Experimental Setup for Accuracy Analysis of Multi-Detector Boron Meter

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1. Introduction

PWR operated in Korea controls the combustion reaction by changing the concentration of boric acid water used as a coolant. Accurate measurement of boric acid concentration is necessary to prepare for boron dilution accidents. The boron meter, which is one of the methods for measuring the concentration of boric acid, has the advantage of being able to perform on-line measurement at all times, but shows a high error (2%) [1]. To improve the accuracy of the boron meter, a study was made on the boron meter using the selective detector. It prevents pulse pile-up and perturbation, and also enables stable counting rate measurement even at high boric acid concentration. MCNP simulation was performed to evaluate the accuracy of the multi-detector boron meter and showed a low error (0.4%) [2]. Based on the simulation conditions, the experiments were carried out in a limited environment and showed up to 65% higher accuracy than single detector boron meter detectors [3].

The accuracy of the multi - detector boron meter was confirmed through previous studies and the system was constructed for the experiment in the actual cooling water circulation environment.

2. Experimental Setup for Accuracy Analysis

2.1 Boron Meter

Fig. 1 shows the design of a multi-detector boron meter. The fast neutrons emitted from the neutron source inserted in the central column are decelerated to thermal neutrons due to the boric acid water circulating inside the boron meter and then counted by the detectors. The internal detector uses four LND 20292 BF_3 detectors (11.3 cps/nv) and two LND 2528 ^{3}He detectors (28 cps/nv).

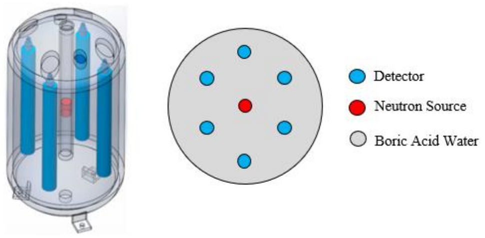

Fig. 1. Design of Boron Meter.

The neutron source inserted inside is Eckert & Ziegler N20 capsule, and the nuclide is Am-Be. To compare the accuracy with the single detector boron meter, the experiment is performed using the same activity (1 Ci). Fig. 2 shows the source information.

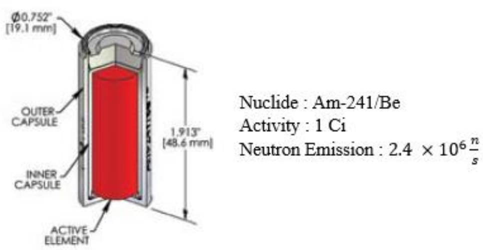

Fig. 2. Am-Be Neutron Source.

2.2 Boric Acid Water Circulation System

Fig. 3 shows the boron water circulation system including the boron meter.

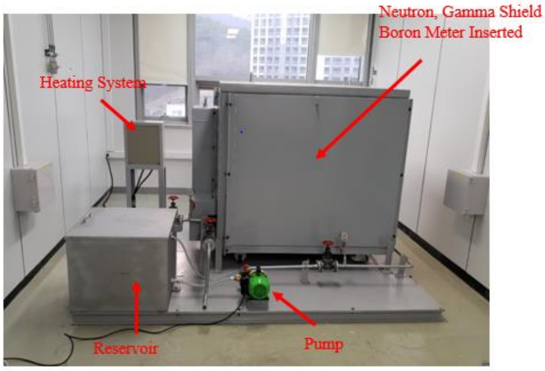

Fig. 3. Boric Acid Water Circulation System.

A shield was constructed to prevent gamma ray and neutron damage caused by the neutron source inserted into the boron meter. The whole circulation system is made of stainless steel and can be run in an environment of 200 psig (13.79 bar), which is the actual reactor coolant pipe environment. A heating system for the calibration of the boron meter accuracy according to coolant temperature was constructed. Experiment of change of count rate in environment of maximum 60 ℃ is carried out.

3. Conclusion

Accurate analysis of the multi-detector boron meter can be performed by installing a system designed based on the actual reactor coolant circulation. The development of a more accurate boron meter will enable real-time coolant concentration measurement, which will improve the stability of nuclear power plants.

ACKNOWLEDGMENTS

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