IASCC test method using Proton Irradiated Stainless Steel Specimens in a High Temperature Water Chemistry Environment

Seung Mo Hong *, Han-Hee Lee, Seong-Sik Hwang
Nuclear Materials Research Division, Korea Atomic Energy Research Institute
1045 Daedeog-daero, Yuseong-gu, Daejeon, 305-353
**Corresponding author: smhong540@kaeri.re.kr*

1. Introduction

Inspections of reactor internals integrity were carried out in France (1988), USA (1992 ~ 1997) and Japan. From inspection results of France and USA, some flaws were detected on baffle former bolts, and a main factor of flaw was stress corrosion cracking. In Korea, weak parts integrity of reactor internals was checked up by GTSP defect occurrence in YG 2 plant. Baffle former bolts are located near reactor and can be assisted by neutron irradiation.

Irradiation assisted stress corrosion cracking (IASCC) of reactor internals is one of the degradations in a light water reactor (LWR) component. Under the consideration of a nuclear power plant life extension, it is attached great importance to an IASCC degradation management in LWRs [1].

IASCC is a complex phenomenon involving many variables. It is very difficult to test with neutron irradiated specimen. So, the proton irradiation method is attractive to perform experiments using safety and less expensive irradiation techniques. At a similar dose rate, proton irradiated specimen test has a very good agreement for intergranular stress corrosion cracking [2].

This paper aims to set up IASCC test methods in high temperature water chemistry environment with proton irradiated stainless steel specimens.

2. Experiments

To study the IASCC effect of proton irradiated stainless steel specimens in the high temperature water chemistry environment, test conditions will be prepared by test flow diagram. (Fig. 1)

2.1 Test conditions

For SCC test, the test condition was prepared with simulating the controlled Li-B condition chemistry condition of PWR. Test pressure is up to 320 ℃ and test temperature is 320 ℃. Dissolved oxygen level was controlled under 5 ppb, and hydrogen gas was injected into the test loop. Conductivity and pH of the test solution were decided by B-Li concentrations. The test condition was intended to simulate the primary water chemistry condition of PWRs.

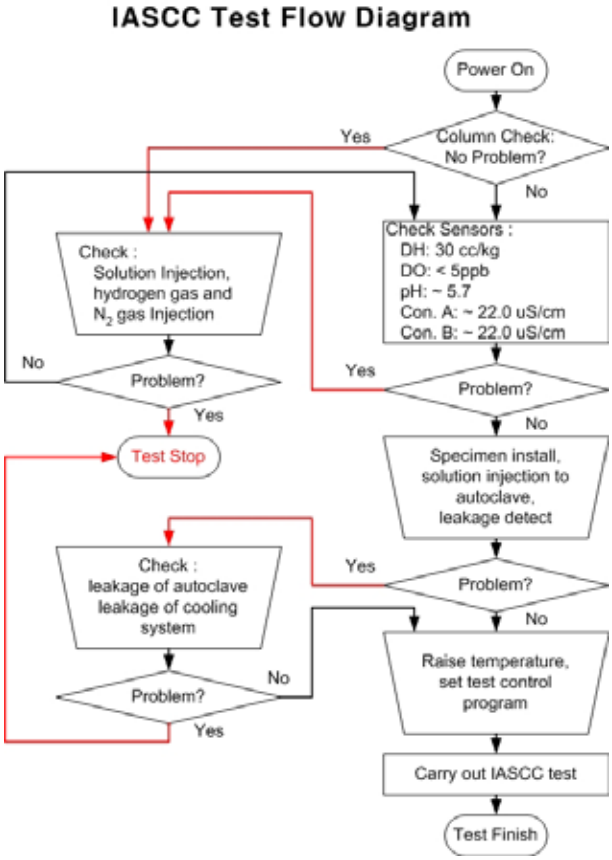

Fig. 1. Flow diagram for IASCC test

2.2 SCC behavior

For SCC experiments, small size samples for proton irradiations were provided as shown in Fig. 2 [3].

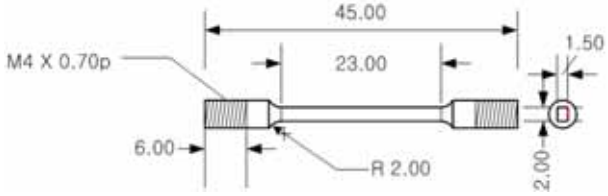

Fig. 2. Schematic of tensile SCC test sample

Samples were fabricated by electric discharge machining then proton irradiated at high temperature up to 340 ℃. SCC test with the irradiated specimens will be carried out in the primary water simulated water chemistry environment condition. Main environmental variables are dissolved oxygen, dissolved hydrogen,

conductivity and pH of the test solution. Test speed will be followed with past studies as 1×10^{-7} s^{-1}.

Test results will be analyzed with measuring the crack density, average crack length, and crack length per unit area. After those, surface observations will be performed.

Tests will be carried out with proton irradiated specimens and dummy specimens.

3. Summary

For the evaluation of IASCC degradation effects, IASCC test system was installed. IASCC test with unirradiated 316 stainless steels was performed in simulated primary water chemistry condition.

SCC results for the proton irradiated specimen can be analyzed for a stress to strain, a dose dependence to strain to failure, comparison of fracture surface, cracking observation on irradiated surface, inter-granular cracking susceptibility, and correlation between strain to failure and ductile fraction on the fracture surface both of conditions at normal water chemistry and hydrogen water chemistry.

REFERENCES

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