The application of Alanine/ESR dosimetry in nuclear power plants

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1. Introduction

Environmental effects to the degradation of cables in nuclear power plant were known as heat and radiation[1][2]. The effect of radiation to the cable material is dependent on the total absorbed dose quantity[2]. Alanine/Electron spin resonance(ESR) has been proven very effective tool which dosimetric characteristics is better suitable than generally used personnel dosimeter for long term dose estimation.

For estimation of the absorbed dose, alanine/ESR dosimeters were installed in containment building of nuclear power plants for one or two operating cycles. L-α-alanine has unusual stability of radiation induced radicals. The fading is known as about 1% a year by IAEA technical documentary[2][3]. It also has linear signal response on gamma rays over the wide range of dose quantity. Alanine is a kind of unnecessary amino acid in 20 amino acids

2. Methods and Results

Dosimeter and spectrometry system

Commercial alanine dosimeter was and purchased and used which contained α -amino acid alanine, CH_3-$CH(NH_2)$-COOH. Teflon was also used as binding material(ratio>9/1) to form dosimeter as pallet. First, stable alanine radical(SAR) was produced by deamination process by radiation to L-α -alanine pallet. Until now, three alanine radicals have been known already but SAR is the most critical element in dose estimation.

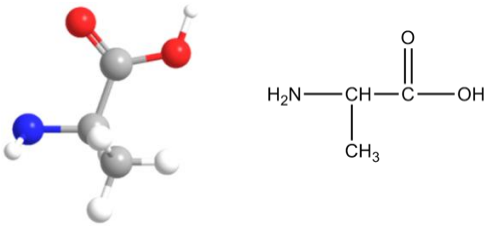


Figure 1. chemical formula of alanine

The alanine dosimeter was 5mm in diameter and 3mm in height and weighed 64.5±0.5mg. Standard alanine dosimeter for e-scan was irradiated in NPL(national physical laboratory, England) by cobalt-60 gamma-ray field and rest of the additive gamma irradiation was done by cesium-137 in blood irradiator of our institute RHRI(Radiation Health Research Institute).

Installation and measurement

Installation period of alanine pallet in nuclear power plant was two fuel cycles, and all 30 installing position was selected before first fuel cycle start, 3 alanine dosimeters were installed for each position, as put in plastic capsule, made of acetal polymers. After first fuel cycle, one of the three alanine pallet was exchanged for EPR measurement in the period of maintenance. All the samples returned from power plant was stored in controlled temperature and humidity (temperature: 21°C~26°C, RH:16%~22%). All the absorbed dose of alanine dosimeter was determined by e-scan at least 8 times which was corrected by weight of pallet and irradiation temperature (average value) after 3 month in repeat. In case of no temperature data, all the measurement was done as room temperature condition(25°C).

spectrum and analysis

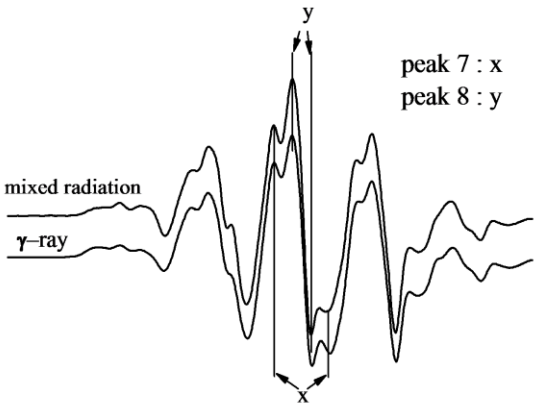
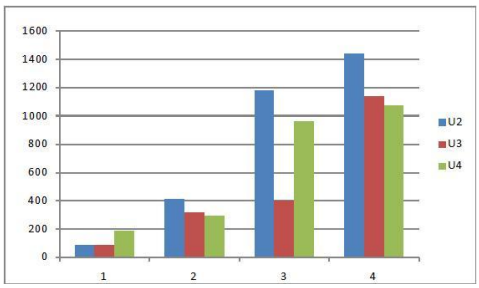


Figure 2. Spectrum of alanine pallet irradiated with gamma ray(1,500 Gy) and mixed radiation(1,800 Gy) measured by EMX spectrometer

Spectrum from EMX spectrometer(ESR spectrometer for general experiment) for alanine was reviewed for confirmation compared to the data from e-scan(ESR spectrometer for alanine pallet). In three nuclear plant " Hanul" NPP. several points showed high radiation level over 1 kGy as below plot 1. A few points in Hanul unit 2 shows relatively high accumulated dose level compared to that of unit 3, 4. The measurement result

seems to come from characteristics of the design of Hanul unit 2.



Plot. 1. Comparison of high gamma dose among "Hanul" NPP unit 2,3,4. Y axis is accumulated gamma dose estimation(Gy)

Conclusion

Estimation of the accumulated gamma dose is important to predict the life expectancy of cables. However, exact estimation of gamma dose at containment building of NPP is very difficult, because the variability of estimation value is apparently depending on the each installation position in containment building. Especially, some installation positions near reactor change extremely. So, the data from ESR measurement should be checked to the details on referring installation map and pictures.

REFERENCES

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