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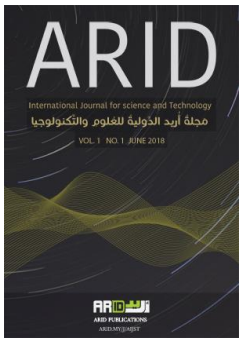

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A STUDY OF NATURAL RADIOACTIVITY IN CEMENT OF MASS FACTORY FROM NORTH IRAQ

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دراسة النشاط الإشعاعي الطبيعي لإسمنت معمل ماس في شمال العراق

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ABSTRACT

The aim of this work is to measure the specific activity of Ra-226 which belongs to U-238 chain, Ac-228 which belongs to the Th-232 chain, and K-40 in the cement samples manufactured in Mass factor (north of Iraqi-Sulimania). These specific activities can be determined by gamma-radiation detection Unit based on p-type coaxial Hyper-Purity Germanium (HPGe) detector cooled by liquid nitrogen typeGCD-40 190 in a low background configuration. Measurement of natural radioactivity in the environment are of very importance to monitor and control the levels of radiation from, the earth, the sky and different atoms existing in the wider, water, food, metals and building materials.

Indoor exposures arise from the soils in the building stand, which was used during construction. All building materials include levels of radionuclides of U-238; Th-232 and K-40.Result study show the amount of these specific activities and the risk of exposure to natural radiation from those radioactive isotopes. Where the results we have obtained are shown to be within the permissible limits compared to the results of the International Atomic Energy Agency. Therefore, the cement product of a Mass plant has characteristics and radiation properties that are safe when using these materials in building materials. Where the results obtained in this study were shown (50.27, 36.841 and 132.58 $Bq.kg^{-1}$for Ra-226, Th-232 and K-40) respectively is 0.46 $msv.y^{-1}$ {UNSCEAR;2000}.

Keywords: Neutral radioactive, building material and Hyper-Purity Germanium (HPGe).

الملخص

إن هدف الدراسة هو قياس تراكيز النشاط الإشعاعي الطبيعي لنظير(Ra-226)المتواجد ضمن سلسلة اليورانيوم (U-238)و (Ac-228) المتواجد ضمن سلسلة الثوريوم(Th-232) وكذلك نظير(K-40) .إن النماذج المقاسة في هذه الدراسة تمثل نماذج عدده ستة تم اختيارها من معمل اسمنت ماس الواقع في شمال العراق – محافظة السليمانية وهذا الاسمنت الأكثر استخداما في الأسواق العراقية . تم استخدام كاشف الجرمانيوم م عالي النقاوة نوع (GCD-40 190) لقياس هذه النماذج المربوط مع منظومة متعدد القنوات . إن دراسة النشاط الإشعاعي الطبيعي لمختلف المواد المتواجدة في البيئة مهم جدا لكونها تمثل العنصر الأساسي لاستمرار الحياة، وتحتاج إلى مراقبة مستمرة للمواد الرئيسية التي تدخل كعنصر أساسي في حياة الإنسان مثل الغذاء والماء والهواء ومواد البناء . وأهمية دراسة النشاط الإشعاعي في مواد البناء هو استخدام الإنسان لها بشكل مستمر ومباشر مما يعرضه لاستلام جرع إشعاعية إضافية. إن النتائج التي حصلنا عليها في هذه الدراسة وهي (50.27).(36.841)و(132.58)Bq/Kg للنظائر(Ra-226),(Th-232)و(K-40) 0.46 msv/y هي طبيعية وضمن الحدود المسموحة عالميا مقارنة بالمحددات التي وضعتها الوكالة الدولية للطاقة الذرية، وخصوصا للنظائر (Ra-226),(Th-232) و(K-40) التي تؤثر بالجرعة الاشعاعية $0.46\ msv.y^{-1}$ (UNSCEAR,2000).

1. Introduction:

The environment in which we live consists of several substances that affect our lives. In other words. The environment consists of the main factors are air, water and soil, which are an important part of human life. These factors include naturally radioactive elements; the human receives the natural radiation of cosmic, terrestrial rays and building materials consist of different amounts of natural radioactivity in the soil, mainly containing U-328, Th-228 and K-40 agree with {UNSCEAR, 2000}is 0.46 $mSv.y^{-1}$[1,2,3]

The study of radioactivity in the building materials is of great importance to monitoring. Due to the natural environmental radiation hazards affecting humans, it is necessary to continuously monitor the environment for the purpose of determining the limits according to the requirements of the IAEA. Determination of natural radionuclide determinants can be used to determine the personal exposures of humans according to the environment in which they live. Construction materials are derived from both natural sources (e.g. rock and soil) and waste products (e.g. phosphate, alum shale, coal fly ash, oil shale ash and certain slugs). It is necessary to study the natural environmental radiation level from building materials for the estimation of the exposures to natural radioactivity [1].

The International Atomic Energy Agency (IAEA) has published data and limitations on the radiation doses that humans can be exposed to in their lives. The exposures to cosmic -ray are about 0.38 $mSv.y^{-1}$ to terrestrial radiation 0.45 $mSv.y^{-1}$, this figure increase about 20% for brick concert buildings, to air, water and food 1.5 $mSv.y^{-1}$.

The exposures from air flights, color TV and nuclear power plants is about 0.1 $mSv.y^{-1}$ and to the other factor like X-rays diagnostics are about 0.4$mSv.y^{-1}$. Thus, the human being receives about 2.7 $mSv.y^{-1}$ from natural radiation. The lowest radiation dose received by the general population

is 1 $mSv.y^{-1}$. Cement is one of the important and expensive materials used by the building industry in Iraq. [4]

Most of the construction in Iraq uses cement, which contains natural radioactive isotopes, which is an additional factor exposed to humans {UNSCGAR, 2000} [5].

2. Samples Preparation:

Six samples were collected from production plants of local cement Mass-North of Iraq for analysis.

Each sample, estimated to be 1 kg, was dried in an oven at about $80c^{o}$ for four hours until complete removal of any residual moisture and ensuring that a constant weight samples are used. The samples are placed in a Marinelli Beakers to measure the radioactivity by (HPGe) which were stored one month to allow for radioactive equilibrium to be reached (secular equilibrium where the rate of decay of the daughter becomes equal to that the parent).[6,7]

3. Method of Measurement:

Before activity measurement, we must make calibration to determine absolute gamma-ray energies. In this study a Gamma source (Eu-152) was chosen for energy calibration due to the wide range of gamma-ray energies (121 kev to 1408 kev) emitted from this source.

The calibration source (Eu-152) was placed in liter Marinelli Beaker of the same geometry as that of sample measurement in order to reduce the error in the determination of the peak energy {Gilmore 2008} as shown in figures (1) and (2).

Efficiency $\varepsilon_{(E_\gamma)}$ is a measure of the percentage of radiation that a given detector detects from the overall yield that is emitted from the source into a solid angle of usually 4π in the photo-peak .The detector efficiency is calculated as in the following equation.

$$\varepsilon\,(E_\gamma) = \boldsymbol{N}\mathrm{t} * 100/\boldsymbol{N}_\gamma$$

Where: -

$\mathbf{N}_t$ = Net area per unit of time over the whole recorded spectrum (minus the background rate).

$\mathbf{N}\gamma$ = Absolute activity per unit of time.

Spectrum of full energy for range of discrete gamma-ray energies chosen from standard sources is illustrated in Figure (3). Each sample was analyzed by using high resolution Gamma spectrometry system. It consists of high pure germanium detector having 40% relative efficiency, its energy resolution measured in terms of Full With Half Maximum (FWHM) is 2.1 keV at 1332 keV of Co-60 Gamma energy. The pulse amplitude is converted to a discrete number using the 4096 channel in a multi-channel analyzer (MCA). Gamma ray spectrometry measurements were analyzed using genie 2000 software [8,9].

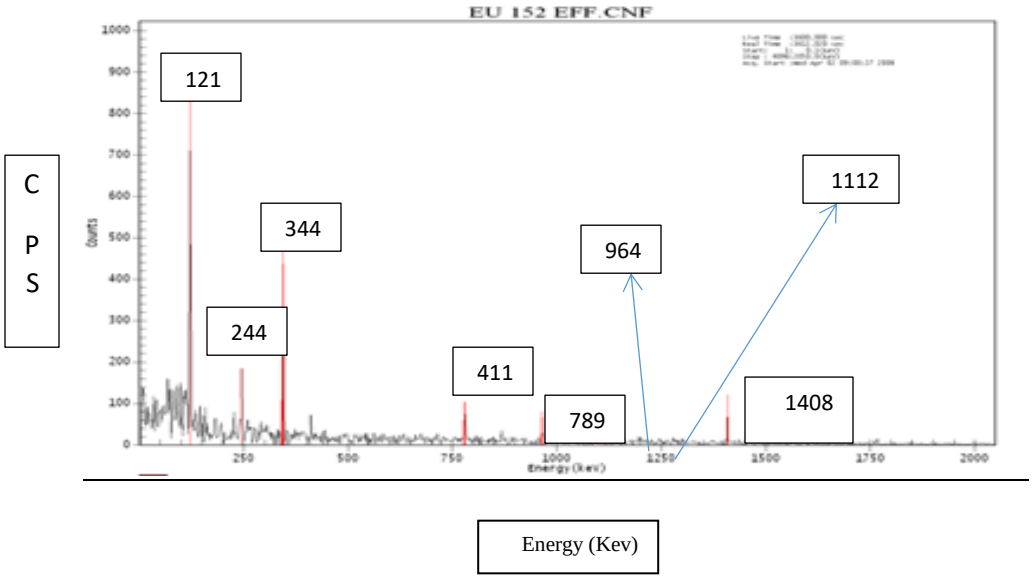

Figure (1): Calibration spectrum energy for rang of discrete gamma-ray for Eu-152.

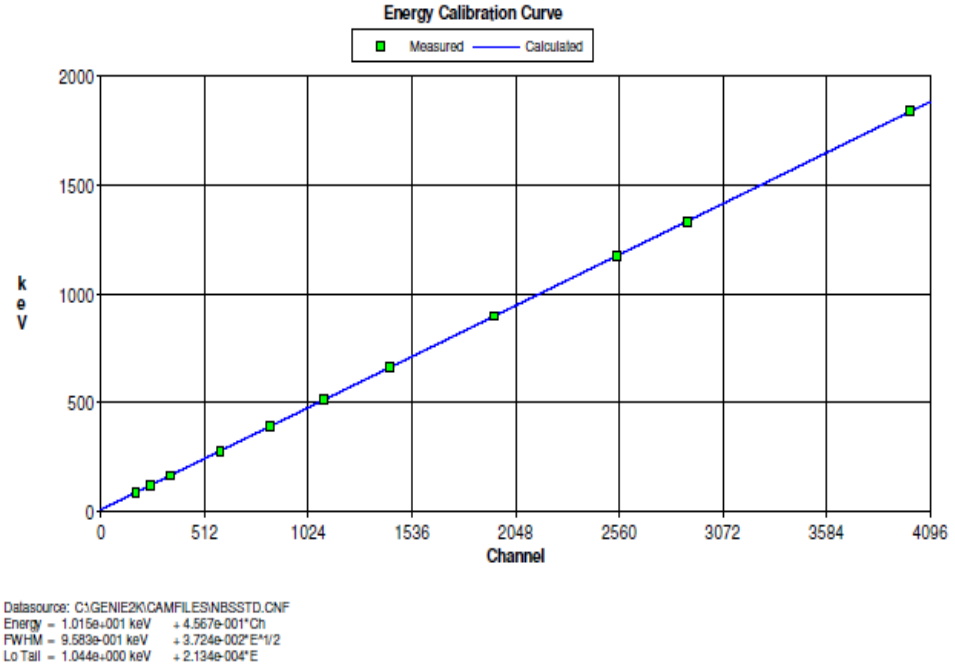

Figure (2): Energy calibration using Eu-152 radioactive standard

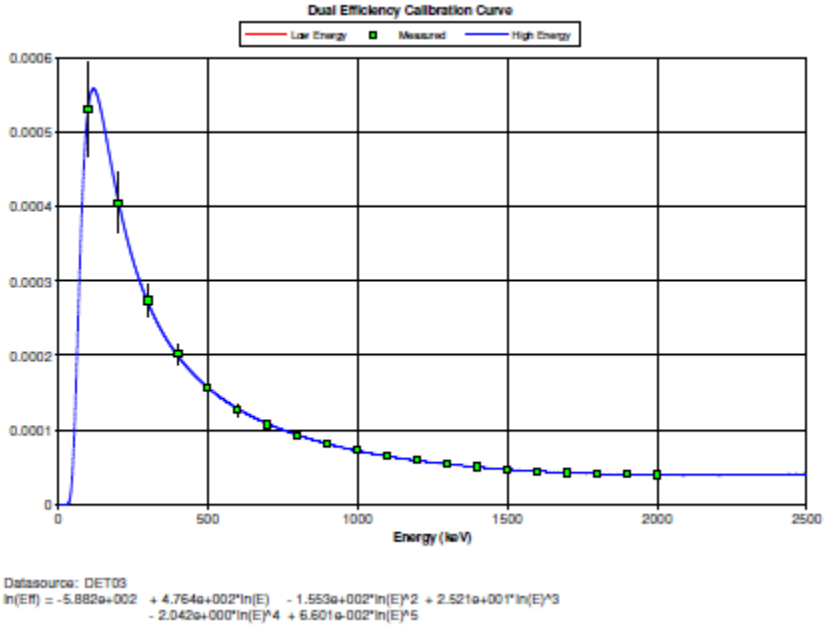

Figure (3): Efficiency calibration curve of (HPGe) detector using Eu-152

4. Results and Discussion:

Cement is a very important construction material for house and building material of Iraq. It is used for plastering and concrete manufacturing as well as for building block sand walls, which are made of bricks. However, the information of the specific activates in terms of the activity concentration is defined as the activity per unit mass of the sample. After by using net area of spectrum, the specific activity calculated of the mean range of three radionuclides (Ra- 226, Th-232, and K- 40) are 50.27, 36.841 and 132.58 Bq. kg^{-1} respectively and have been determined as presented in Table (1).

The specific activity spectrum of cement sample is shows in Fig (4) the specific activity for Ra-226, Th-232 and K-40 was calculated using the following relation:

$$\boldsymbol{A}(\, Bq.kg-1\,) = \boldsymbol{N}/\,\varepsilon\,(\,E_{\gamma}\,)\,\boldsymbol{I}(\,E_{\gamma}\,)\,\boldsymbol{tcm}$$

where: -

A: - Is the specific activity in (Bq. kg^{-1}).

N :- Is the corrected net peak area of the ($N = N_s - N_b$).

N_s :- Is the net peak area in the sample spectrum .

N_b :- Is the corresponding net peak area in the background spectrum.

$\boldsymbol{\varepsilon}_{(E_\gamma)}$:- Is the efficiency of the detector .

$\boldsymbol{I}_{(E_\gamma)}$:-Is the intensity of gamma energy [E]

$\boldsymbol{t}_c$;- Is the counting time.

m :- The mass (kg) of the sample.

Energy (Kev)

The results in the present study for cement have also been compared with values of the worldwide specific activity of Ra-226, Th-232 and K-40 (in $Bq.kg^{-1}$) for other countries of the world are shown in Table (2). Therefore, the cement product of a Mass plant has characteristics and radiation properties that are safe when using these materials as building materials [3, 8, 10, 11, 12, and 13].

Table (1): Results of cement plants Mass samples

Samples No.North Iraqi/cement Mass	Ra-226 $Bq.kg^{-1}$	Th-232 $Bq.kg^{-1}$	K-40 $Bq.kg^{-1}$
M1	60.32	35.37	130.11
M2	55.54	37.45	135.21
M3	58.62	37.88	128.5
M4	65.34	36.23	140.12
M5	50.68	36.61	125.33
M6	56.12	37.51	136.21
Average	50.27	36.841	132.58

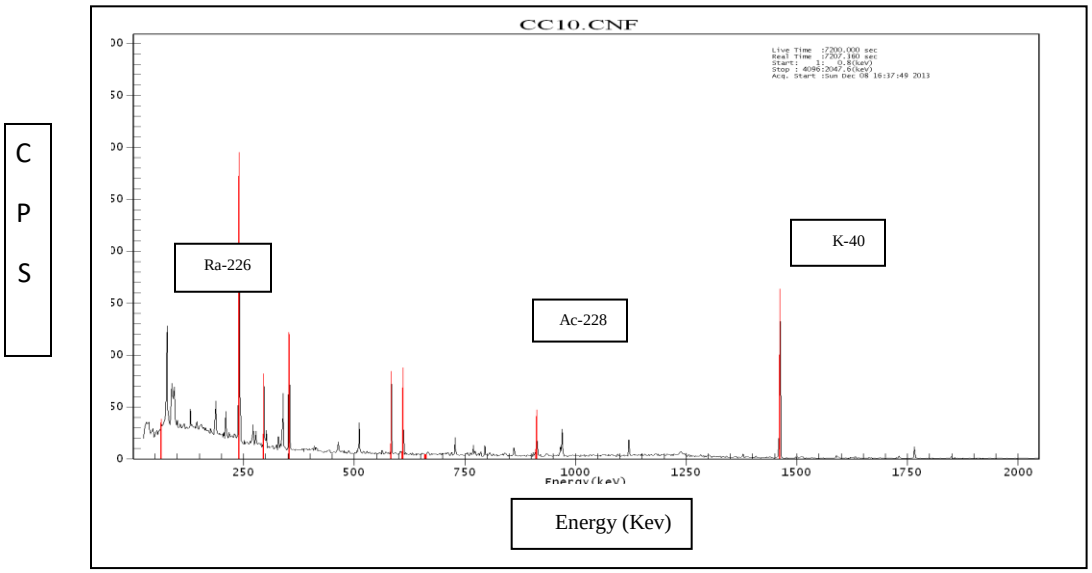

Figure (4): Spectrum of the radioactive sample for cement Mass – north of Iraq

Table (2): Comparison between the activity concentrations (in $Bq.kg^{-1}$) of our building materials cement with that of other countries of the world.

Country	Ra-226	Th-232	K-40
Average cement Mass-Iraq	50.27	36.841	132.58
Egypt[8]	31.3	11.1	48.6
Iran[10]	39.6	28.9	290
Jordan[3]	43.21	11.23	265.12
K.S.A[11]	38.4	45.3	86
Turkey[12]	24.7	20.7	249.31

5. Conclusions

We believe all construction materials are important and the most important is the cement material because it contains several primary materials collected from mines from different countries. Therefore, you need continuous monitoring, especially radiological monitoring. As we have previously said, humans live for long periods of time in contact with cement. From the observation of the results, Mass cement is widely used in Iraqi markets. It was found that natural radionuclide in these studies were within permissible limits compared with global research publications.

List of Abbreviations:

1- International Atomic Energy Agency (IAEA).

2- Hyper-Purity Germanium (HPGe).

3- Full of Half Maximum (FWHM).

4- Multi-channel analyzer (MCA).

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