New Approach For Calibration The Efficiency Of HpGe Detectors

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Abstract. This work evaluates the efficiency calibrating of HpGe detector coupled with Canberra GC3018 with Genie 2000 software and Ortec GEM25-76-XLB-C with Gamma Vision software; available at Neutron activation analysis laboratory in Malaysian Nuclear Agency (NM). The efficiency calibration curve was constructed from measurement of an IAEA, standard gamma–point sources set composed by ^{214}Am, ^{57}Co, ^{133}Ba, ^{152}Eu, ^{137}Cs and ^{60}Co. The efficiency calibrations were performed for three different geometries: 5, 10 and 15 cm distances from the end cap detector. The polynomial parameters functions were simulated through a computer program, MATLAB in order to find an accurate fit to the experimental data points. The efficiency equation was established from the known fitted parameters which allow for the efficiency evaluation at particular energy of interest. The study shows that significant deviations in the efficiency, depending on the source-detector distance and photon energy

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INTRODUCTION

Gamma-ray spectrometry with germanium detectors is a non-destructive technique which is extensively used to determine the radioactive concentration of natural and artificial radionuclides in the environment[1-2]. The most important step in the analysis using a gamma ray spectrometer is the determination of the number of photons emitted by the source and received by the detector. The determination the activity for each radionuclide requires a prior knowledge of the full-energy peak efficiency (FEPE), at each photon energy for given measuring geometry. This requires the calculation or measurement of the detection efficiency, ε, as a function of photon energy. The efficiency of a detector is a measure of how many pulses occur for a given number of γ- or x-rays. The efficiency calibration of HpGe detector was measured by using standard gamma point sources with exactly the same geometry, density and chemical composition as sample under study. The efficiency depends on the gamma energy, the detector and the geometry of measurement[3].

Clearly, to be useful, the detector must be capable of absorbing a large fraction of the gamma ray energy. This is accomplished by using a detector of suitable size[4]. For high-resolution gamma-ray measurements, HpGe detectors have better performance than Ge (Li) detector in both properties and peak-to-Compton ratio. For this reason, more quantitative data on the efficiencies of HpGe detectors are required[5]. Gamma-ray spectrometry has been widely used in various environmental and natural sciences by its ability to determine the concentrations of each radionuclide of the samples, and also because of the easiness in sample preparation and measurement procedures[2]. High-resolution gamma-ray spectrometry with a high-purity germanium (HpGe) detector is one of the most widely used procedures to determine the concentrations of natural and artificial radionuclides in the environmental samples[2].

The purpose of γ-ray spectroscopy in NAA is for measuring the energies and intensities of the photons emitted by the radionuclides. In general, a γ-ray is emitted from the sample and enters the detector, where it goes through a number of interactions ultimately resulting in the ionization of the germanium atoms in the detector crystal[6].

The present study aims at checking the validity of the efficiencies by determining the efficiency calibration curve for different source-detector distance. A simple computer program was written using Matlab to calculate the efficiency for each energy at different distances. The data of efficiency curve were fitting using polynomial function.

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