Activation Characteristics for Concrete Shielding Wall of KRR-2 : verification of technology using in-situ measurement

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INTRODUCTION

❖ Background of the Study

- Concrete waste accounts for more than 70% of radioactive waste in decommissioning a nuclear facility.
- Therefore, reducing the amount of concrete waste can ensure the economic feasibility of the decommissioning project.
- In-situ measurement technique should be developed that can quickly and accurately evaluate the radioactivity distribution of concrete shielding walls without sampling.

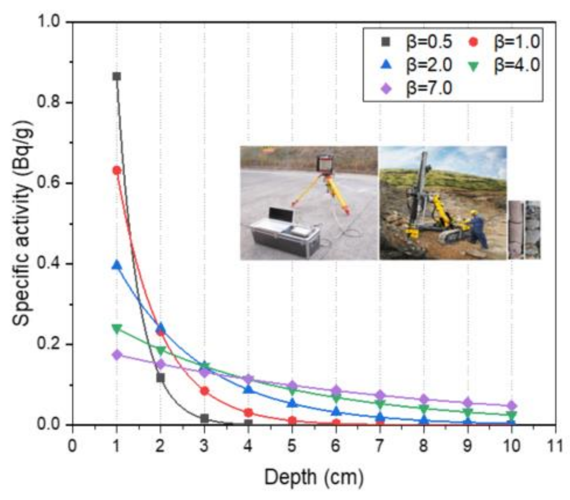
❖ Research Objective

- Analysis of the radioactivity distribution of concrete shielding walls in KRR-2 using a Peak to Compton (PTC) method.
- Verifying the reliability of evaluation algorithms through the field application tests of KRR-2.

BACKGROUND

❖ Characteristics of Activation Concrete by the Depth

- Case of decommissioning of KRR-2 and Trojan NPP
  - As the increase in thickness of the concrete, radioactivity is decreased exponentially

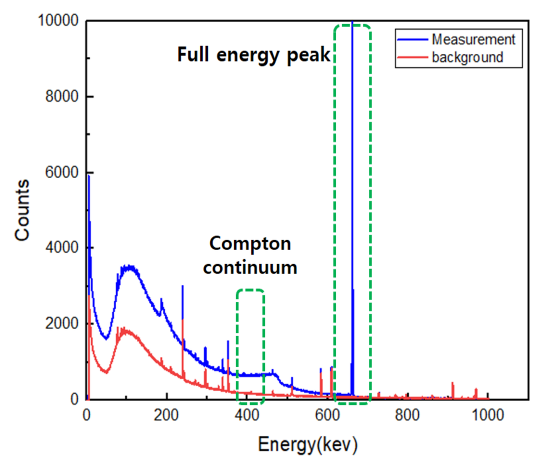


$$A(\zeta) = A_0 exp\left(-\frac{\zeta}{\beta}\right) = A_0 exp\left(-\frac{\rho x}{\beta}\right)$$

A_0 : Specific activity of surface(Bq/g)
ς : Effective mass per unit area(g/cm^2)
β : Relaxation mass per unit area(g/cm^2)
α : Relaxation depth(cm^{-1})
χ : Depth(cm)
ρ : Density(g/cm^3)

❖ Peak to Compton Method

- Analysis using the characteristics of the change in the counting rate of the peak &Compton area by the depth



$$Q_{PTC} = \frac{C_F}{C_C}$$

- Q_{PTC} = Peak to Compton Counting rate ratio
- C_F = Full energy Peak Net Counting rate
- C_C = Compton Continuum Net Counting rate

METHODS

❖ Detector

Detector	MFG. Co	Model	Relative Efficiency	Energy Resolution
ISOCS	Canberra	GC-3018	30 % (at 3 inch NaI(Tl))	0.18 % (at 1332 keV)

❖ Experimental Method

- In-situ measurements were conducted at many concrete facilities in KRR-2.(general, reactor floor, basement, etc.)
- 3600 s for each measurement point

❖ Evaluation Method

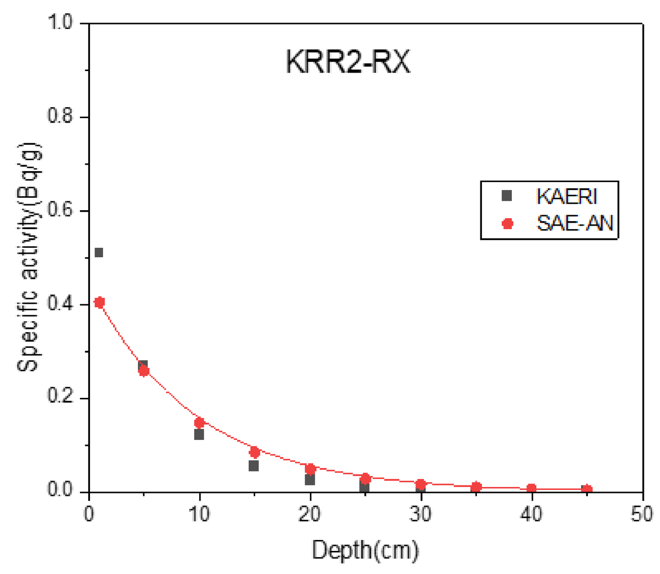
- Calculate the Q-value after removing the BKG spectrum from the measured spectrum.
- Activation of the concrete : derived by substituting Q-values into the evaluation algorithm
- Validation of New Technology(Qualitative analysis)
  - Comparison of SAE-AN & KAERI analysis results

RESULTS

❖ Calculating the Activation for Concrete

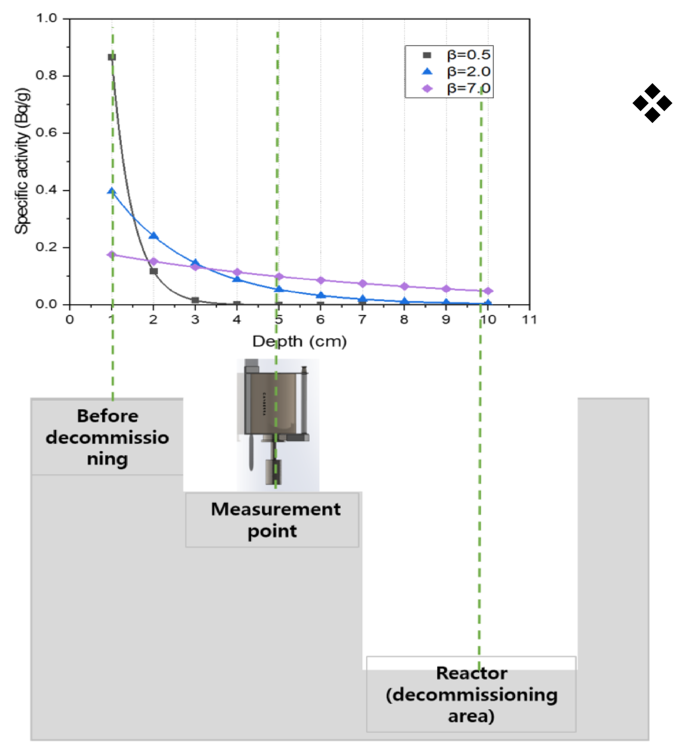
- It was confirmed that ^{60}Co and ^{152}Eu, which are representative gamma radionuclides of activation concrete were detected only on the reactor floor of the KRR-2.
- Excluding the effect of steel : evaluated only ^{152}Eu

	SAE-AN	KAERI	Relative Efficiency
In-situ Q	0.48	0.21	-
In-situ β	30.18	33.60	5.67 %



❖ Radioactivity by the Concrete Thickness

- The ratio for total radioactivity
  - SAE-AN : 40.5 %(1 cm), 66.3 %(5 cm), 81.0 %(10 cm)
  - KAERI : 37.6 %(1 cm), 62.7 %(5 cm), 77.8 %(10 cm)
- The relative error for the radioactivity distribution by depth was about 3.4 % : highly consistent



❖ Limitations of Technology Application

- KRR-2 : removal of the activation for concrete
- β value : level of residual activity
- It has been confirmed that there are limitations to the application of this technology in the case of removing the activation of concrete.

CONCLUSIONS

- Verifying the reliability of evaluation algorithms(based on the PTC method) through Field Application Tests of KRR-2.
- In-situ β : Result of the analysis of the relative error with KAERI(core technology) was 5.67 %.
- As a result of calculating the probability of distribution of radioactivity by depth based on residual radioactivity levels : the two organizations showed a high level of consistency with an error of less than 3.4 %.
- Confirmed that the validity of the PTC method was demon-started to evaluate the activation of concrete shielding walls.

PROPOSAL

- In the future, research on reliability verification should be conducted based on quantitative analysis results by providing a chance for laboratory analysis after sampling.