A comparison of the experimental and ISOCS gamma spectrometric methods for activated concrete samples

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1. Introduction

The decommission activities of the KRR-2 reactor were started in Jan. 2003. All components of reactor pool were removed and packaged in the waste container. Currently, we are preparing dismantling the biological shielding concrete of the KRR-2.

Several studies of residual radioactivity in the concrete shields of research reactor have appeared in open literature, but there is little information available on the KRR-2 research reactor.[1,2] To determine the activated level and range, we have to prepare core sample. But, there are difficulties in sample preparation and determination of the measurement. In this study, measurement results for comparison of laboratory analysis and ISOCS analysis for activated concrete sample from the exposure room in the KRR-2. The most active long-lived radionuclides in the concrete sample were found to be ^{60}Co, ^{152}Eu and ^{154}Eu. The comparison results of each sampling point are presented.

2. Methods and Results

In this section, the used measurement methods and results for activated concrete are described.

2.1 Structure of KRR-2

In this study the concern involves radionuclide contamination in activated concrete in the exposure room of KRR-2. Fig. 1 shows sampling point of the exposure room. During operations, a small neutron flux from the reactor is activated the concrete in the exposure room which is constructed for irradiating a bulk experimental sample.

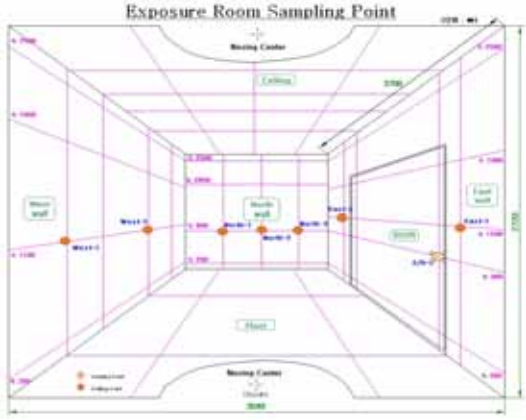

Figure 1. Sampling points of the exposure room

2.2 Laboratory measurements

Analysis of concrete samples by the analytical laboratory was performed in a low-background shielded cavity, with HPGe detector attached to a computer-based, Multi-channel gamma spectroscopy system. By the measurement of the gamma activity of activated concrete samples, we determined the concentrations of radioactive nuclides in the samples emitting gamma rays by using HPGe detector.

Radionuclieds specific concentration data was obtained to define the contamination of surface distribution. Prior to analysis, characterization included taking approximately 5cm slices of the concrete core. Each slice was analyzed to provide an estimate of the average concentration with in the sliced sample. The most active long-lived neutron activation products measured in the core samples were found to be ^{60}Co, ^{152}Eu and ^{154}Eu.

To determine depth distribution, core sample from the exposure room door was sliced and crushed the unit length(1cm) and measured by using U-8 container.

Figure 2. Core boring concrete samples.

2.3 ISOCS measurement

The ISOCS(in situ object counting system) calibration method is a convenient tool for calibrating the detector efficiency as a function of energy for a wide variety of source geometries and activity distribution. The ISOCS method consists of a Canberra characterization of the detector, user input of source geometry data, and the ISOCS software which uses those to produce the efficiency calibration. During the characterization, an MCNP model of the detector was developed. The ISOCS software contains a series of mathematical models that can be simulated a wide variety of sample shape.[3,4] In this study, the Circular Plane and Exponential Circular Plane template was adopted for calculating efficiency of the surface and depth distribution. To utilize the Exponential Circular Plane for activity concentration vs. depth profile, we have to know the DMAX and relaxation length. DMAX

is the depth, with in the exponentially varying source layer, where the greatest concentration of radioactivity starts. The relaxation length is defined as the depth at which the activity concentration falls to a factor of 1/e times its value at DMAX. We therefore need to estimate at what depth the activity concentration for our sample decreases to 37% of its maximum value.[5] The measured DMAX and relaxation length is 0.8cm and 6cm for the core samples of the exposure room door.

For our analysis, the analysis was performed by accumulation in situ a gamma radiation spectrum using an ISOCS detector which was mounted on the mobile cart. The gamma spectrum from each position was evaluated by using the ISOCS software. The detector was configured using 50mm lead shields and 90° field of view. The distance form the detector and sampling point is about 82cm.

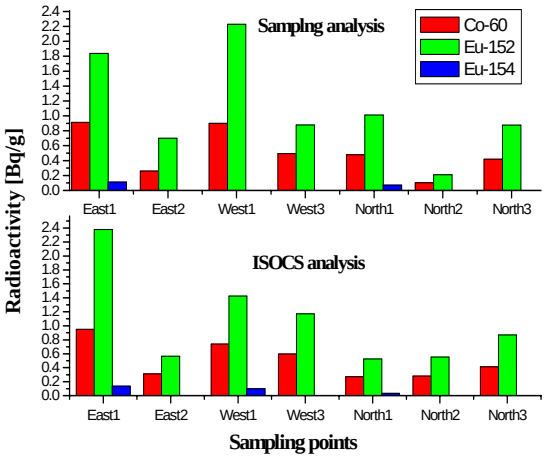

Figure 2. Comparison of the laboratory analysis with ISOCS analysis for the surface of concrete sample of the exposure room.

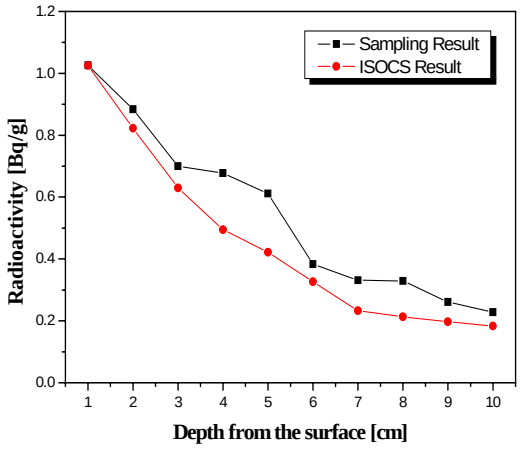

Figure 3. Comparison of the depth distribution of ^{60}Co for activated concrete sample between laboratory and ISOCS analysis.

3. Conclusion

We have been conducted to validate use of ISOCS analysis and laboratory analysis for activated concrete from the exposure room in KRR-2 research reactor.

The relative error for comparison of the laboratory and ISOCS analysis was calculated about >20% for the surface contamination of ^{60}Co. The ISOCS analysis was lower estimated than laboratory analysis for depth distribution of ^{60}Co. The difference between the ISOCS and laboratory results can be expected difference of composition of concrete and detected area for measuring the concentration using ISOCS.

The results of analysis for activated concrete will be used radioactivity analysis of the biological shield concrete and based on the management of activated or non-activated waste during the decommission and decontamination of KRR-2 .

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