

Design of the Dual Instrumented Fuel Rods to Measure the Nuclear Fuel Characteristics during Irradiation Test at HANARO

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1. Introduction

The instrumented capsule for the nuclear fuel irradiation test (hereinafter referred to instrumented fuel capsule), which are crucial for the verification of a nuclear fuel performance and safety, have been developed at HANARO(High-flux Advanced Neutron Application Reactor). The irradiation test of the first instrumented fuel capsule(02F-11K) was carried out in March 2003 for 1,296 MWD(Mega Watt Day) and the irradiation test of the second instrumented fuel capsule(03F-05K) was carried out in April 2004 for 1,533MWD at HANARO.[1][2][3] Through the irradiation tests of the two capsules, the design specifications and safety of the instrumented fuel capsule were verified successfully.

In the 02F-11K instrumented fuel capsule, only the technologies for measuring the center temperature of the nuclear fuel and neutron flux were implemented. In the 03F-05K instrumented fuel capsule, the technologies for measuring the center temperature of the nuclear fuel, the internal pressure of the fuel rod, the elongation of the nuclear fuel and the neutron flux were implemented. [4][5] [6]

The purpose of this paper is to develop the dual instrumented technology that enables two characteristics to be measured simultaneously in one fuel rod. Therefore, this paper presents the design of the dual instrumented fuel rods and the plan of the irradiation test for the newly designed fuel rods.

2. Design of the Dual Instrumented Fuel Rods

2.1 The Instrumentation Technologies

In the instrumented fuel capsule, the C-type thermocouple was used to measure the center temperature of the nuclear fuel, the pressure transducer and the LVDT(Linear Variable Differential Transformer) were used to measure the internal pressure of the fuel rod, the elongation detector and the LVDT were used to measure the elongation of the fuel pellets and the SPND(Self-Powered Neutron Detector) with a rhodium emitter was used to measure the neutron flux. And the K-type thermocouple will be used to measure the surface temperature of the nuclear fuel.

2.2 Design the Dual Instrumented Fuel Rods

The dual instrumented fuel rods have been designed to enhance the efficiency of the irradiation test using instrumented fuel capsule. There are six types of an dual instrumented fuel rods. The designed dual instrumented fuel rods are shown in Fig. 1. The types of dual instrumented fuel rods are summarized as follows; 1) to measure the center temperature of the nuclear fuel and the internal pressure of the fuel rod, 2) to measure the center temperature of the nuclear fuel and the elongation of the fuel pellet, 3) to measure the surface temperature of the nuclear fuel and the internal pressure of the fuel rod, 4) to measure the surface temperature of the nuclear fuel and the elongation of the fuel pellet, 5) to measure the center and surface temperature of the nuclear fuel, and 6) to measure the center temperature of the nuclear fuel of the upper and lower part. Fig. 2 shows the cross section of the assembled fuel rod for measuring the center and surface temperature.

2.3 The Plan of Irradiation Test

The instrumented fuel capsule(05F-01K) will be designed and manufactured for a design verification test of the dual instrumented fuel rods. The irradiation test of the 05F-01K instrumented fuel capsule will be carried out at the OR5 vertical experimental hole of HANARO in the latter half of this year. Only three dual instrumented fuel rods can be installed in an instrumented fuel capsule(05F-01K) at HANARO.

3. Conclusion

The dual instrumented fuel rods have been successfully designed as a part of the technology enhancement program for the instrumented fuel capsule. The dual instrumented technologies for measuring the nuclear fuel characteristics will contribute to enhancing the efficiency of the irradiation test using an instrumented fuel capsule at HANARO.

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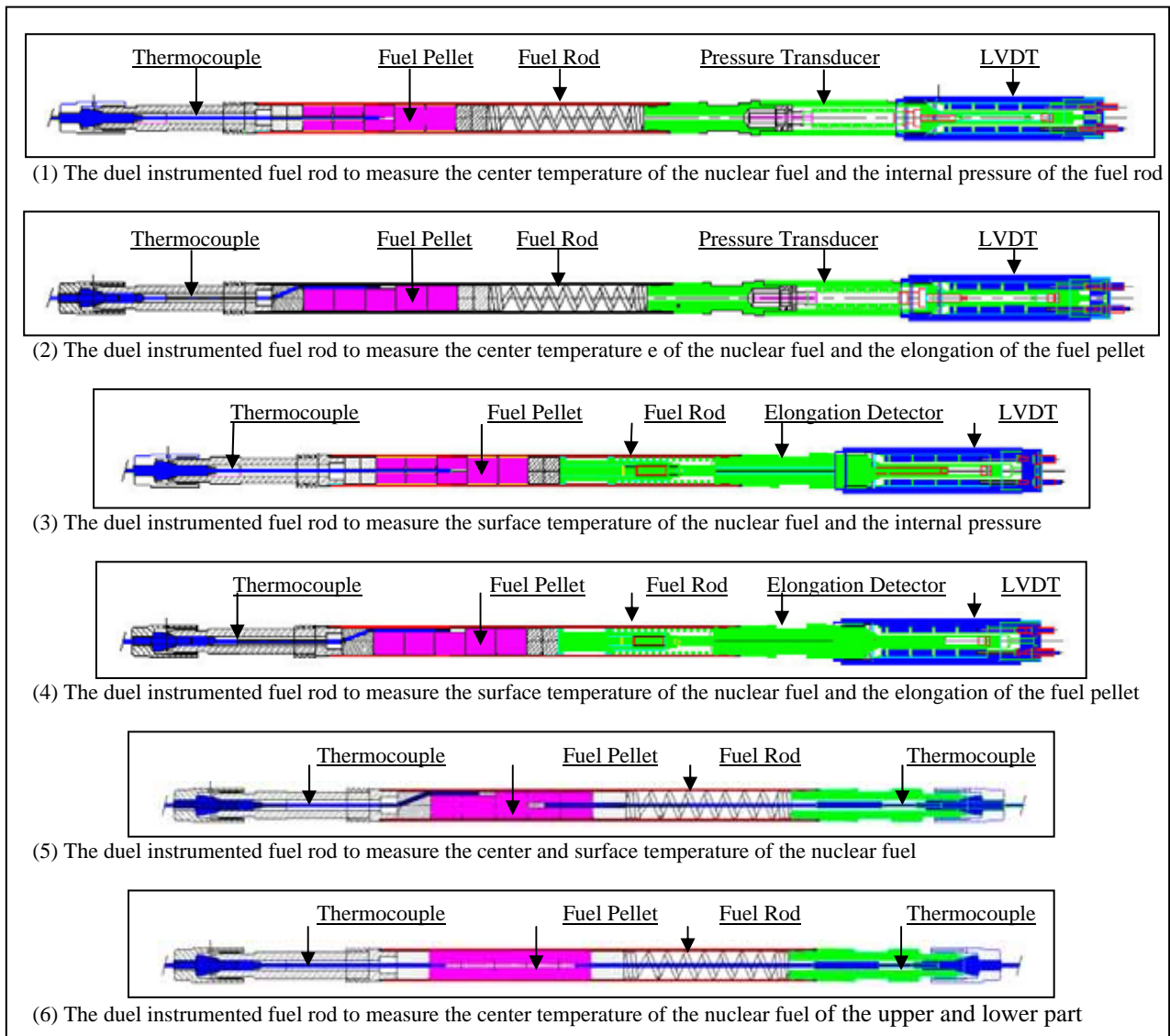


Figure 1. The Dual Instrumented Fuel Rods

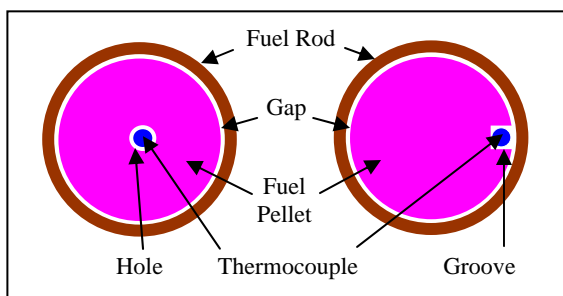


Figure 2. The Cross Section of Assembled Fuel Rod

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