International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Preparation and Measurement of Soil Standard Source as a Petri Dish Using ^{152}EuIsotope

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Abstract: ***Our first observations on nuclear physics labs in universities recorded their need a standard sources for the purpose of calibration gamma spectrometers,especially small size samples that are less than half a liter and specifically the size of the petri dish of that are collected in a small size,for this reason we have prepared and measured standard sourcefor this size using^{152}EuIsotope , that can be adopted in the experimental measurements .The prepared sample was measured by the firstlabwhich was in central laboratories directorate / nuclear research center at Tuwaitha, and the second lab was bydepartment of physics/ college of education for pure science/Ibn Al-Haitham, University of Baghdad using Gammaspectroscopy system with a high-purity germanium detector (HPGe). The specific activity of the preparedstandard sample was calculated using an efficiency curve , which drawn by using the Monte Carlo Program. The specific activity for sample measurement by lab.1 isequal to (1103.617Bq/kg) and in lab.2 is (942.8344Bq/kg) , so the average was equivalent to(1023.226 Bq/kg).From this work, we can use this source to calculate theradioactivity for other radionuclide in small samples (street dust), which is difficult to obtained in large quantities, by a calibration spectrum for efficiency and energy of this prepared source.***

Keywords: Soil, HPGe, petri dish, Gamma spectroscopy

1. Introduction

The accuracy of the standard sample sources is one of the basic components of measurement systems in most detectors used in nuclear research because all the results depend on energy calibration and efficiency, especially for gama detectors such as HPGe detector and NaI (Tl) [1].

Some of the important characteristics that should be available in the world standard sources, including the standard source, engineering arrangement, radiation activity and other important characteristics that represent the basic aspect of standard resource preparation, should be considered. It is very important to determine the geometric shape and order of the standard source with non-samples Is known as well as a fixed volume of special containers[2] . Therefore, a standard source has been prepared with a small size (petri dish) in the same shape and geometric arrangement of the container used to measure unknown samples. Radioactivity of the standard sample source should be slightly or slightly higher than the radioactivity of the samples to be measured, since it is not easy to manufacture such sources because of radiation hazards and the risk of contamination associated with the preparation, as well as the cost of equipment and high-cost technology[3] , Which should be available for this purpose, so that the global standard sources are prepared at higher concentrations than the activity of anonymous samples that are measured in order to maintain these standard sources that are usable for a long time, Is reduced over time according to the radioactivity law[4] .

2. Material and Method

2.1 Preparation Standard Sample Method

1) Added 10ml of Hydrochloric acid (HCl) with 0.1M to the container of the powder of ^{152}Eu to prepare a soluble solution of it . This volume of HCl, which show the largest possible size of the vial glass (container), has been selected to reduce the radioactivity that can be tow from this quantity.stirring of ^{152}Eu powder in 0.1M HCl solution will increase the solubility and homogeneity of solution. Aging the solution for one hour to get homogeneous solution.
2) Using micropipette, 5µl of ^{152}Eu solution was added to 100g of powdered soil sample,Thissample has been heated at 100^{o}C for two hours to evaporate, calcified and sedimentation of Europium element to have soil powder again .
3) The prepared powder has been mixed for two hours, to get perfect homogeneity.
4) Petri dish containers have been filled and locked completely by powder. The rest has been placed in sealed plastic containers.
5) After activity calculations; A label has been fixed on container stating the name of the used radioactive element, its radioactivity and the date of manufacture.

2.2 Standard Sample Measurements

A. The gamma spectroscopy system in the lab.1 (central laboratories / Nuclear Research Center at Tuwaitha /Ministry of Science and Technology), was calibrated for the energy by using multi-sources , then the spectrum of prepared standard sample (Petri Dish) was recorded. The system consists of a high purity germanium detector (HPGe), Which is one of a semiconducting detectors

materials type (P-type) made by Canberra company, a model (GC4018) contains a crystal (Model 7500 SL) of a diameter (62mm),and length (60 mm) with(4.67mm) distance from the window. This detector works with operating voltage 4500 V , efficiency (≥40%) and Resolution (≤1.8 keV) for the energy 1.332 MeV (^{60}Co) isotope. The (HPGe) detector is kept cold by immersing it in a liquid-nitrogen vessel at (-196°C) to reduce the leakage current to acceptable levels. The detector wasshielded by lead of 10cm thickness to reduce the background radiation, The spectra of a personal computer analysis (PCA) made by Lenovo company, a personal computer equipped with electronic units is working on the receipt and the rating of the pulse coming from the amplifier according to capacity and then stored in the sites depends on capacity, and therefore showing in the form of a visual image on the personal computer screen . The used Program(Genie 2000 software / version 3.1), which is an integrated program for qualitative analysis and quantitative for gamma spectra to find the radioactivity of radionuclides emitting of the gamma rays of the sample .The figure (1) showing the Europium standard Source spectrum for the petri dish sample which registered by gamma spectroscopy system in central laboratories.

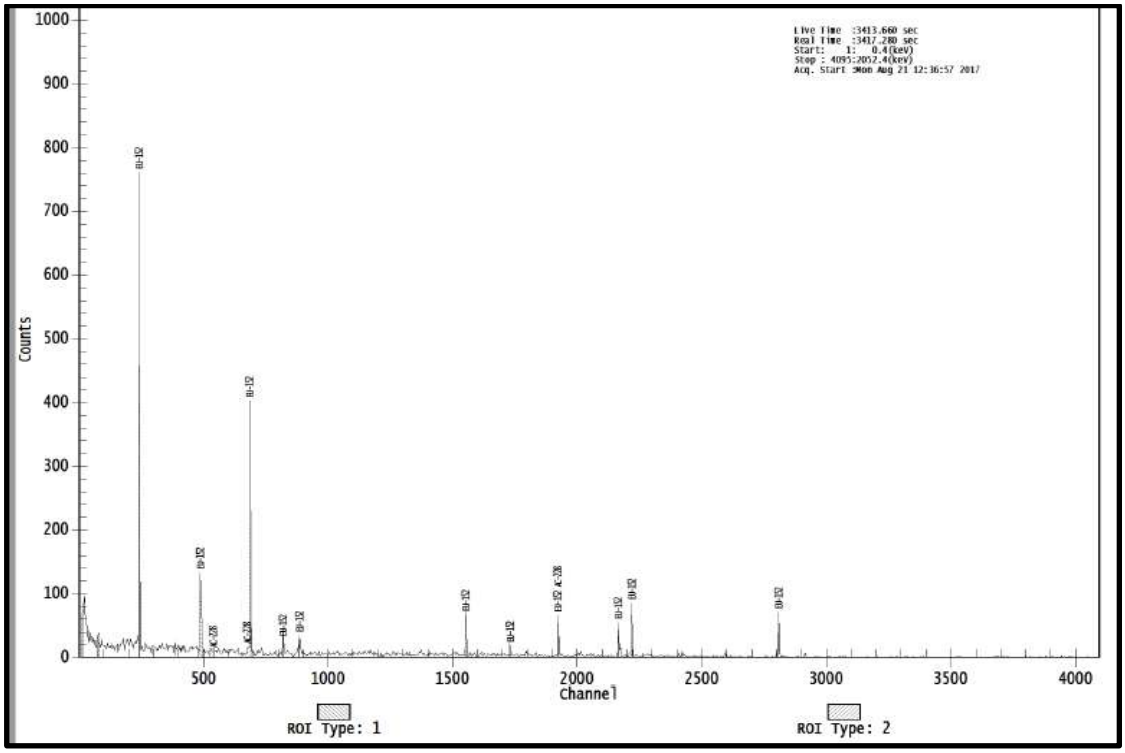

Figure 1: Spectrum of the prepared standard sample (petri dish) in the lab.1

B. The gamma spectroscopy system in the lab.2 (College of Education for Pure Science / Ibn Al-Haitham/ University of Baghdad) was calibrated for the energy by using ^{60}Co and ^{137}Cs isotope, then the spectrum of prepared standard sample (Petri Dish) was recorded . The system consist from multichannel analyzer computer card from (CANBERA) with integrated computer spectrometer version-2 software (ICS-PCI 4K) Copyright 2003-2005, which analyses the spectrum in 4096 channels with a maximum count 16M , with primary and main amplifier, and (HPGe) detector (CANBERA-model 7229N, USA) with an efficiency of 40 % is a high purity N-type semiconductor detector with physical characteristics of (geometry closed-end coaxial, 3×3 inch and operation voltage is (-3500V)). And Resolution 2.3 keV for the energy1.33MeV of 60Co isotope , the (HPGe) detector is kept cold by immersing it in a liquid-nitrogen vessel at (-196°C) to reduce the leakage current to acceptable levels. The detector is surrounded by lead shield of about 10cm thickness to reduce the background radiation. The figure (2) showing the spectrum of the prepared standard sample , through which it was identified energies of Europium-152 and extract the net count for peak each energy .

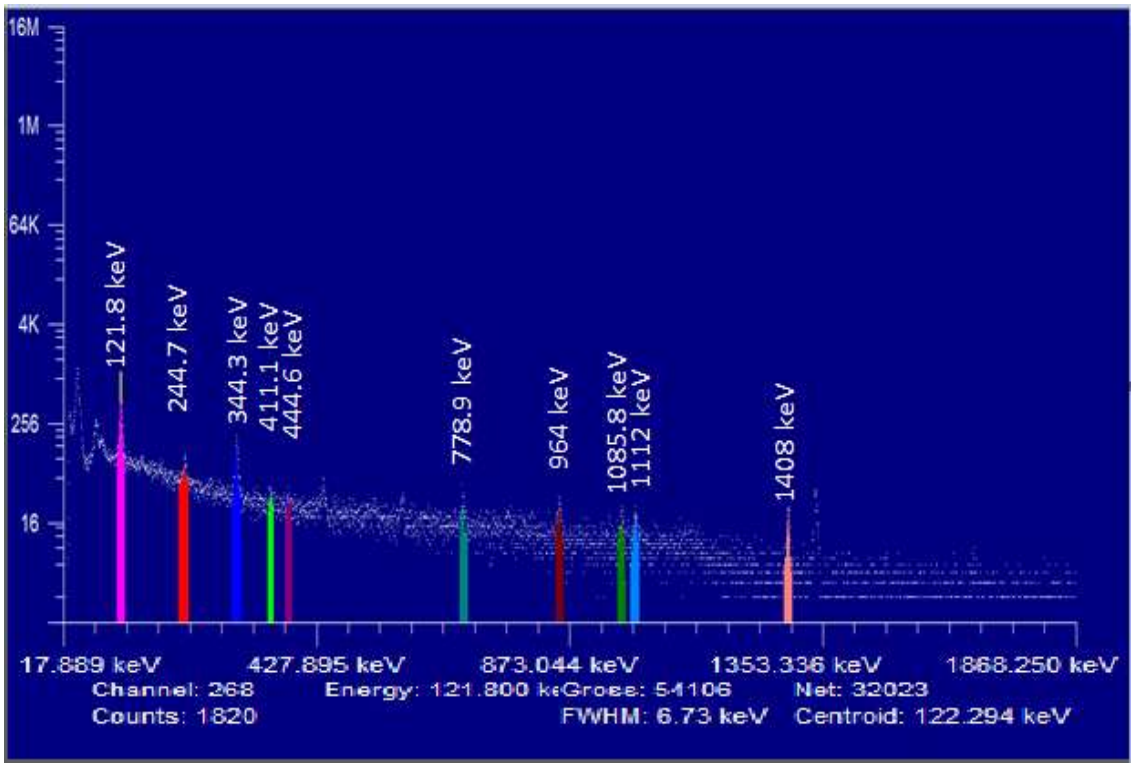

Figure 2: Spectrum of the prepared standard sample (petri dish) in the lab.2

C. The specific activity of the sample prepared was calculated by determining the efficiency value for eachenergy of the standard sample energies (Petri dish of Soil) by using an efficiency curve, which has beendrawn by using a program of Monte Carlo , as shown in figure (3).

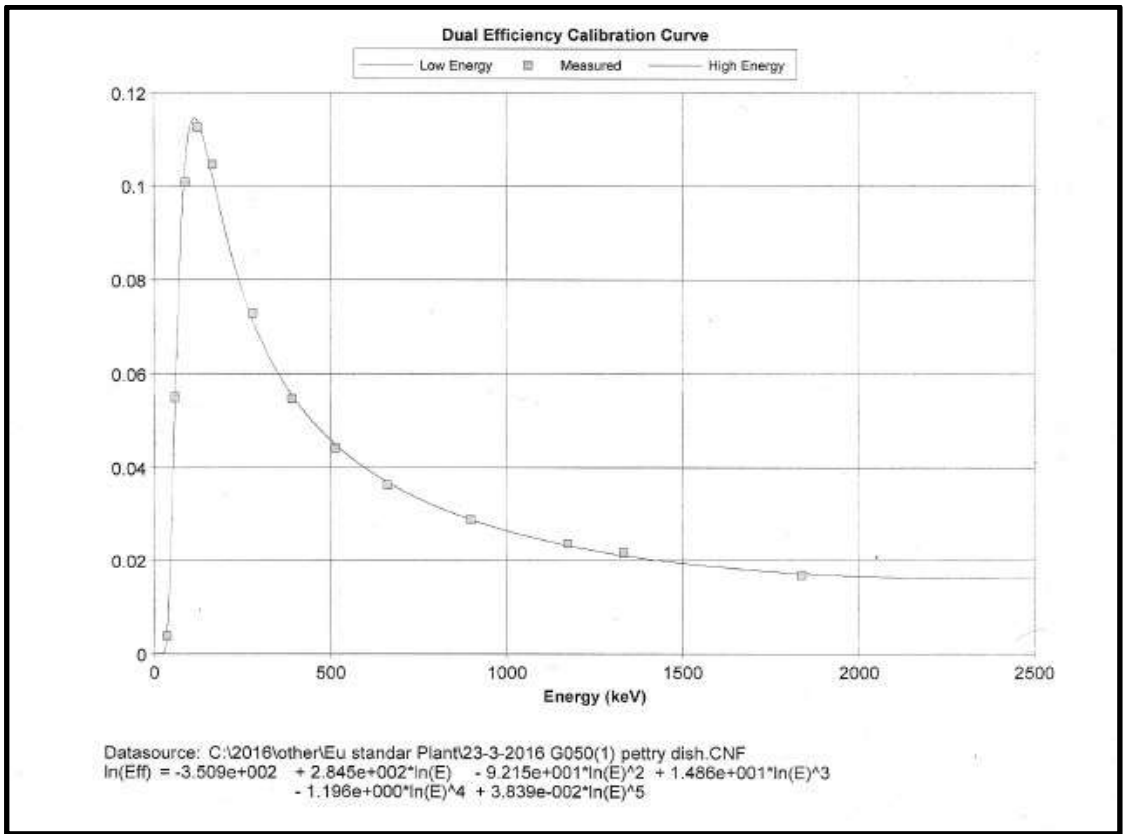

Figure 3: Efficiency curve, which has been drawn by using a program of Monte Carlo

3. Calculations and Results

A. Through the efficiency curve equation , which has been drawn in program of Monte Carlo, efficiency values were extracted of each energy from the standard source energies (Europium-152) by using equation (1) as shown in table (1), which used in the two laboratories to calculate the specific activity of the standardsample.

$$\ln(\varepsilon) = -3.509 \times 102 + 2.845 \times 102 \times \ln(E) - 92.15 \times (\ln(E))^2 + 14.86 \times (\ln(E))^3 - 1.196 \times (\ln(E))^4 + 3.839 \times 10^{-2} \times (\ln(E))^5 \ldots\ldots\ldots(1)$$

B. Through the spectrum, which has been drawn in the lab.2, the net area for each energy of the standard source the energies of Europium, was extracted as showing in the table (1), then calculated specific activity for each energy in the standard sample prepared (Petri dish) by using the equation(2)[5]:

$$A = \frac{N}{t \times I_\gamma \times \varepsilon \times M} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:
N: Net area of the standard source spectrum for Petri dish sample , the measured in lab. (2) from the table(1).
ε: Efficiency values from the table (1).
M: Mass of the prepared sample (0.066 kg).
t: Measurement time in lab. (1) (10800 Sec).
I_γ: Intensity of gamma energies of the standard source (^{152}E) .
then a calculationof the average as shown in table (2),

Table 1: Efficiency, net area and intensity of the energies for standard sample

NO.	Energy (keV)	I_γ (intensity) [5]	Net Area (for the spectrum in the lab.1	ε (from eq.2)
1	121.8	0.2837	32023	0.121644
2	244.7	0.0751	3998	0.077389
3	344.3	0.2658	10717	0.056167
4	411.1	0.223	609	0.047162
5	444.6	0.0312	732	0.043585
6	778.9	0.1296	1949	0.023811
7	964	0.1462	1603	0.018519
8	1085.8	0.1016	1133	0.016032
9	1112	0.1356	1368	0.015572
10	1408	0.2058	1690	0.01169

C. The results of the specific activity for each energy and the average in the lab. 1 (central laboratories /Nuclear Research Center at Tuwaitha) were reported, as shown in the table (2).

Table 2: Specific activity (S.A.) of the prepared standard sample in the lab.1 and lab.2

NO.	Energy (keV)	S.A. (Bq/kg) in the lab. 1	S.A. (Bq/kg) in the lab. 2
1	121.8	544.7379	1301.802
2	244.7	3234.572	965.061
3	344.3	763.0426	1007.085
4	411.1	741.6683	812.3669
5	444.6	835.6495	755.1796
6	778.9	922.8809	886.0566
7	964	289.6517	830.6113
8	1085.8	1309.156	975.838
9	1112	1129.446	908.872
10	1408	1265.369	985.4718
	Average	1103.617	942.8344

It can be seen that the average value of the specific activity of a prepared standard sample in the lab.1 is an approach to the average value of the specific activity in the lab. 2. And the overall average is (1023.226Bq/kg). The net weight of the soil in a petri dish is 66 gm , and thus the activity of the sample in a petri dish is
as follows:

1023.226 Bq / kg X 0.066 kg = 67.53 Bq

4. Conclusion

1) By Convergence of results by the two laboratories to for the prepared standard sample, which were (1103.617Bq/kg) and (942.8344Bq/kg) respectively , we can be concluded that this method is successful and reliable in the preparation for other standard samples in different shapes and sizes, in addition to using the Monte Carlo program and this is compatible with the reference[6] , especially as the error rate is few due to the convergence of laboratory results and accuracy of the measurement system.
2) The average specific activity for the prepared standard sample was (1023.226 Bq / kg) and activity for Petri Dish was (67.53 Bq) that must be close tospecific activity for othersamples.

References

[1] Knoll G. F.," Radiation detection and measurement" ,John Wiley & Sons , Inc , Third Edition), (2000).
[2] ANSIIIEEE Standard 325-1986, Test Procedures for Germanium Gamma Ray Detectors (1986).
[3] Meyer R. A., Tirsell K. G. &A.Armantrout G., in Secondary, Proceedings, ERDA X- and Gamma-Ray Symposium, Ann Arbor, MI, (CONF-760539, 1976), p. (40).
[4] Gehrke R. J. & and et al., Nucl. Instrum. Meth. , Vol.147 , p 405(1977).
[5] Jose A.& et al., "Analysis of the 40K Levels in Soil using Gamma Spectrometry", Brazilian Archives of Biology and Technology Journal, (221-228), (2005).
[6] AL-Ubaidi K.H. , AL-Nasri S.K. , AL-Bayati A.T., " Preparation of Standard Source as a Petri Dish for Plant by Using 152Eu Element", University of Baghdad , Iraq , 13-18 ,2016.