

## The 1st Irradiation Test Results of the High Burn-up Large Grain UO<sub>2</sub> Pellets in HANARO

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### 1. Introduction

The large grain UO<sub>2</sub> pellet developed for the high burn-up PWR fuel was finished the 1st irradiation test in the HANARO since July of 2002[1,2]. The large grain UO<sub>2</sub> pellets will be irradiated up to the burn-up higher than 70 MWD/kgU. To irradiate the UO<sub>2</sub> pellets up to the burn-up 70 MWD/kgU, it will take about 60 months. Now the 1st irradiation test for about 30 months was finished[3]. The burn-up of the fuel rods was 33.62 MWD/kgU for the upper three fuel rods and 37.39 MWD/kgU for the lower three fuel rods, as of the June of 2005 by which the effective irradiation time is 320.6 day at the OR-4 of HANARO. These test rods were burned the lower about 9 % against target burn-up because the control rod of HANARO was operated at the lower position than analysis condition. The lower test rod assembly is loading into the new non-instrument capsule for the 2nd irradiation test and the 2nd irradiation test will be started in time.

### 2. Methods and Results

#### 2.1 Purpose and Method

The purpose of this irradiation test is to confirm the in-pile performance of the large grain UO<sub>2</sub> pellet developed for the high burn-up PWR fuel. The in-pile test conditions of large grain UO<sub>2</sub> pellet, which use the non-instrument capsule in the OR-4 hole at HANARO, are similar to the commercial reactor operating condition. After this in-pile test, the post irradiation fuel test will be perform to investigate such as the FGR, the crack shape of pellet, the distribution of the pore, and the effect of the rim structure, etc. The large grain UO<sub>2</sub> pellet was fabricated by the addition of U<sub>3</sub>O<sub>8</sub> seeds and heat treated at 1,300 °C for 4hrs in the air condition. At this time, the grain sizes were ranged from 12 to 20 μm(Table 1.)

Table 1. Characterization of test fuel rod specimen

Parameter	Description	Grain size	Amounts(Pellet)
Test rod 1	STD Commercial Pellet	8 μm	Upper/Lower each 5ea
Test rod 2	Large Grain Pellet	15 μm	“
Test rod 3	Annealed Pellet	23 μm	“

The 1st irradiation test in the OR-4 hole at HANARO since July of 2002 was finished. The test conditions were as follows.

- irradiation hole : OR-4 in HANARO
- test rod LHGR
  - the maximum LHGR was calculated using the MCNP and HANAFMS at the up 27.125 cm to the central core position [4]
    - reactor power : 24 MW
    - control rod position : 450 mm
    - scram rod position : WRO
    - maximum LHGR(Hot Spot) :72.35 kW/m
- coolant mass flow rate : 7.447 kg/sec
- coolant pressure : 0.4 MPa
- target burn-up :
  - 1st in-pile test : ~ 35 MWD/kgU
  - 2nd in-pile test : ~ 70 MWD/kgU

The non-instrument capsule schematic drawing used in the irradiation test is shown in Fig. 1[5,6].

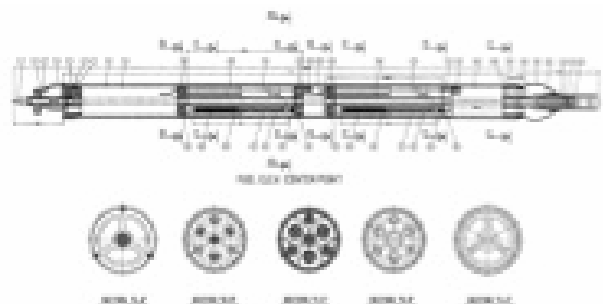


Fig 1. Schematic drawing of the non-instrument capsule

## 2.2 Analysis and Results

The maximum LHGR was calculated using the MCNP and HANAFMS code at the up 27.125 cm to the central core position [4]. The burn-up was compared to the VENTURE analysis result using the HANARO operation history and the preliminary CARO-D analysis result. Until now, the burn-up of the test fuel rods was 33.62 MWd/kgU for the upper three fuel rods and 37.39 MWd/kgU for the lower three fuel rods, as of the June of 2005 by which the effective irradiation time was 601.02 days. At this time, the average LHGR was 31.55 kW/m for the upper test rod assembly and 28.7 kW/m for the lower test rod assembly(Fig.2). This burn-up was decreased the lower about 9 % than preliminary result. It was caused that the control rod was operated at the lower position than steady state.

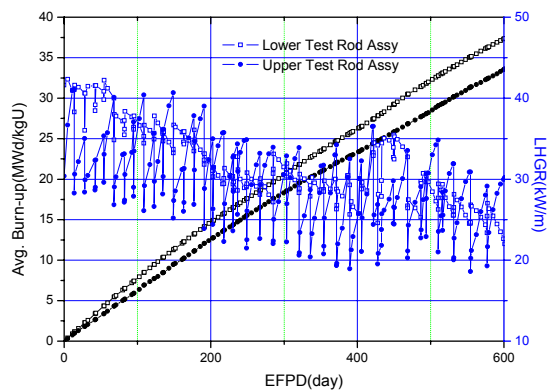


Fig. 2. Average Burn-up and LHGR at EFPD

## 3. Conclusion

The target burn-up of this irradiation test is reached a till up to the 70 MWd.kgU in HANARO as a long-term project. The 1st irradiation test was finished at the June of 2005 and the effective irradiation time was 601.02 days at this time. The average rod burn-up were 33.62 MWd/kgU and 37.39 MWd/kgU for the upper and the lower respectively. The analysis result was confirmed to burned the lower than the planned burn-up because of the control rod operation changes of HANARO. The 2nd irradiation

test will be start at the November of 2005 using the new non-instrument capsule included the lower test rod assembly in HANARO.

## REFERENCES

- [1] D.H.Kim etc., "Design of Test Fuel Rod for High Burn-up  $UO_2$  Pellets in HANARO Irradiation Capsule," 2000 fall KNS, 2000.
- [2] C.B.Lee etc., "Irradiation Test of Large Grain  $UO_2$  Pellet for LWR Fuel," HANARO Workshop 2000, 2000.
- [3] C.B.Lee etc., "Irradiation test plan of advanced PWR  $UO_2$  pellets," KAERI/TR -2144/2002, 2002.
- [4] C.G.Seo, "Preliminary nuclear characterization analysis of advanced PWR  $UO_2$  pellets irradiation test," HAN-RR-CR-900-00-082, KAERI, 2000.
- [5] D.H.Kim etc., "Design and manufacturing of non-instrumented capsule for advanced PWR fuel pellet irradiation test in HANARO," KAERI/TR-2117/2002, 2002.
- [6] D.H.Kim etc., "Non-instrumented capsule design of HANARO Irradiation test for the high burn-up large grain  $UO_2$  Pellets" 2001 fall KNS, 2001.