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Preparation of Irradiation Device for Irradiation Testing of Coated Particle Fuel at HANARO

Bong Goo Kim[a*], Sung Jae Park[a], Seong Woo Yang[a], Dae Ho Kim[a], Moon Sung Cho[a]
[a]*Korea Atomic Energy Research Institute, Daedeok-daero 989-111, Yuseong-gu, Daejeon, 305-353, Korea*
[*]*Corresponding author: bgkim1@kaeri.re.kr*

1. Introduction

Before settling the final design of an irradiation device for irradiation testing of coated particle fuel at HANARO, three preliminary devices were designed and fabricated. Also, out-of-pile testing including a measurement of the pressure drop, vibration, and endurance was performed. Therefore, the validity of their designs was confirmed. After approving the final design of the device for irradiation testing of coated particle fuel at HANARO according to the results of out-of-pile testing, the final device excluding the test fuel rods was manufactured. Also, the irradiation testing of coated particle fuel using this device will be started at the end of 2012.

2. Design and fabrication of Irradiation Device

Fig. 1 shows an assembly drawing of a mockup device for coated particle fuel irradiation testing which consists of the bottom guide structure, the main body, and the top guide tube. The rod tip of the bottom guide structure is assembled with a receptacle in the reactor core, and the main body is a major part of the capsule in which the test rods are installed, and it includes an external tube of a cylindrical shell with a 56 mm external diameter, 2.0 mm thickness, and about 1,000 mm length. This design was based on an instrumented capsule for nuclear fuel irradiation testing [1-2]. This device has no central rod. That is, there is a distinct difference between this device and former devices for nuclear fuel irradiation testing.

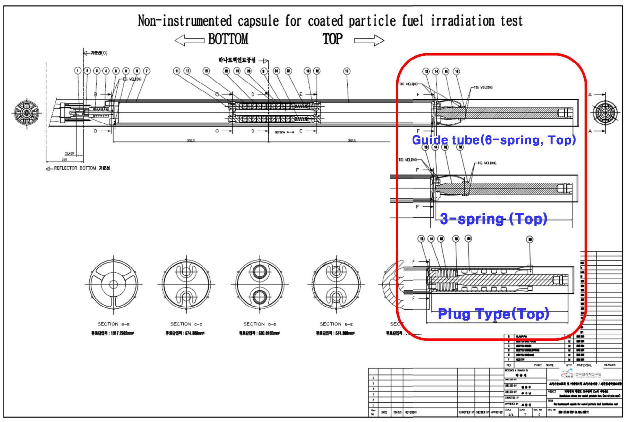

Fig. 1. Assembly drawing of mockup device for coated particle fuel irradiation testing [3].

Three kinds of mockup devices, such as a 6-spring type, 3-spring type, and plug type, on the basis of assembly drawings were prepared, as shown in Fig. 2.

Fig. 2. Mockup devices (from top; 6-spring, 3-spring, and plug type) [3].

3. Out-of-Pile Testing of Irradiation Device

Out-of-pile tests were carried out using three mockup devices, as shown in Fig. 2. Compatibility with the test hole and requirements, such as pressure drop (> 200 kPa at 12.7 kg/sec of rated flow; see Fig. 3) and vibration (less than 300 μm at 110% of rated flow; see Fig. 4 and Table 1) were verified. As shown in Fig. 3, a pressure drop of the 6-spring type was 210 kPa at 12.7 kg/sec of rated flow; that of the 3-spring type, 209.4 kPa at 11.78 kg/s; and that of the plug type, 209.7 kPa at 11.45 kg/s.

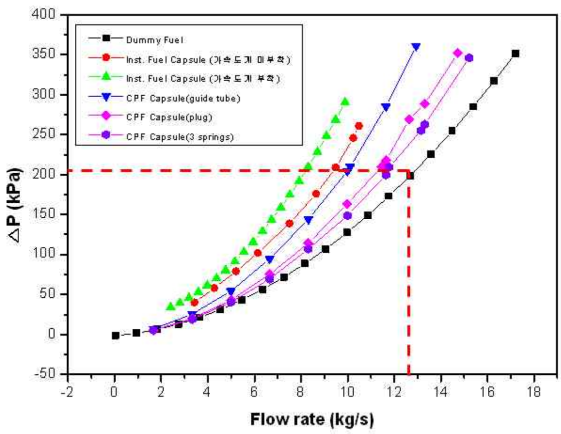

Fig. 3. Effect of pressure drop on the flow rate [3].

Fig. 4 shows that the vibration displacement of the plug type was smallest; and that of the 3-spring type, the largest. In Table 4, the vibration displacement appeared qualitatively smaller in the order of plug type, 6-spring type, and 3-spring type. The maximum vibration displacements of the 6-spring type, plug type were 68 μm, 37.2 μm, and 126 μm, respectively. These are smaller than the 90 μm of the 18-element fuel assembly of a HANARO drive fuel [4]. However, the maximum vibration displacement of the 3-spring type was 126 μm. Also, the RMS of the three types was 3.29 to 33.4 μm. These appeared to be smaller than the 19 to

43 μm of the 18-element fuel assembly of the HANARO drive fuel [4].

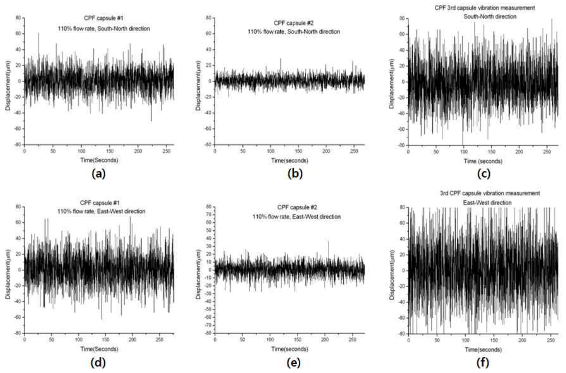

Fig. 4. Effect of vibration displacement on the measured directions 0° (a; 6-spring type, b; 3-spring type, c; plug type) and 90° (d; 6-spring type, e; 3-spring type, f; plug type) [3].

Table 1. Vibration displacements of maximum, minimum and RMS [3]. (unit: μm)

	Max.			Min.			RMS		
	#1	#2	#3	#1	#2	#3	#1	#2	#3
0°	61.6	29.2	84	-50.4	-20	-82	13.7	3.29	22.1
90°	68	37.2	126	-62.4	-28	-104	16.8	12.7	33.4

#1; 6-springs type, #2; plug type, #3; 3-springs type

An endurance test was also performed under a 110% rated flow of 12.7 kg/s for about 50 days. According to the results of an out-of-pile test, the plug-type device is best for loading in an OR test hole of HANARO. Therefore, a detailed drawing was accepted, and the device, except the test rods, was fabricated to load in the test hole, OR, of HANARO, as shown in Fig. 5. This device with the test rods will be loaded and irradiated at the test hole from the end of 2012 at HANARO.

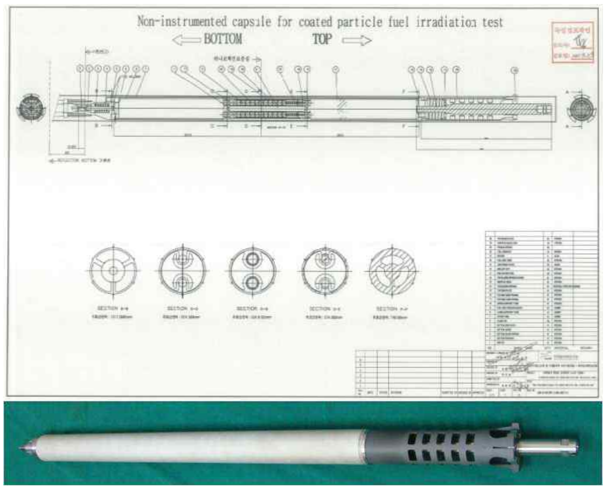

Fig. 5. Assembly drawing accepted and the device to irradiate coated particle fuel at HANARO [3].

4. Summary

1) Three kinds of mockup devices, 6-spring, 3-spring, and plug type, on the basis of the assembly drawings were prepared.
2) After performing out-of-pile tests using three mockup devices, compatibility with the test hole and requirements, such as pressure drop (> 200 kPa at of 12.7 kg/sec of rated flow) and vibration (less than 300 μm at 110% of rated flow), were verified.
3) The plug-type device with test rods will be loaded and irradiated at the test hole, OR, from the end of 2012 at HANARO.

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