In this study, the structural integrity assessment of IFMIF TA is focused and proposed the possible procedure for Non Destructive Evaluation (NDE) and sampling specimen from TA as a work of engineering design under IFMIF/EVEDA (Engineering Validation and Engineering Design Activity) project.

2. Non Destructive Evaluation (NDE)

Applicable technique: NDE would be necessary to assure the structural integrity of TA and to verify the welded area on a lip flange. The evaluation at the Back Plate (BP) in TA is especially important because the results of the evaluation are relevant with specimen sampling under Post Irradiation Examination (PIE) activity. Inspection items contain the identification of crack and its shape and size, the hardness distribution and the wall thickness at the BP. A Radiation Transmission (RT) test is widely used technique of NDE to identification of crack and its shape. The RT test, however, would not be applicable since the BP would be activated by neutron irradiation because of IFMIF operation. Therefore, the Penetrate Test (PT) or potential drop technique would be more appropriate instead of the RT test. Although RT test would be applicable to the welded area on a lip flange where the neutron irradiation would not be so severe, it is desirable to commoditize the testing machine in order to utilize the Test Cell (TC) space and to prepare a spare testing machine. On the other hand, it is well known an Ultrasonic Testing (UT) is widely employed to maintain the hardness and thickness of the welded area by using the portable tester and/or portable gage [2]. Thus, UT is reasonable to estimate the hardness distribution and the wall thickness at the BP as well as the welded area on a lip flange.

BP at TA: Not only identification of a crack but measurement of the crack shape and size should be necessary. And then, it is important to evaluate a crack growth through analyzing the identification and measurement data obtained by NDE. The hardness distribution and the wall thickness at the BP should be also measured. The inspection before annual TA replacement will be performed in order to check the soundness of the TA and to sample specimens for PIE activity. The in-service inspection (ISI) of TA will be also performed with appropriate interval. The inspection after new TA installed in TC wouldn't be required because a quality certification of new TA is enough.

Welded area on a lip flange: Identification of porosity, i.e. a crack, at the welded area on a lip flange will be evaluated. The hardness distribution and the thickness at the welded area should be also measured. The inspections before and after in-service will be performed at the welded area on a lip flange. Namely, the validity of welding and cutting will be checked during each inspection to assure the soundness of lip seal flange. That is, all over the welded area will be evaluated before in-service, while Heat Affected Zone (HAZ) will be evaluated after in-service.

3. Sampling specimen from BP in TA

Although liquid lithium is not considered to be very corrosive, some elements in the liquid lithium, such as nitrogen, oxygen and hydrogen, are regarded as impurities. It is reported that high nitrogen content in the liquid lithium is enhanced forming nitride ternary compounds [3]. Thus, BP at TA is exposed to corrosive environment by impurities such as nitrogen as well as centrifugally-stress by lithium flow. Also beam footprint area where neutron irradiates at BP would be most serve region for the structural material. Therefore, it is better to sample a specimen from BP after the TA replaced.

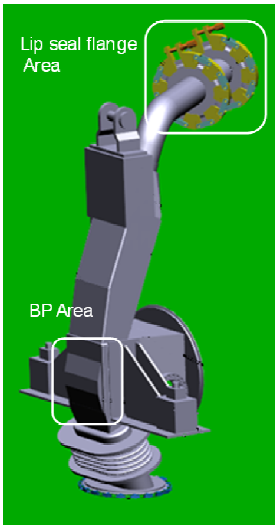

Fig.1 BP area and lip seal flange area

4. Summary

The structural inspection and integrity assessment of IFMIF TA is focused in this study. The possible procedure for NDE at TA and sampling specimen cut out from TA is proposed in a design work.

References

[1] IFMIF, Plant Design Description Document.
[2] Taketo Yamakawa, *Journal of the Japan Welding Society*, Vol. 59 (1990) No. 8, pp. 585–589.
[3] O.K. Chopra and D.L. Smith, *Journal of Nuclear Materials*, Vol. 141–143 (1986), pp. 584–591.