Water Loop System Development for IASCC tests at High Temperature

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1. Introduction

The effect of a irradiation on a stress corrosion cracking (SCC) at a high temperature is needed for an application of new materials to a pressurized water reactor. Proton irradiation technique as an alternative tool of a neutron irradiation seems to appeal to evaluate the effect on the SCC behavior of stainless steels. The SCC technique can be used for a screening of various material and environmental conditions.[1-2] However, the proton-irradiation should be confirmed for its role of in-core irradiation on crack growth and in performing a final verification of the effect of alternative irradiation on candidate alloys. In spite of the handicap of the proton irradiation, some test plans have been set up by using the proton irradiated materials due to a good feature of the technique such as a low radio activity.

This paper aims to introduce the SCC test facility for IASCC on the proton-irradiated materials.

2. Experimental

2.1. Construction of Water Loop System

The water loop consists of a closed-loop, flowing water system, high pressure metering pump and measuring devices as shown in Fig.1. Controlled water chemistry is prepared by using a closed water loop, where high purity demineralized water is stored in two glass columns. Gas is supplied through the columns and a small positive gas pressure can be applied in order to control the dissolved gas content of the water. Both columns are connected to a recirculation loop that directs the water through an ion exchanger to maintain purity. As the primary column contains the water to be used for the experiment, a pH meter, conductivity meter, hydrogen meter and an oxygen meter are installed in the recirculation loop in order to permit continuous monitoring of the values. When a pre designed water conditions are reached, the water is pressurized and heated up to the test temperature using pre heater before it flows into the autoclave. A high-pressure metering pump pushes the water from the primary column to the autoclave through a preheater and controls the flow rate for the experiment up to 150- 200 ml/min. The water finally goes through a 60 ㎛ filter and a back pressure regulator (BPR), where the pressure is reduced. The section of the loop between the pump and the BPR is at the system pressure. The system pressure is controlled by the BPR and measured by a pressure gage and two pressure transducers. After the BPR, the water is at atmospheric pressure and flows through a conductivity meter and hydrogen meter and an oxygen meter before returning to the primary column.

2.2. SCC test system (SSRT)

The slow strain rate tester(SSRT) is used for conducting the SCC test in pure water, up to 2500 psi of a pressure and 340℃, in a controlled, refreshed environment. The test variables are dissolved oxygen content, dissolved hydrogen, conductivity and pH. Oxygen levels below 5 ppb and hydrogen levels below 3 ppb inlet conductivity of 0.05 ㎲/cm are kept for the test period. The make-up and control on the environment is performed in the water loop, described in detail below. Constant strain rate, constant load and constant *K* experiments can be conducted, in addition to low cycle fatigue pre-cracking..

2.3. SSRT Specimen design

Stainless steel alloys were used for this work in their solution-annealed condition. The surfaces of the tensile and TEM specimens as shown in Fig. 2 are ground by using SiC paper to a final finish of #1200 grit. The samples were then electropolished in a 10% perchloric acid, 90% methanol solution at -50℃ to get a mirror like surfaces prior to irradiation experiment.

3. Discussion and Results

Water loop and SSRT test facility for a SCC on proton-irradiated specimens in a high temperature water has been developed at KAERI. SCC test can be conducted in simulated primary side water chemistry of a PWR up to 2500 psi of a pressure and 340℃. In this work, four tensile specimens are loaded simultaneously under a constant extension rate. By using a DCPD system, the facility permits to load one CT under constant *K* and to measure the crack propagation rate. The facility will be utilized for an evaluation test of a reactor internal material like stainless steels by reproducing a set of experiments previously performed at a high temperature corrosion laboratory of KAERI.

REFERENCES

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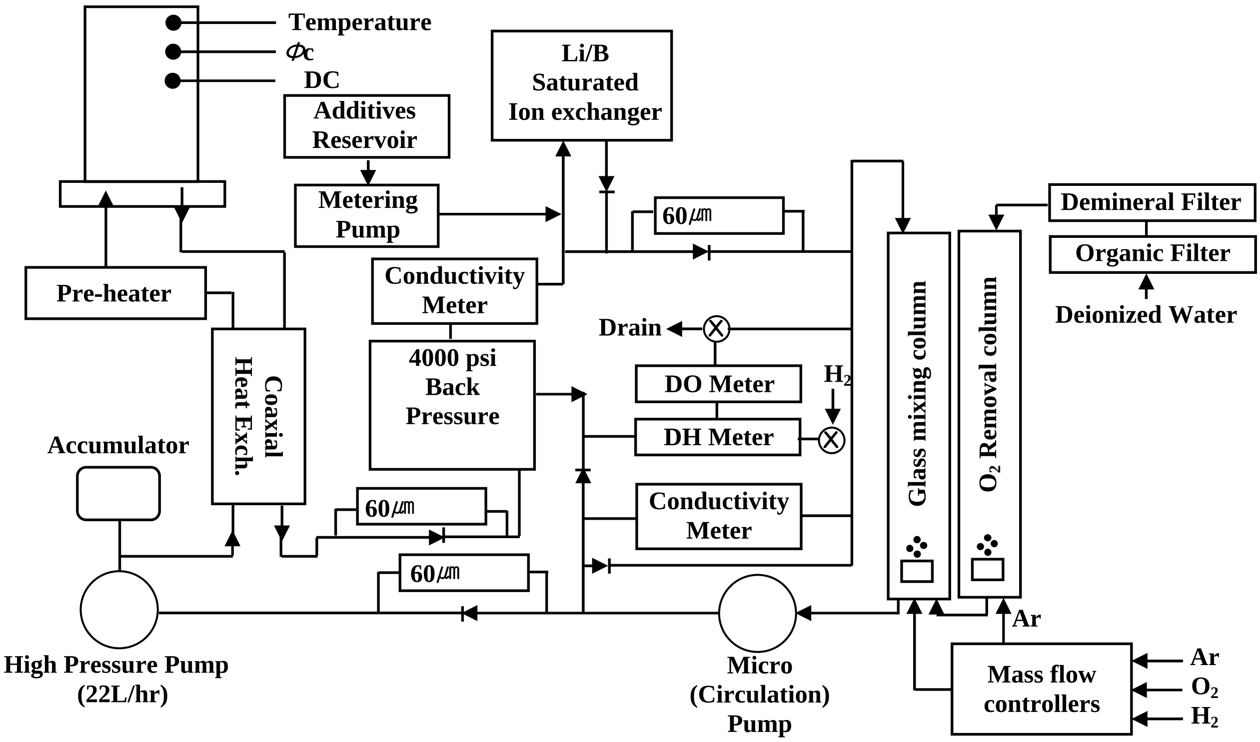

Fig.1. Water loop system of KAERI

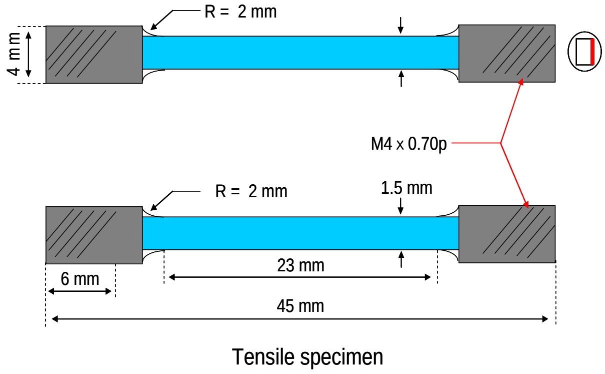

Fig.2. Dimensions of the tested tensile specimens