Uranium Enrichment Evaluation of Various Samples with a High Resolution Gamma-ray Spectrometer

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Nuclear materials in Environment Sample (ES) contain much information capable to verify declared nuclear activities at nuclear facilities. Korea Institute of Nuclear Nonproliferation And Control (KINAC) analyzes ES to characterize nuclear materials and activities conducted at specific locations.

KINAC had established a laboratory and equipment to analyze ES including High Resolution Gamma Spectrometry (HRGS) for the purpose of screening to discriminate samples required detailed analysis. HRGS, one of the non-destructive analyses, has a lot of advantages, such as short detection time and high reproducibility. For reproducibility, samples analyzed with HRGS could be measured again with other equipments. Then gamma results and other measurement results were compared to each other and reliability of results could be verified.

However, HRGS has limitation when evaluating uranium enrichment. $^{238}$U peak does not appear in general gamma spectrometry, because $^{238}$U radionuclides emit gamma rays only 0.0697% and 0.0174% (@ 49.55 keV and 113.5 keV). On the other hands $^{234m}$Pa, a daughter nuclide of $^{238}$U in secular equilibrium (Ref. 1, 2), emits gamma rays 0.837% (@ 1001.03 keV), which is more detectable compared with $^{238}$U gamma ray peaks. Higher enrichment of $^{235}$U makes it hard to detect $^{234m}$Pa peak because the amount of $^{238}$U becomes smaller.

Therefore, this article expected that enrichment could be evaluated with high accuracy using HRGS when uranium enrichment is lower than Low Enriched Uranium (LEU). Soil, swipe and sludge samples were selected for the experiment. Gamma spectrum would be taken by using an N-type coaxial HPGe detector with 60% efficiency. The results of the experiment would be compared with certified values, alpha spectrometry results by KINAC, and SIMS results by ITU(Germany) or Korea Basic Science Institute (KBSI).

It seems that analyzing uranium enrichment of environment samples with HRGS is effective to characterize samples rapidly. However, KINAC expects most HRGS results are similar with other result only when uranium enrichment is low as LEU regardless of sample type. Further study to increase accuracy and precision will be continued by detecting many kinds of samples and evaluating uranium enrichment.

REFERENCES
