Multi-Channel Mechanical Test Machine for HANARO (I)

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1. Introduction

Design and fabrication of multi-channel mechanical test machine is useful and important for the study of in-pile test of nuclear materials in HANARO. The dimension and shape of the multi-channel mechanical test machine should be fixed to a test reactor and their objectives[1]. KAERI successfully developed a non-instrumented multi-channel mechanical test machine for material irradiation tests in a domestic research reactor, HANARO[2]. This results in strongly stimulating and accelerating irradiation tests of materials in domestic industry and research fields with HANARO. Although various types of in-pile creep capsule were made for well installation in each test reactor, there is no in-pile creep multi-channel mechanical test machine for HANARO[3]. Hence, the objectives of this study are to fabricate and test a multi-channel mechanical test machine of HANARO.

2. Methods and Results

A multi-channel mechanical test machine of HANARO was designed and fabricated, which was able to apply tensile stress to zirconium cladding tubing homogeneously by external gas pressure. The machine was designed based on HANARO operating conditions. JAERI and AECL models[4, 5]. The design criteria of the multi-channel mechanical test machine were that the multi-channel mechanical test machine was sustained at the working conditions of <400□, 3 watt/g of gamma heating rate, $5x10^{20}$ n/cm^2, neutron flux and maximum load of 200 MPa with a fixed dimension of HANARO.

Fig. 1 is the photos of multi-channel mechanical test machine, which has four modules each of which contains a specimen. The module works independently or simultaneously. Each module mainly made of 304 stainless steel consisted of three separate chambers. One is an high pressure chamber located at the bottom of the multi-channel mechanical test machine which contained bellows inside to apply tensile load to the specimen through the contraction of the bellows by external gas pressure. Another is a main chamber which contained grips, yokes, specimen, a push rod, heater and bearing. The parts were designed and assembled for the specimen to be effectively exposed in neutron flux during creep test. The grips were good for both round or plate specimen and fixed them by parallel two pins at both ends of the specimen. The third is a connecter chamber with control wire and electrical outlets. This chamber was designed to protect gas lease from the main chamber and to feed though electrical and thermocouple wires. Considering the multi-channel mechanical test machine diameter and each connector size, six feed-though connectors were installed for gas lines, electrical line and thermocouples. Each chamber has separate gas feed lines for controlling bellows in the high pressure chamber, temperature of the main chamber and gas lease of the connector chamber.

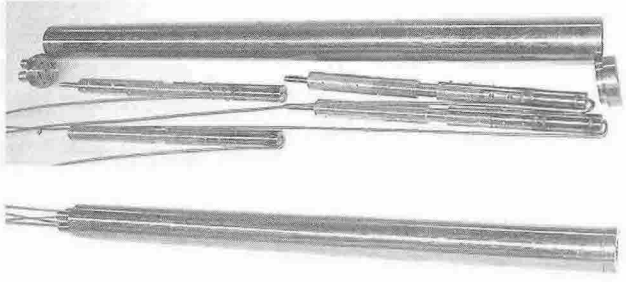

Fig. 1 Drawing and photo of multi-channel test machine and four modules : (top) dissembled, (bottom) assembled

Fig. 2 is load-displacement data of zirconium specimen determined for testing performance of a module.

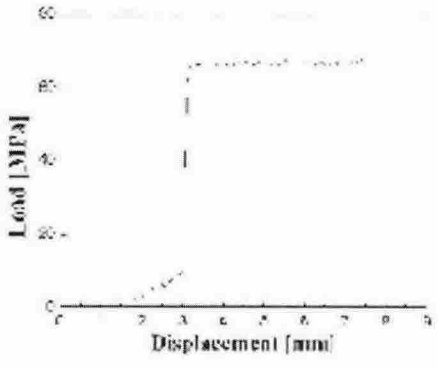

Fig. 2 Load-displacement curve determined by a module

As shown in Fig. 2, the load-displacement of zirconium specimen was well observed which means that the module was operating in good condition.

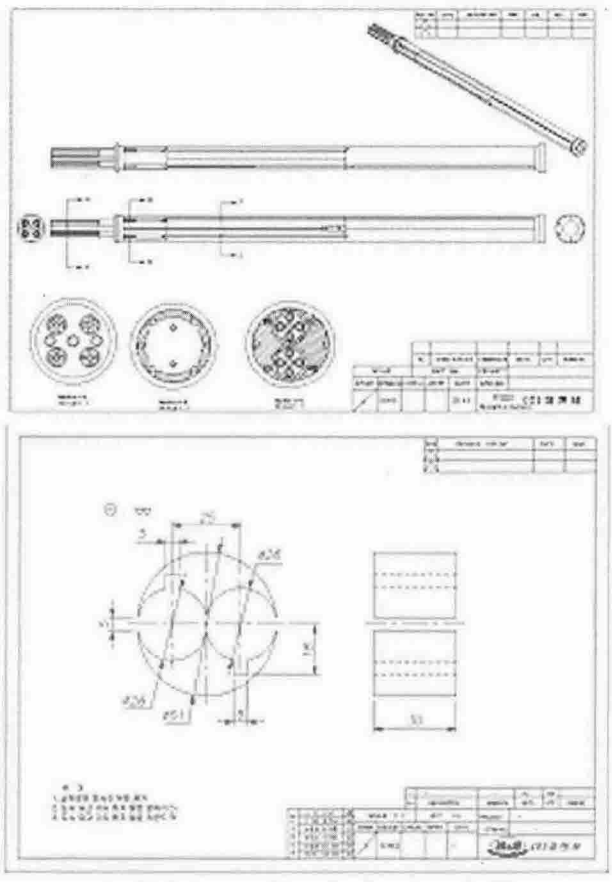

Fig. 3 Drawings to show a shape and position of thermal insulator in the multi-channel mechanical machine

Fig. 3 is the drawings to show the shape and position of thermal insulator. The thermal insulators have different shape with the positions of test machine to completely fit in the main chamber. The thermal insulators are made of pure aluminum which was melt, cast and extruded in a domestic company. The thermal insulators are fabricated by electron spark-machining and will be assembled in the main body of the test machine.

3. Summary

A multi-channel mechanical test machine for HANARO was designed and fabricated based on the design criteria of the multi-channel mechanical test machine sustained at the working conditions of <400□, 3 W/g of gamma heating rate, $5x10^{20}$ n/cm^2, neutron flux and maximum load of 200 MPa. The multi-channel mechanical test machine made of 304 stainless steel consisted of four modules. Two of them locate upper part of the machine and the others locate lower part with 90 degree rotation. Each module was evaluated by determine load-displacement curve of zirconium specimen. Thermal insulators were also made by electron spark-machining of pure aluminum which was prepared in a domestic company.

Acknowledgement

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