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Radioactivity of Some Building Materials Samples Measured by Using (Hpge) Detector

Ali Hassan Ressen[2] Firas Hashem Ahmed[1] Waleed Jabbar Mhana[3]
Radhi Shadhan. Al -Taweel[4] Mahmood Salim Karim[5]
[1,2,4,5]Department of Physics, College of Education, Mustansiriyah University
[3]Department of Physics, College of Science, Mustansiriyah University
[1]Email: firashashem@uomustansiriyah.edu.iq [5]Email: mahmood_msc74@yahoo.co.uk
[2]Email: dr.ahrh77@gmail.com

Abstract

Determinations of specific activity concentrations of ten building materials samples acquired from various governors (Baghdad, Najif, Babylon, Salahaddin, Karbala, Sulaymniya and Kadesea) were done utilizing (HPGe) detector. Results of estimation have demonstrated that average values of specific activity concentrations for ^{238}U, ^{232}Th and ^{40}K were equivalent to (20.568 Bq/kg), (22.829 Bq/kg) and (192.691 Bq/kg), respectively. Less than their comparing suggested worldwide esteems detailed by (UNSCEAR, 2000) publication. The radiation hazard indices [Ra_{eq} ,D_γ , $(AEDE)_{in}$,$(AEDE)_{out}$, I_γ , H_{in} and H_{ex}] were additionally considered, and all the obtained results and their average value results were likewise observed to be not as much as their relating permitted limits given by (UNSCEAR , 2000). Along these lines, the results of the present work have demonstrated that, all the examined samples of building materials don't represent any noteworthy wellspring of radiation risk and in this manner they are safe when utilized.

Key Words: Building Materials, Natural Radioactivity, Marinelli beaker, Radiation hazard indices.

إيجاد النشاط الإشعاعي الطبيعي لنماذج من مواد البناء

أ.م.د. علي حسن رسن٢, م.د. فراس هاشم احمد ¹ أ.م.د. وليد جبار مهنا٣,
أ.د. راضي شدهان الطويل ⁴ أ.م.د. محمود سالم كريم ⁵
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الخلاصة

في الدراسة الحالية تم قياس الفعالية الاشعاعية النوعية لعشر نماذج من مواد البناء من محافظات مختلفة (بغداد، نجف، بابل، صلاح الدين، كربلاء، سليمانية، والقادسية) باستعمال كاشف الجرمانيوم عالي النقاوة (HPGe) وقد أظهرت النتائج بان معدل الفعالية الإشعاعية النوعية لكل من (^{238}U، ^{232}Th، ^{40}K) كانت (20.568 Bq/kg), (22.829 Bq/kg) و (192.691 Bq/kg) على التوالي وكانت جميع النتائج المتحصلة وكذلك نتائج المعدلات للفعالية الاشعاعية النوعية هي اقل من القيم المسموحة و الموصي بها و المنشورة من قبل (UNSCEAR , 1994) . كما تمت دراسة معاملات الخطورة الإشعاعية [H_{ex}, H_{in} , I_γ , $(AEDE)_{out}$, $(AEDE)_{in}$, D_γ, Ra_{eq}] وكانت جميع النتائج المستحصلة لهذه المعاملات وكذلك معدلاتها هي اقل من القيم المسموحة والموصي بها والمنشورة من قبل (UNSCEAR , 2000) . وبذلك فان نتائج الدراسة الحالية قد بينت بان جميع نماذج مواد البناء المدروسة لا تعتبر مصادر إشعاعية خطرة ويمكن استعمالها بأمان.

كلمات مفتاحية: مواد البناء، النشاط الإشعاعي الطبيعي، قدح مارينيللي، معاملات الخطورة الأشعاعية.

Introduction

The production industry of building materials generates few sorts of strong and fluid waste, scales, sludge and water. There are commonplace deposits which can be found in such facilities and can be sullied with Naturally Occurring Radioactive Materials (NORM). Because of building materials preparing, the natural radionuclides can be packed in such residues, so the shaping is called Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). The vast majority of the radionuclides that show up in building materials belong to the Th-232 and U-238 natural series, in addition to K-40. Attention was given to the quantification of Ra-226, Th-232 and K-40 since these radionuclides are in charge of the vast majority of the outer exposure in such facilities [١].

NORM for example, the ones from the U-238, Th-232 series and K-40, are fundamental constituents of the outside of earth, and can be found in higher than ordinary fixations in a few locales of the earth, which are known as high natural radiation areas. The awareness about radiation dosages because of characteristic radiation has been the reason for expanded worry as of late. The specific consideration has been centered around the mining and handling industry, as these operations can be in charge of the grouping of NORM in items or deposits. In past examinations, Kinsara et al. [٢] have examined specific activity in twenty four samples of building materials gathered from used quarries dispersed randomly in a high natural background radiation zone lies in Hail province, Saudi Arabia, and they found that granites and clays surpassed the proposed peril files for the use as building materials and ought to be confined, whereas the sands and the crushed black rocks conformed to these records and can be utilized without limitations. Additionally, Ismael et al. [3] decided the radioactivity substance of twenty four building materials tests in Alkharj territory and presume that the deliberate radioactivity of these specimens are inside satisfactory levels and does not represents any hazard from radiation security. Huda et al. [٤] measured levels of common radioactivity in twenty specimens of building materials utilized as a part of the State of Qatar and found that these levels are generally well beneath the prescribed wellbeing limits. As needs be, the present work is concerned with the determination of the specific activity concentration of (^{238}U, ^{232}Th and ^{40}K) and their associated radiation hazard indices, such as, radium equivalent activity, absorbed gamma dose rate, indoor and outdoor annual effective dose equivalents, activity gamma index, and also internal and external hazard indices for some selected building materials samples acquired from various governors, by using a high purity germanium (HPGe) detector.

Materials and Method

Ten building materials samples got from various governors (Baghdad, Najif, Babylon, Salahaddin, Karbala, Sulaymniya and Kadesea) were gathered in the present work. One kilogram Marinelli beakers were utilized as a part of the present examination. Estimations with exhaust

Marinelli beakers under identical conditions to evaluate the background radiation were additionally performed. The net weights of the specimens were found from the distinction in weights of a sample - filled and an empty beaker.

The samples were then kept for around one month before measurements keeping in mind the end goal to accomplish common harmony for Th-232 and U-238 with their respective progenies [5].

A basic prerequisite for the estimation of gamma producer is the correct character of photo peaks presents in the spectrum produced by the detector system. The energy calibration was performed by using a standard source of one kelogram capacity of Marinelli beaker of Europium-152, with energies (964.0, 1408.0, 344.3, 411.1, 444.6, 778.9, 121.8, 1112.0, 1085.8 and 244.7 keV). The Energy calibration source ought to be tallied sufficiently long to create very much characterized photo-peaks. The proficiency alignment of the (HPGe) detector was accomplished utilizing the same standard source of Europium-152.

The specific activity concentrations of radionuclides in building materials samples were gotten by using the equation [6]:

$$A = (Net \quad Area \quad under \quad the \quad peak) / M \times I_{\gamma}(E_{\gamma}) \times T \times eff \quad \ldots\ldots\ldots (1)$$

Where:

A: Specific activity concentration of radionuclides (Bq/kg).

M: Mass of the building material sample (kg).

$I_{\gamma}(E_{\gamma})$: Abundance at energy E_{γ}.

T: Time of measurements which was equal to (7200 s).

eff: Efficiency of the detectors at energy E_{γ}.

Radiation Hazard Indices

In the present work, the accompanying surely understood radiation hazard indices were resolved.

1. Radium Equivalent Activity (Ra_{eq}):
   Which was ascertained utilizing the relation [7]:

$$Ra_{eq}\,(Bq/kg) = 0.077A_K + 1.43A_{Th} + A_U \quad \ldots\ldots\ldots\ldots (2)$$

Where, A_K, A_{Th} and A_U are the specific activity concentrations of K-40, Th-232 and U-238 respectively.

2. Absorbed Gamma Dose Rate (D_{γ}):
   Which was ascertained utilizing the relation [8]:

$$D_{\gamma}\ (nGy/h) = 0.0417A_K + 0.604A_{Th} + 0.462A_U \qquad \dots\dots\dots (3)$$

3. Annual Effective Dose Equivalent:

Which was ascertained utilizing the relations [9], [10]:

$$(AEDE)_{in}\ (mSv/y)= D_{\gamma}\ (nGy/h)\times10^{-6}\times8760\ h/y\times0.7Sv/Gy\times0.80 \qquad \dots\dots\dots(4)$$

$$(AEDE)_{out}\ (mSv/y)= D_{\gamma}\ (nGy/h)\times10^{-6}\times8760\ h/y\times0.7Sv/Gy\times0.20 \qquad \dots\dots\dots(5)$$

4. Activity gamma Index (I_{γ}) :

Which was ascertained utilizing the relation [10]:

$$I_{\gamma} = \frac{A_K}{1500} + \frac{A_{Th}}{100} + \frac{A_U}{150} \qquad \dots\dots\dots\dots (6)$$

5. External (H_{ex}) and Internal (H_{in}) Hazard Indices:

(H_{ex}) was ascertained utilizing the relation [11]:

$$H_{ex} = \frac{A_K}{4810} + \frac{A_{Th}}{259} + \frac{A_U}{370} \qquad \dots\dots\dots\dots (7)$$

Internal exposure to radon ^{222}Rn and its radioactive offspring is controlled by the internal hazard index (H_{in}) and it is given by the relation [11]:

$$H_{in} = \frac{A_K}{4810} + \frac{A_{Th}}{259} + \frac{A_U}{185} \qquad \dots\dots\dots\dots (8)$$

Results and Discussion

The results of the specific activity for ^{238}U, ^{232}Th and ^{40}K radionuclides for ten building materials samples are displayed in Table (1). From Table (1), it can be seen that:

The specific activity of ^{238}U was observed to be be extended from 16.650 Bq/kg (Brick) (Baghdad origin) to 26.270 Bq/kg (Cement) (Sulaymniya origin), with an average value of 20.568 Bq/kg, see Fig. (1). These qualities were not as much as the world normal estimation of (35 Bq/kg) given by (UNSCEAR, 2000) [9].

The specific activity of ^{232}Th was observed to be extended from 17.630 Bq/kg (Gravel) (Karbala origin) to 27.440 Bq/kg (Brick) (Baghdad origin), with an average value of 22.829 Bq/kg, see Fig. (1). These qualities were not as much as the world normal estimation of of (30 Bq/kg) given by (UNSCEAR, 2000) [9].

The specific activity of ^{40}K was observed to be extended from 123.87 Bq/kg (Brick) (Najif origin) to 264.07 Bq/kg (Sand) (Karbala origin), with an average value of 192.691 Bq/kg, see Fig. (1). These qualities were not as much as the world normal estimation of (400 Bq/kg) given by (UNSCEAR, 2000) [9].

The radium equivalent activity (Ra_{eq}), was observed to be gone from 63.132 Bq/kg (Gravel) (Karbala origin) to 730343 Bq/kg (Sand) (Karbala origin), with an average value of 68.051 Bq/kg, see Fig. (2). These qualities were not as much as the world normal estimation of (370 Bq/kg) given by (UNSCEAR, 2000) [9].

The values of absorbed gamma dose rate ($D_γ$) were observed to be extended from 28.882 nGy/h (Brick) (Najif origin) to 34.094 nGy/h (Sand) (Karbala origin), with an average value of 31.326 nGy/h, see Fig. (2). These qualities were not as much as the world normal estimation (55 nGy/h) given by (UNSCEAR, 2000) [9].

The values of indoor annual effective dose equivalent $(AEDE)_{in}$ was observed to be run from 0.142 mSv/y (Brick) (Najif origin) to 0.167 mSv/y for both (Cement) (Sulaymniya origin) and (Sand) (Karbala origin), with an average value of 0.154 mSv/y, see Fig. (3). These qualities were not as much as the world normal estimation of (1 mSv/y) given by (UNSCEAR, 2000) [9].

The values of outdoor annual effective dose equivalent $(AEDE)_{out}$ was observed to be extended from 0.035 mSv/y (Brick) (Najif origin) to 0.042 mSv/y (Cement) (Sulaymniya origin), with an average value of 0.038 mSv/y, see Fig. (3). These qualities were not as much as the world normal estimation of (1 mSv/y) given by (UNSCEAR, 2000) [9].

The values of activity gamma index $I_γ$ was observed to be gone from 0.227 (Brick) (Najif origin) to 0.271 (Sand) (Karbala origin), with an average value of 0.247, see Fig. (3). These qualities were not as much as the world normal estimation of (1) given by (UNSCEAR, 2000) [9].

The internal hazard index was observed to be gone from 0.220 (Brick) (Babylon origin) to 0.271 (Sand) (Karbala origin), with an average value of 0.239, see Fig. (4). These qualities were not as much as the world normal estimation (1) given by (UNSCEAR, 2000) [9].

The external hazard index was observed to be extended from 0.171 (Gravel) (Karbala origin) to 0.198 (Sand) (Karbala origin), with an average value of 0.184, see Fig. (4). These qualities were not as much as the world normal estimation of (1) given by (UNSCEAR, 2000) [9].

Table (1) Kind, Origin, specific activity concentrations and hazards indices for the building materials samples studied in the present work.

Kind of building materials and their origins	U-238 (Bq/kg)	Th-232 (Bq/kg)	K-40 (Bq/kg)	Ra_{eq} (Bq/kg)	D_{γ} (nGy/h)	(AED) (mSv/y) $(AED)_{in}$	$(AED)_{out}$	I_{γ}	H_{in}	H_{ex}
Brick (Baghdad)	16.650	27.440	163.57	68.484	31.087	0.153	0.038	0.247	0.230	0.185
Brick (Najif)	21.370	22.920	123.87	63.684	28.882	0.142	0.035	0.227	0.230	0.172
Brick (Babylon)	17.090	19.420	254.58	64.463	30.241	0.148	0.037	0.239	0.220	0.174
Gravel (Salahaddin)	22.230	23.620	221.26	73.044	33.763	0.166	0.041	0.266	0.257	0.197
Gravel (Karbala)	25.310	17.630	163.78	63.132	29.171	0.143	0.036	0.228	0.239	0.171
Cement (Najif)	21.520	24.320	148.98	67.769	30.844	0.151	0.038	0.243	0.241	0.183
Cement (Sulaymniya)	26.270	18.010	263.24	72.294	33.992	0.167	0.042	0.265	0.266	0.195
Sand (Karbala)	17.460	24.860	264.07	73.343	34.094	0.167	0.041	0.271	0.245	0.198
Sand (Najif)	21.060	22.690	143.82	64.581	29.432	0.144	0.036	0.232	0.231	0.174
Sand (Kadesea)	16.720	27.380	179.74	69.713	31.757	0.156	0.039	0.253	0.233	0.188
Ave.	20.568	22.829	192.691	68.051	31.326	0.154	0.038	0.247	0.239	0.184
Min.	16.650	17.630	123.87	63.132	28.882	0.142	0.035	0.227	0.220	0.171
Max.	26.270	27.440	264.07	73.343	34.094	0.167	0.042	0.271	0.266	0.198
worldwide averag [9]	35	30	400	370	55	1	1	1	1	1

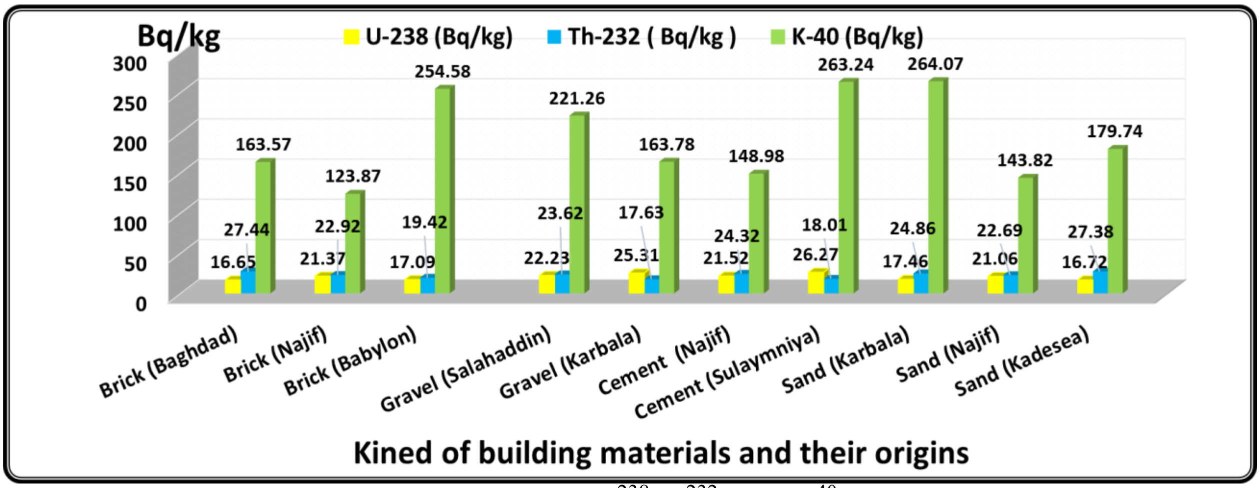

Figure (1) Specific activity concentrations of (^{238}U, ^{232}Th and ^{40}K) for all building materials samples contemplated in the present work.

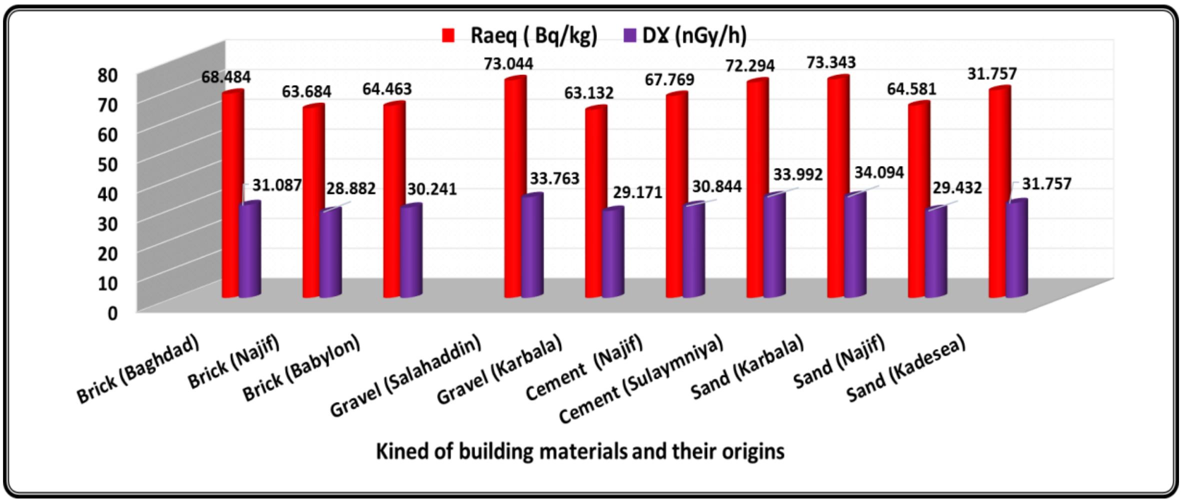

Figure (2) Radium equivalent activity and absorbed dose rate for all building materials samples contemplated in the present work.

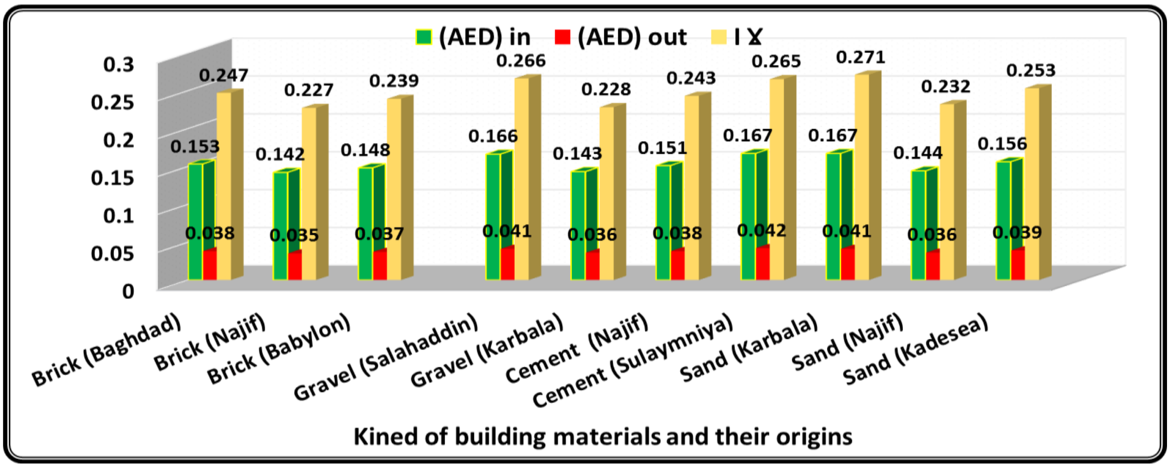

Figure (3) Indoor and outdoor annual effective dose equivalents and activity gamma index for all building materials samples contemplated in the present work.

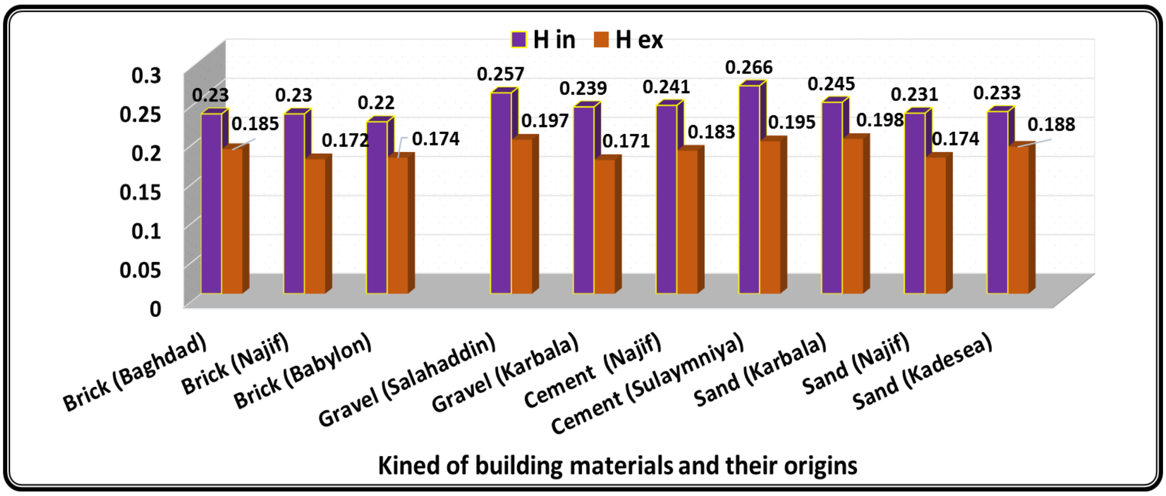

Figure (4) Internal and external hazard indices for all building materials samples contemplated in the present work.

Conclusions

All consequences of the present work concerning estimations of the specific activity for (^{238}U, ^{232}Th and ^{40}K), radiation hazard indices [Ra_{eq} ,D_Y , $(AEDE)_{in}$,$(AEDE)_{out}$, I_Y , H_{in} and H_{ex}] were observed to be lower than their comparing permitted limits. It could accordingly be inferred that the potential cancer-causing hazard from gamma radiation measurements acquired in this work is low or irrelevant and consequently will posture generally none genuine wellbeing hazard.

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