The result of Alanine/ESR dosimetry at Wolsung unit 1

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1. Introduction

It needs accurate estimation of radiation level for verifying machinery and cable in Nuclear Power Plant. Therefore, in this study, we used ESR(Electron Spin Resonance) system for estimate dose of Alanine dosimeter. Alanine/ESR dosimetry, already known as a dosimetric method in medical and industrial field, was applied to estimate dose quantity at cable locations within a nuclear power plant as a part of equipment qualification program[1]. Alanine/ESR dosimetry of absorbed dose range is 1 ~ 100 kGy. The alanine dosimeter is not significantly affected by temperature and fading is limited to 1% per year[2]. The alanine dosimeters were fixed on the targeted cable or nearest position to measure dose quantity to get accurate value. Alanine dosimeters were scanned by commercially used two different ESR systems, e-scan and EMX series for alanine dosimeters. To estimate more accurate dose, two environmental correction factors, irradiation temperature and dosimeter weight, were used in calculation of absorbed dose quantity. In this study, dose values which are alinine dosimeter from Wolsong unit 1 are measured by two ESR systems. And then the results was compared each other.

2. Methods and Results

2.1 alanine dosimeters

L-α-alanine has attracted considerable interest for use in radiation dosimetry and has been formally accepted as a secondary standard dosimeter for high-dose and transfer dosimetry. In this experiment, used dosimeters were BioMax alanine dosimeter which contain α-amino acid alanine, CH3-CH(NH2)-COOH and Teflon as binder material to form dosimeter as pallet. The alanine dosimeter pellets was 5mm in diameter and 3mm in height and weighed 64.5±0.5mg.

2.2 Dose estimation on e-scan & EMX series

The e-scan is a benchtop ESR spectrometer dedicated to the evaluation of absorbed dose in alanine dosimeters (either film or pellet). With the appropriate accessories, the e-scan measures absorbed dose from a few Gray to about 200 kGy.

EMX spectrometer was recorded with a microwave power of 31.65mW, a modulation frequency and amplitude of 100kHz and 0.2mT, a time constant of 40.96ms. The magnetic field sweep width was 16.0mT, while the number of sampling points was 1024. The microwave frequency was about 9.73GHz. The double rectangular cavity was used in EMX spectrometer. Pellet Insert was produced by materials not to make ESR signal. $Mn2^{+}$ used for normalization about sensitivity changes.

2.3 Experimental

Firstly, install alanine dosimeter at objective position in Wolsing unit 1 in the period of pre-scheduled maintenances. The alanine was inserted into capsule like Figure 1-(a) and then installed to minimizing several effects during installation. Also, the temperature measurement equipment was installed to check irradiation temperature.

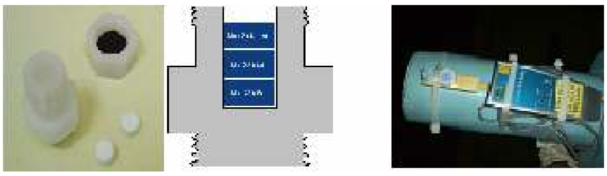

Figure 1. (a) Alanine dosimeter & capsule
(b) picture of installation in Wolsung unit 1

After one or two fuel cycle, retrieved and analyzed the dosimeters using the ESR dosimetric system. e-scan measurement process is explained following details.

Calibration curve was obtained from 24 dosimeters (4 dosimeters per dose point) exposed using ^{60}Co at NPL(National Physical Laboratory). The e-scan has a set of default parameters that are specifically optimized for each type of dosimeter insert. And then, calibration curve was separated by three region (0.5~20Gy, 20~25Gy and 250~300Gy). The dose of Wolsung unit 1 was estimated using this calibration curve. And then, based on the result of e-scan, only selected high-dose dosimeters were measured by EMX spectrometer. Generally, the spectrum of alanine does not show satellite relatively small peak beside main peak as spectrum in Figure 2. However, in this experiment, relatively high microwave power value was applied to get such a spectrum which has small satellite peak in central parts of alanine spectrum. It will be useful to research the several factors which affect spectrum shape. Intensity was estimated by peak-to-peak method. Figure 3 describes the dose measurement result.

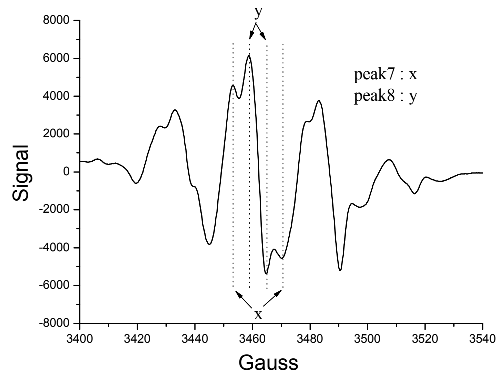

Figure 2. Alanine spectrum was measured by EMX spectrometer

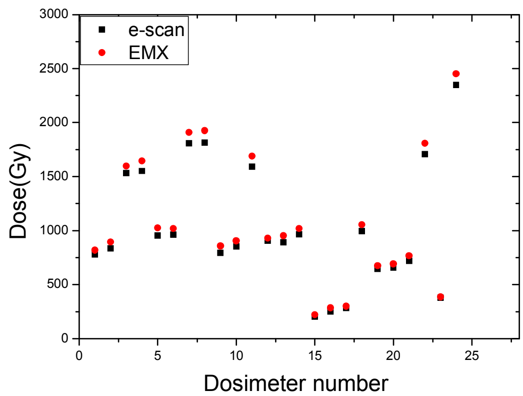

Figure 3. Dose value of high dose dosimeters in Wolsung unit 1

In the result, the values of measured dose using EMX are higher than e-scan. This is because, e-scan corrected irradiation temperature and dosimeter weight as an alanine-only equipment. For alanine dosimeters that are mixed with binders, the effect of irradiation temperature on response could be influenced by the binder type. With Teflon binder, temperature coefficient is 0.14%$℃^{-1}$[3]. For measuring accurate dose value, we will adjust the e-scan correction method to EMX spectrometer.

3. Conclusion

In this study, we measured radiation level of Wolsong unit 1, most of the estimated dose values inside the nuclear power plant were below 10Gy, but some dosimeters positioned at high radiation field, seems to be beside coolant loop in containment vessel were estimated above 1 kGy for about one or two fuel cycle. These high dose positions could be considered as positions exposed to the mixed radiation field, gamma, neutron and other rays. Neutron changes the alanine spectrum shape[4]. Therefore, the dosimeter which was affected by neutron is different from the dosimeter from NPL which was exposed only gamma-ray. Consequently, this difference occur error in dose measurement. Hence, nowadays we are researching the change of alanine spectrum which is mixed with gamma and neutron ray. From this study, we expect that it can estimate accurately dose value of nuclear power plant.

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