Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-2 Issue-1 || February 2023 || PP. 215-219

https://doi.org/10.55544/jrasb.2.1.31

Calculation of Radon Gas Concentration in the Buildings of College of Women Education - Tikrit University using the Nuclear Track Detector CR-39

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www.jrasb.com || Vol. 2 No. 1 (2023): February Issue

Received: 30-01-2023	**Revised:** 20-02-2023	**Accepted:** 02-03-2023

ABSTRACT

This study analyses the radon gas content in (17) samples taken from buildings of the College of Women's Education - Tikrit University. Using a long-term measuring approach and a nuclear effect detector, the effects of radon's alpha particles were measured (CR-39). Radon concentrations were discovered to fluctuate, with the greatest levels being found in computer lab buildings (1).it reaching (72.7 Bq.m-3), while the lowest value was in a Department of Psychological Sciences if it reaches (15.8 Bq.m-3) compared to the radioactive background of (39.0 Bq.m-3) There is no risk to the College's workforce, including workers and students, and there was no exposure to excessive levels of radiation or environmental pollution. This provided the College with an advantage in that it was not subjected to harmful amounts of radiation or contamination.

Keywords- Radiation Hazard, Radon, Track Detector CR -39.

I. INTRODUCTION

Naturally occurring in soil and rocks, radon is a radioactive, chemically inert, invisible, odorless gas. Three isotopes of radon, 222Rn, 220Rn, and 219Rn, are known and are called radon, thorium, and actinium, respectively. The decay chains from which radium and thorium and actinium originate are 238U and 232Th, respectively, and 235U. Due to their rarity, however, thoron and action have far shorter half-lives than radon (55.6 and 3.96 seconds, respectively). Four of Radon's pups have died prematurely. This set includes 214Pb, 218Po, 214Bi, and 214Po. Radiation such as alpha particles or gamma rays detected during 222 Rn and its daughter nuclides' decay is the basis for all radon monitoring and its progeny [1]. Ionizing radiation like radon is a leading cause of lung cancer, second only to smoking. The only documented adverse effect of radon exposure on human health is lung cancer. [2]. Radon levels can vary greatly from one place to the next due to differences in geology [3].

There are many numerous articles have examined the levels of radon n several such countries.

In 2015, Asia and others estimated the excess of radon gas lung danger factor for several residences in Al-Fallujah city. Also estimated were Annual Effective Dose and Excess Lung Cancer Rates per Million People per Year (ELC), which ranged from 0.941 to 2.350 mSv.y-1 with an overall average of 1.581 mSv.y-1 and 565 to 1410 with an overall average of 948, respectively[4].

In 2019, Gehad M. Saleh et al. conducted a study on Radon Gas and Its Dangers to the Environment at The Hamash Gold Mine in Egypt. Their ICRP and IAEA's global recommendation for radon concentrations are lower than what was found in all tests. [5].

In 2020, Rasha, Sarwa, and Esam will use the Nuclear Track Detector CR-39 to calculate the concentration of radon gas in the buildings of Samara

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University (Iraq). The radon concentrations varied from 3.8 to 175.9 Bq.m-3, with a mean concentration of 41.4 Bq.m-3[6].

In 2020, Esam et al. measured radon concentrations in powdered milk, Using the Nuclear Track Detector CR-39. Where the radon level ranged between 1371 and 151 Bq.m-3 with an average value of 577 Bq.m-3[7].

In 2021, Mohammed, Esam and Sarwa "Determination Radon Concentration in Urine of Patients with Cancer in Kirkuk" He was found that the concentrations of radon were ranged between 8.9 and 1.5 Bq.m-3 having a mean value of 3.7 Bq.m-3 [8].

II. METHODOLOGY

Sampling

In this research, the solid-state nuclear track detector (SSNTD) method was utilized to take extensive readings of radon levels in indoor air. This work used the cupping technique; Fig. 1 is a diagram of how it was done (1). Each cup had a height of 7cm, a diameter of 5 cm, and a ($1*1cm^2$) of CR-39 nuclear track detector attached to the bottom of the cup.

The study area

Tikrit is an Iraqi city on the Tigris River, around 140 kilometers (87 miles) northwest of Baghdad and 220 kilometers (140 miles) southeast of Mosul. It is the administrative center of the Saladin Governorate. In 1987, when the University of Tikrit was established, so too was the College of Education for Women. It's where the University of Tikrit all started. In the scientific community, it is often recognized as the "Mother College" due to its long history. The Women's College of Education is widely recognized for its research and scholarship. It represents a major achievement in the fields of humanities and sciences at the University of Tikrit. Located in the heart of Tikrit, off-campus, it consists of two locations, one of which houses the scientific and other humanitarian departments. We put 17 cups throughout College buildings for 52 days. Table 1 shows the locations of the radon dosimeters.

Table 1: The locations of the radon dosimeters

Dosimeter Location	Details
L1	History department classroom
L2	Mathematics department
L3	Department of Psychological Sciences
L4	Department of Biological Sciences
L5	College portal (1)
L6	College portal (2)
L7	college mosque
L8	chemistry department
L9	Deanship of the College
L10	Department of Quran Sciences
L11	Student Center
L12	home economics department
L13	Department of English
L14	college library
L15	Geographical Department
L16	computer laboratory (1)
L17	computer laboratory (2)

III. MATERIALS AND METHODS

The soil, which is part of the composition of the Earth's crust outer and the end outcome of rock fracture usingintricatethe interplay between chemistry and physics, is one from the source of naturally to naturally-occurring ionizing radiationpeople are exposed. As a result, the soil contains long-lived radionuclides like U238, thorium Th232, and K40, which are already present in many building materials and whose radiation contributes to the Earth's background radiation [9].

Natural radioactivity, which is dependent on geological and geographic factors, is what this is. Sources of industrial radioactivity include, among others, atomic energy (reactors and nukes), mineral and fossil fuel extraction, select forms of electrical technology (TVs, computers), and medical, agricultural, industrial, academic, and phosphate-based applications of radioisotopes [10]. A Form of Naturally Occurring Radioactivity That Has Been Improved Through Technology, or "TENORM".

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The techniques for detecting radiation and its byproducts, as well as measuring their concentrations in materials, have evolved in response to the diversity of its sources. The long-term measurement method, which is based primarily on the use of nuclear reagents, is one of these techniques. [11].

Both of these types are extremely sensitive to the radon-emitting alpha particles, but the first is the better choice for long-term measurements in extreme environments or in areas without access to electricity because of its inexpensive price, ease of use, and lack of complexity compared to the second [12,13]. CR-39, an acronym for (Columbia Resin), was discovered at the University of California in 1978. It has an ionization potential of (70.2 ev), is insoluble in chemical solvents, and has a density of (1.32 gm.cm-3). The liquid monomer with a hydrogen composition (C12H18O7) is polymerized to create it [14,15,16]. As a result of the foregoing and its specifications, the CR-39 detector is among the best known detectors of nuclear impacts. The CR-39 detector is one of the most well-known nuclear impact detectors as a consequence of the aforementioned and its specs. Due to the lack of a prior investigation to assess the levels of radioactive radon, the study was conducted in the College of Education buildings for girls. The study involved roughly (17) college buildings and different room areas from each school were chosen because they have good air circulation and are frequented by professors, staff, and students. Radon levels may be affected by several things, but one of them is the materials used to construct a structure. levels, samples were gathered from all structures, old and new, with little to no ventilation.

The detectors were carefully removed from the cans, etched in a NaOH solution with 6.25 N at 70 C for 8 hours, and eroded in distilled water, The detectors were then dried and rinsed once more with distilled water. Then, accounting for the backdrop, the alpha tracks were counted using an optical microscope at a magnification of 400x [17]. The following calculation was used to compute the radon concentrations in (kB.qm-3):

Radon Concentration Measurement:

For dosimetric purposes, it is essential to determine the average radon concentration for a period that is sufficiently longer than the normal time scale for radon variations produced by environmental circumstances. Using the following equation (1), 222Rn concentration (CRn) in (Bq.m-3) can be calculated derived using the detector's integrated track density (track.m-3), the average calibration factor of 222Rn in [(Bq.day)] per number of tracks, and the exposure duration, T. (days). [18]:

$$CRn = \rho / KT \quad ---------- (1)$$

The concentration Equivalent Equilibrium (EEC) value, which is the balanced radon concentration value, may be calculated using the following relation [18].

$$EEC = CRn * K \quad ---------- (2)$$

Furthermore, EEC is evaluated by (Bq.m-3). To calculate the Effective Annual Dose (D), which is represented by the symbols, we may use the following equation: (mSv.-1y) [18].

$$D = EEC * H * t * Df \quad ---------- (3)$$

(H) With an occupancy rate equal to 0.8.
(T) represents the number of hours in the year = 8760y.-1h.
Df is (actor conversion d) = 9*10-6 (MSV/Bq.m-3.h).
Radiation risk

Radiation has two kinds of effects: The first: is deterministic effects, which happen for sure when doses are high enough to kill a lot of cells, and the Second: is stochastic effects, which are thought to happen more or less in proportion to dose at all dose levels. Table (2) shows the average amount of radiation a person gets from different sources [19].

Out of the 98% of the average radiation dosage that humans receive from natural sources, 52% is attributable to radon, thoron, and their offspring that are present in the homes listed by UNSCEAR. Radon is regarded as having no minimum recommended dosage threshold since it is a class A carcinogen, that's what the International Agency for Research on Cancer says (IARC) [20].

Table 2: Shows the average effective dose per caput per year.

Source Dose	$mSv.y^{-1}$
Natural background.	2.4
Diagnostic Medicine.	0.4
Atmospheric weapon testing.	0.005
Chernobyl accident.	0.001
Nuclear fuel cycle.	0.0001
Occupational Exposure.	0.001

IV. RESULTS AND DISCUSSION

The findings from (17) samples demonstrate that there is a range in radon concentrations, as indicated in table (2), and the cause is the variety of buildings and the volume of ventilation they get. In contrast to buildings with broad areas and excellent ventilation, small offices with poor ventilation had significant levels of radon gas concentration. The earth's uranium ore is the primary source of radon in buildings, although construction materials also play a significant role because of the naturally occurring uranium they contain. Doors and windows help to collect radon gas that has been discharged from the walls, floors, and ceilings. In order to lower the radon concentration, the problem can be solved by venting the rooms at least twice a day. The decay products of radon-222 gas are rarely in equilibrium with the parent [21]. The radon

ISSN: 2583-4053

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concentrations obtained at different regions in in the Faculty of Education for Girls, 17 locations, the mean radon concentrations ranged from (15) Bq.m-3 to (72) Bq.m-3 as shown in Table (3).

Table 3. Shows The concentrations of radon

N	sample code	C_{Rn} (Bq/m3)	AED (mSv/y)	LCR Cases per year per 10^6persons	PAEC (mWL)	ECC
1	L1	25.29	0.64	11.48	2.73	4.27
2	L2	25.29	0.64	11.48	2.73	4.27
3	L3	15.80	0.4	7.18	1.71	2.67
4	L4	22.13	0.56	10.05	2.39	3.74
5	L5	25.29	0.64	11.48	2.73	4.27
6	L6	28.45	0.72	12.92	3.08	4.81
7	L7	56.90	1.44	25.84	6.15	9.62
8	L8	47.41	1.20	21.53	5.13	8.01
9	L9	34.77	0.88	15.79	3.76	5.88
10	L10	31.61	0.8	14.35	3.42	5.34
11	L11	41.09	1.04	18.66	4.44	6.94
12	L12	37.93	0.96	17.22	4.10	6.41
13	L13	28.43	0.72	12.92	3.08	4.81
14	L14	41.09	1.04	18.66	7.86	6.94
15	L15	28.45	0.72	12.92	6.83	4.81
16	L16	72.70	1.83	33.01	7.86	12.29
17	L17	63.22	1.59	28.71	6.83	10.68
	MIN	15.80	0.40	7.18	1.71	2.67
	MAX	72.70	1.83	33.01	7.86	12.29
	AVE	36.81	0.93	16.72	3.98	6.22

The radon concentration at the College of Education for Girls' facilities is determined to be significantly within the permitted natural limits defined by competent bodies after comparing results to international equipment from the International Radiation Protection Organization. All the structures in the neighborhood are far within the safe radon levels, thus there is no dangerous or radioactive radon pollution in the air.

V. CONCLUSION

The findings from (17) demonstrate that there is a range in radon concentrations, as given in table (3), and the cause is the variety of buildings and the volume of ventilation they get. In contrast to buildings with broad areas and excellent ventilation, small offices with poor ventilation had significant levels of radon gas concentration. The earth's uranium ore is the primary source of radon in buildings, although construction materials also play a significant role because of the naturally occurring uranium they contain. Doors and windows help to collect radon gas that has been discharged from the walls, floors, and ceilings. Ventilating the rooms at least twice a day will help to solve this issue and lower the radon levels.

REFERENCES

[1] D. Saguatti, V. Tyzhnevyi, G. Giacomini, “Alpha-particle monitoring systems based on a BJT detector on high-resistivity silicon” 7th Conference on Ph.D. Research in Microelectronics and Electronics, PRIME 2011 (Trento), (2011).

[2] Doug Macdougall, "Nature’s Clocks; How Scientists Measure the Age of Almost Everything", the University of California Press, 2008.

[3] A. B. Brill, The Journal of Nuclear Medicine, 35, 2 (Feb 1994) 342-348.

[4] A. Al-Mashhadani, S. Shafik, M. Saeed “Estimating excess of the lung risk factor of radon gas for some houses in Al-Fallujah city” *Iraqi* Journal of Physics, Vol.13, No.26, PP. 160-170 2015.

[5] G. Saleh1, H. Yousef, M. Mitwalli and A. El-Farrash “Environmental Radioactivity of Radon and its Hazards in Hamash Gold Mine, Egypt” Arab J. Nucl. Sci. & Applic. Vol. 52, No. 4 (2019).

ISSN: 2583-4053

Volume-2 Issue-1 || February 2023 || PP. 215-219

https://doi.org/10.55544/jrasb.2.1.31

[6] Rasha W. Kleeb, Sarwa A.M. Salah, Esam S. Ali "Calculation of Radon Gas Concentration in the Buildings of Samara University Using the Nuclear Track Detector CR-39" Neuro Quantology 2020;18(2):82-87

[7] Esam S. Ali, Sameen F. Mohammed, Chinar N. Mohammed, Zainab S. Mahmoud "Measurement of Radon Radiation Concentration in Imported and Local Powdered Milk using Nuclear Track Detector CR - 39" Journal of Physics: Conference Series 1530 (2020) 012133.

[8] Mohammed M. Asker, Esam S. Ali, Sarwa A. Mohammed "Determination Radon Concentration (Radon Gas) in Urine of Patients with Cancer" Neuro Quantology 2021, Volume 19, Issue 4, Page 87-91.

[9] Peter, Adam. Naturally occurring Radioactive Material 1996.

[10] Al. Vbidi, Khalid HM. I dentification and Measurement of Natural and Industrial Radioactive Pollutants in Environment of Baghdad city using Gamma Spectrometry and solid state Nuclear Track Detector CR-39. Ph. D. Thesis, Baghdad University, College of Education Ibn AlHaitham 2006.

[11] Al-Ataby NAR. Study of Environmental Radioactivity in the Soil of Al-Tuwaitha Zone and its Surrounding Sides (Doctoral dissertation, Ph. D. Thesis, Baghdad University, College of Science)2005.

[12] Al-Baidhani MA. Determination of the radioactivity in soil and water in Baghdad, Karbala and Basrah samples. Sc Thesis 2006.

[13] Biswas S, Durgaprasad N, Kajarekar PJ, Sarkar S, Venkatavaradan VS. Detection of relativistic cosmic ray iron nuclei in the plastic track detector CR-39. Nuclear Instruments and Methods 1979; 163(1): 183-187.

[14] Cartwright BG, Shirk EK, Price PB. A nuclear-track-recording polymer of unique sensitivity and resolution. Nuclear Instruments and Methods 1978; 153(2-3): 457-460.

[15] Fujii M, Yokota R. Thermosetting resins for nuclear track detection. International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements 1986; 12(1-6): 55-58.

[16] Azam A, Naqvi AH, Srivastava DS. Radium concentration and radon exhalation measurements using LR-115 type II plastic track detectors. Nuclear geophysics 1995; 6(9): 653-657.

[17] El-Farrash A.H., Yousef H.A., Hafez A.F., (2012). Activity concentrations of ^{238}U and ^{232}Th in some soil and fertilizer samples using passive and active techniques. J. Radiat. Meas., 47(8), 644-648.

[18] Corporation T., Lane W., Creek W. and Fleischer R., "Passive Integrating Radon Monitor for Environmental Monitoring", Health Phys., No.40, p: 693-702(1981).

[19] E. Blviken, G. Storvik, 'Deterministic and stochastic particle filters for state space estimation. In 'Sequential Monte Carlo methods in practice'". Freytas, N, Gordon, N. and Doucet, A. eds. Cambridge University Press, 2001.

[20] UNSCEAR Annex E. Sources-to Effects Assessment for Radon in Homes and Work- places. United Nations, New York, NY, 2009.

[21] Abel-Ghany H.A., "Exposure of school children to alpha particles", Iran. J. Radiat. Res., V 6 N (3): p (113-120) 2008.