Pressure Test of Magnetostrictive Position Transmitter for Position Indicator of CEDM

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1. Introduction

The Control Element Driving Mechanism (CEDM) is a reactor regulating mechanism and a safety grade equipment which is controlled by controlling the position of the control rod assembly inside the reactor core. The position indicator of the CEDM tracks and identifies the position of the control rod for reactivity control. In commercial nuclear power plants, Reed Switch Position Transmitter (RSPT) is used as a position indicator for the CEDM. However, the position indicator of the CEDM for the integrated research reactor under development requires higher precise accuracy and resolution than the RSPT, we intend to apply a Magnetostrictive Position Transmitter (MSPT) to the CEDM for the integrated research reactor under development. The position indicator is regulated as an electrical 1E-class equipment according to the regulations for the light water reactor, it shall be demonstrated to perform its operability by the qualification test in accordance with IEEE std. 323 (KEPIC END 1100) [1~4].

In this paper, the pressure test which is one of the qualification tests was performed for the MPST under the same conditions as the RSPT, and the test results are described.

2. Test Methods and Results

2.1 MSPT

The MSPT is installed on the CEDM vessel and it indicates the position of the control rod assembly by outputting a continuous analog current signal in proportion to the position of the permanent magnet installed on the ball screw connected to the control rod assembly inside the CEDM.

2.2 Method of Pressure Test

Perform the MSPT functional test before and after the pressure test to verify the performance of the MSPT. The functional test measures the position accuracy and resolution of the MSPT.

The accuracy of the MSPT is determined by moving the permanent magnet installed outside the MSPT from the origin(lower end of the MSPT) to the position corresponding to the full stroke distance of the control rod assembly(upper end of the MSPT) at a constant speed, then moving it back to the origin. It is evaluated by comparing the movement position of the permeant magnet and the MSPT output value. The tolerance for the accuracy is 0.45% of the full stroke distance of the control rod assembly.

The resolution of the MSPT is determined by moving the permanent magnet up and down at a constant speed in units of 0.15% of the full stroke distance of the control rod assembly at the origin, the half stroke distance of the control rod assembly(middle of the MSPT), and the full stroke distance of the control rod assembly. It is evaluated by comparing the movement position of the permeant magnet and the MSPT output value. The tolerance for the resolution is 0.15% of the full stroke distance of the control rod assembly.

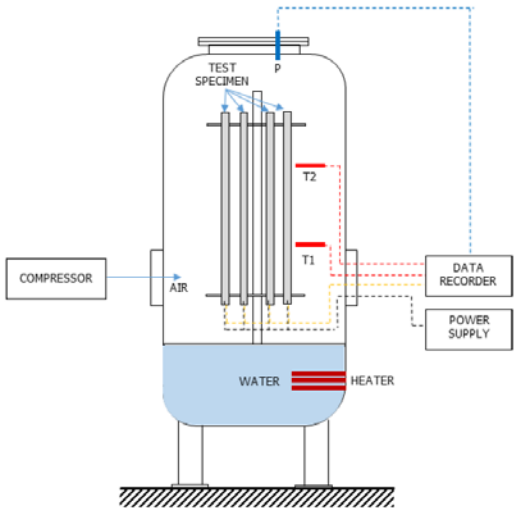

Fig. 1. Conceptual scheme of the test facility and the pressure test

The pressure test of the MSPT is carried out in the test facility as shown in Fig.1. The pressure test is performed at over 66°C and 100 psig for more than 120 hours. The MSPT is installed in the test facility as shown in Fig.2 and in order to create the test conditions, water is filled in the lower part of the test facility, heated using a heater, and air is supplied using a compressor. For the functional test during the test, the permanent magnet is installed on the MSPT at the position of a half stroke distance of the control rod assembly. During the test, the accuracy of the MSPT is evaluated by comparing the fixed position of the permeant magnet and the MSPT output value. The tolerance for the accuracy is 0.45% of the full stroke distance of the control rod assembly.

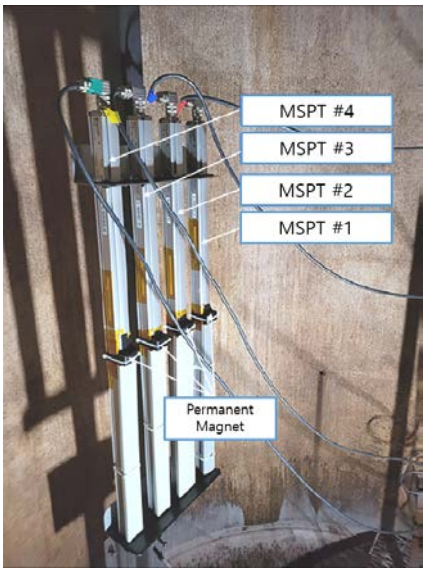

Fig. 2. Installation of the MSPT and the permanent magnet in the test facility.

2.3 Results

Four specimens were used for the pressure test of the MSPT. Table I shows the test results of the functional test before pressure test. Four specimens were checked defects by visual inspection and they were satisfied the tolerances of the accuracy and resolution. The pressure test of the MSPT was performed over 66°C and 100 psig for 124.07 hours. Fig.3 shows the accuracy of a specimen during the pressure test. Other specimens also satisfied the accuracy as shown in Table II. Table III shows the test results of the functional test after pressure test.

Table I: Test result of the functional test before pressure test

MSPT	#1	#2	#3	#4
Accuracy	Pass	Pass	Pass	Pass
Resolution	Pass	Pass	Pass	Pass
Visual inspection	Pass	Pass	Pass	Pass

Table II: Test result of the functional test during pressure test

MSPT	#1	#2	#3	#4
Accuracy	Pass	Pass	Pass	Pass
Temperature	Pass	Pass	Pass	Pass
Pressure	Pass	Pass	Pass	Pass

Table III: Test result of the functional test after pressure test

MSPT	#1	#2	#3	#4
Accuracy	Pass	Pass	Pass	Pass
Resolution	Pass	Pass	Pass	Pass
Visual inspection	Pass	Pass	Pass	Pass

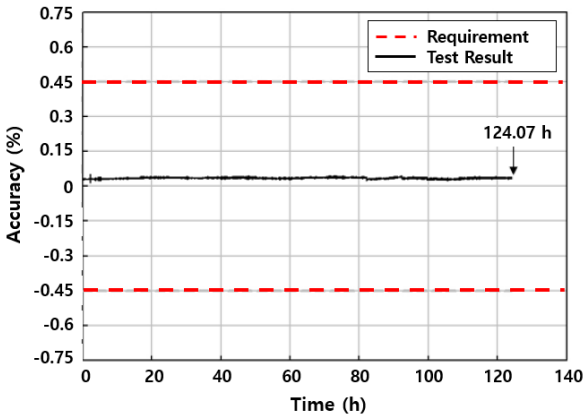

Fig. 3. The accuracy result of MSPT during pressure test.

3. Conclusions

The pressure test of the MSPT was performed in accordance with qualification test method of 1E-class equipment. The MSPT satisfied all the test requirements of the functional test before the pressure test, during test, and after test. In order to apply the MSPT to the CEDM of the integrated reactor under development, other qualification tests such as the aging, radiation, and vibration tests should be performed to confirm the performance.

REFERENCES

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