Measurement of Radon Concentration in College of Education for Pure Science / Ibn Al- Haitham Buildings Using CR-39 Detector

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Abstract

In the present work , radon concentration was measured indoor buildings in the College of Education for Pure Science/ Ibn Al- Haitham University of Baghdad using detector (CR-39) by counting track of alpha resulting from decay series of uranium on the detectors which have exposure to air inside the rooms for (30) days , have been applied the equation (1) and (2) to calculate concentrations of Radon and the results showed that all samples were within the allowable range globally except two samples F1 and F2 where concentrations were (445.868Bq/m^3) and (436.791Bq/m^3) respectively , they were higher than allowable range globally which was (200-300) Bq/m^3 recorded by (ICRP) [1] .

Kay word: Radon, reaction, Calibration**,** detector**,** Radiation.

Introduction

Radon is a gas that results from the disintegration of ^{235}Uand ^{238}U or ^{232}Th, as both sources of Radon are ^{232}Th and ^{235}Uand^{238}U which are found in low concentration in rock and soil [2]. Its atomic number is (86) and mass number is (222) in the periodic table [3]. Radon is a rare natural element as it is found in gas form, noble and radioactive in its isotopes. Radon gas can gather in buildings, especially in closed regions, such as under roofs and basement. It is found in some spring waters and hot springs too [4]. But from other opinion, inhalation may be a problem to human's health. Since Radon is noble gas, this guarantees that it cannot be frozen through chemical reactions [5]. ^{226} Ra whose half-life is (1600) years can be formed through Radon decay with ^{238} U during four intermediate cases in order to form ^{226}Ra, after that it decays to form ^{222}Rngas which has half -life (3.82) days, which in turn gives sufficient time to be diffused through soil and into houses, where it then disintegrates in order that it can produce more radiologically active Radon breeds (Radon daughters) [4]. The presence of ^{226} Ra in the ground of the facilities and in the building materials is considered the main radon source [6]. The outside air also has a role to Radon concentration indoors, through the air ventilation. Other Radon sources can be existed in tap-water; the domestic gas supplies are generally ^{229}Rn source. It was noticed that high indoor Radon levels are created from Radon that is in the underlying rocks and soils [7].

Experimental Details

Radon concentration was measured using solid state nuclear track detectors type CR-39 detector with a thickness of (250 µm) and the approximate area (1cm²) were used in this work. The detectors are covered from both sides with plastic and this plastic is removed when the detector is used to prevent detector from radiation background and there are distortions that occur as a result of exposure to external stresses,where detectors were distributed in random buildings inside College of Education , in every room placed two detector . The detectors were placed at hight (160cm) for (30) days.

After it has been collected for the configured to chemical etching process using sodium hydroxide solution (NaOH) , water bath from type (Memmert) German-made used for heating sodium hydroxide solution (NaOH) and the temperature was suitable for etching process of CR - 39 detectors (60 C°) for four hours , afterward previewed microscopically to count number of track for alpha per unit area and calculate radon concentrations after the comparison process with standard source as shown in figure (1).

Calibration of the CR -39 detector in the present work , four (CR – 39) detectors were used standard source (^{226}Ra) .Figure (2) shows the relation between the exposure of Radon (E_s) and the density of track (ρ_s).

$$\textbf{Slope} = \rho_s / E_s \dots \textbf{(1)}$$

where:

ρ_s is the density of track of standard source (tracks/mm^2).

$E_s$is the exposure of Radon of standard source (Bq/m^3).days = (Bq/m^3)

The radon concentration was determined by using the following equation [8,9] :

$$C_{Rn}(Bq/m3) = 1/slop * (\rho/t) \dots (2)$$

Since : 1/slop= E_s (Bq.d/m^3) /ρ_s(track/mm^2)

$C_{Rn}$is radon concentration

It has been calculation of the effects of radiation ;

1-The annual effective dose (AED) in units (mSv/y) was calculated by using following equation[10] .

AED (m Sv/y) =C_{Rn}* F * H * T * D …(3)

Where , F: is the equilibrium factor , F= (0.4)
H : is the occupancy factor , H =(0.8) [11] .
T :is the time in one year in hours , T= (8760 h/y).
D:is the dose conversion factor D = (9*10^{-6} (m Sv) / (Bq.h.m^{-3})) [11].
2-The lung cancer cases per year per million person (CPPP) was calculated using the following equation [12,13] :

(CPPP) = AED *(18*10^{-6} mSv.y^{-1})… (4)

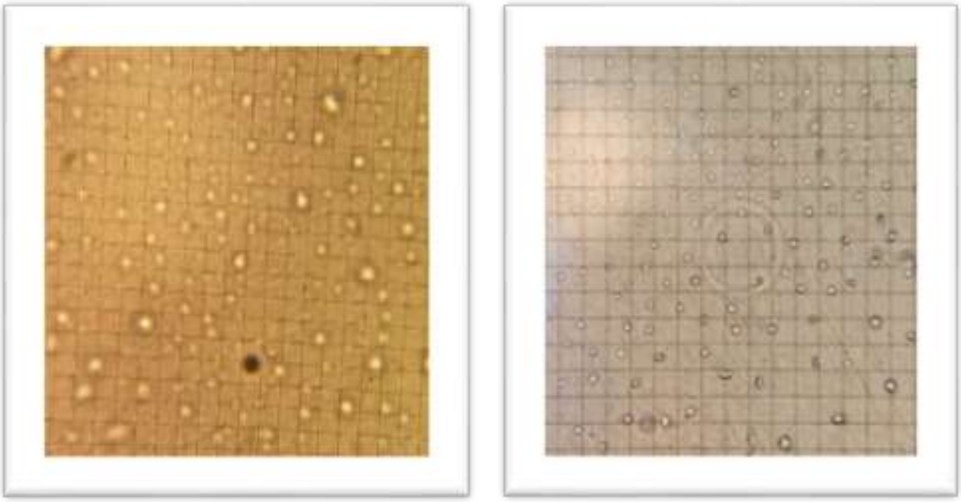
3-Exposure to radon progeny (E_P) in term of (WLM Y^{-1}) units was calculated using the following equation [14]:

E_P(WLM Y^{-1}) = 8760 * n * F *C_{Rn} / 170* 3700 … (5)

n : is the fraction of time spent indoors n= (0.8) .
where the number of hours per yearis (8760) and is the number of hours per working month(170) [11] .
4-The potential Alpha energy concentration (PAEC) in units (WL) were calculated using the following equation [12,15] :

PAEC (WL) = F * C_{Rn} / 3700 … (6)

Where C_{Rn} : is the radon concentration in (Bq.m^{-3}) units .
F : is the equilibrium factor F = (0.4) .



(a) (b)

Figure (1): CR-39 detector

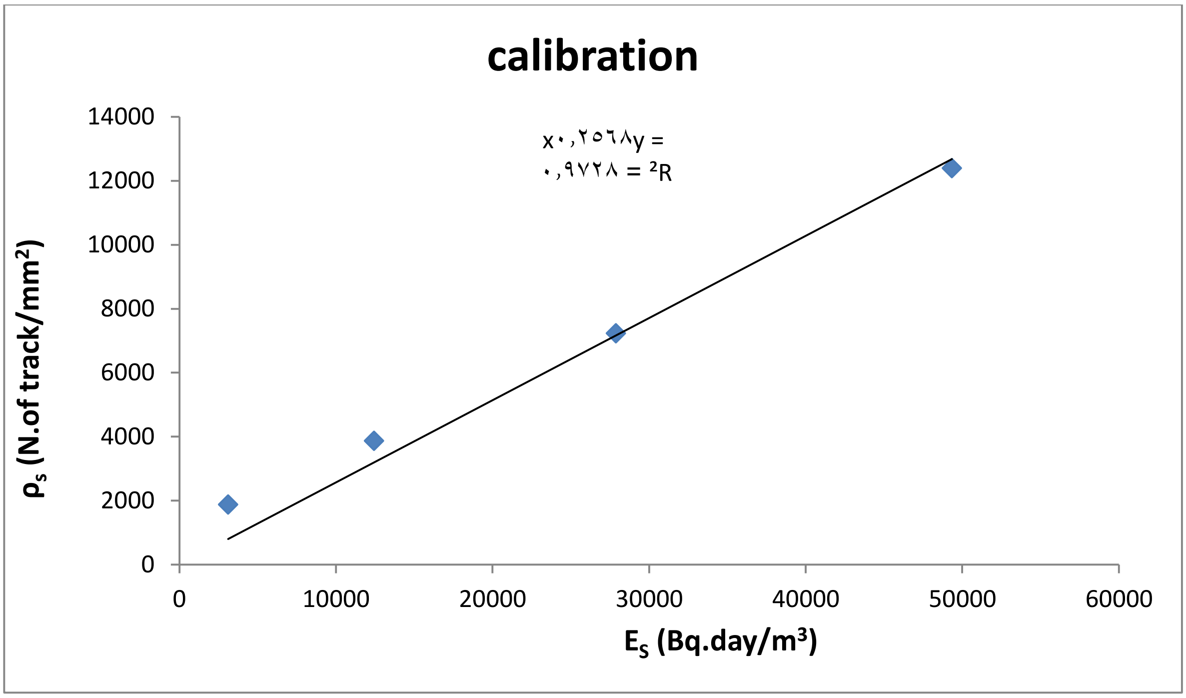


Figure (2): The relation between the exposure of Radon (E_s) and the density of track (ρ_s).

Result and Discussion

In this work, radon concentration was measured indoor buildings in the College of Education. Table (1) the result obtained in this work for radon concentration indoor college buildings.

Table (1): The radon concentration, the effects of radiation ((AED) , (CPPP) ,(E_P) and (PAEC)) for concentration of radon in the buildings indoor college .

Sample code	Sample location	C_{Rn} (Bq/m^3)	AED (mSv/Y)	CPPP $*10^{-6}$	Ep (WLM/Y)	PAEC (WL)
D1	Gr.floor	101.695	2.565	46.18	0.453	0.0109
D2	Gr.floor	152.08	3.836	69.06	0.677	0.0164
D3	Gr.floor	85.58	2.159	38.86	0.381	0.0092
D4	Basement	138.372	3.490	62.83	0.616	0.0149
D5	Basement	177.458	4.477	80.58	0.790	0.0191
PH1	1Fst floor	40.011	1.009	18.16	0.178	0.0043
PH2	1Fst floor	35.01	0.883	15.89	0.156	0.0037
PH3	1Fst floor	92.804	2.341	42.14	0.413	0.0100
PH4	1Fst floor	61.128	1.542	27.75	0.272	0.0066
CH1	Gr.floor	95.397	2.406	43.32	0.425	0.0103
CH2	Gr.floor	108.734	2.743	49.37	0.484	0.0117
CH3	Gr.floor	197.093	4.972	89.50	0.878	0.0213
CH4	Gr.floor	122.257	3.084	55.51	0.544	0.0132
CH5	Gr.floor	125.406	3.163	56.94	0.558	0.0135
CH6	Gr.floor	170.974	4.313	77.64	0.761	0.0184
CH7	1fst floor	164.491	4.149	74.69	0.733	0.0177
BIO1	Gr.floor	101.881	2.570	46.26	0.454	0.0110
BIO2	Gr.floor	202.465	5.107	91.94	0.902	0.0218
BIO3	Gr.floor	102.066	2.575	46.35	0.454	0.0110
BIO4	Gr.floor	131.704	3.322	59.80	0.586	0.0142
PS1	Gr.floor	120.219	3.032	54.59	0.535	0.0129
PS2	Gr.floor	132.074	3.332	59.97	0.588	0.0142
B1	1Fst floor	65.944	1.663	29.94	0.293	0.0071
B2	1Fst floor	97.435	2.458	44.24	0.434	0.0105
B3	1Fst floor	142.262	3.589	64.60	0.634	0.0153
B4	1Fst floor	135.779	3.425	61.65	0.605	0.0146
B5	1Fst floor	87.061	2.196	39.53	0.387	0.0094

Sample code	Sample location	C_{Rn} (Bq/m^3)	AED (mSv/Y)	CPPP *10^{-6}	Ep (WLM/Y)	PAEC (WL)
M1	Gr.floor	147.079	3.710	66.79	0.655	0.0159
M2	Gr.floor	140.225	3.537	63.67	0.624	0.0151
M3	Gr.floor	149.394	3.769	67.84	0.665	0.0161
M4	1Fst floor	78.355	1.976	35.58	0.349	0.0084
M5	Gr.floor	75.577	1.906	34.32	0.336	0.0081
L1	Gr.floor	159.675	4.028	72.51	0.711	0.0172
L2	Gr.floor	74.65	1.883	33.89	0.332	0.008
L3	Gr.floor	58.905	1.486	26.74	0.262	0.0063
L4	First floor	47.976	1.210	21.78	0.213	0.0051
L5	First floor	45.753	1.154	20.77	0.203	0.0049
L6	First floor	34.639	0.873	15.73	0.154	0.0037
C1	Gr.floor	17.412	0.439	7.90	0.077	0.0018
C2	Gr.floor	213.95	5.397	97.15	0.953	0.0231
E1	Gr.floor	21.302	0.537	96.73	0.094	0.0023
E2	Gr.floor	60.387	1.5234	27.42	0.269	0.0065
F1	Basement	445.868	11.248	202.47	1.987	0.0482
F2	Basement	436.791	11.019	198.35	1.946	0.0472
R1	Gr.floor	176.717	4.458	80.25	0.787	0.0191
R2	First floor	186.534	4.706	84.70	0.831	0.0201
H	Gr.floor	60.572	1.528	27.50	0.269	0.0065
A	Gr.floor	133	3.355	60.39	0.592	0.0143
CH8	Gr.floor	117.255	2.958	53.24	0.522	0.0126
	Average	123.8652			(1-2) WLM/Y [17]	
	Global limit	(200-300) Bq/m^3 [1]	(3-10) mSv/ [16]	(170-230) [16]		(53.33) mWL [18]

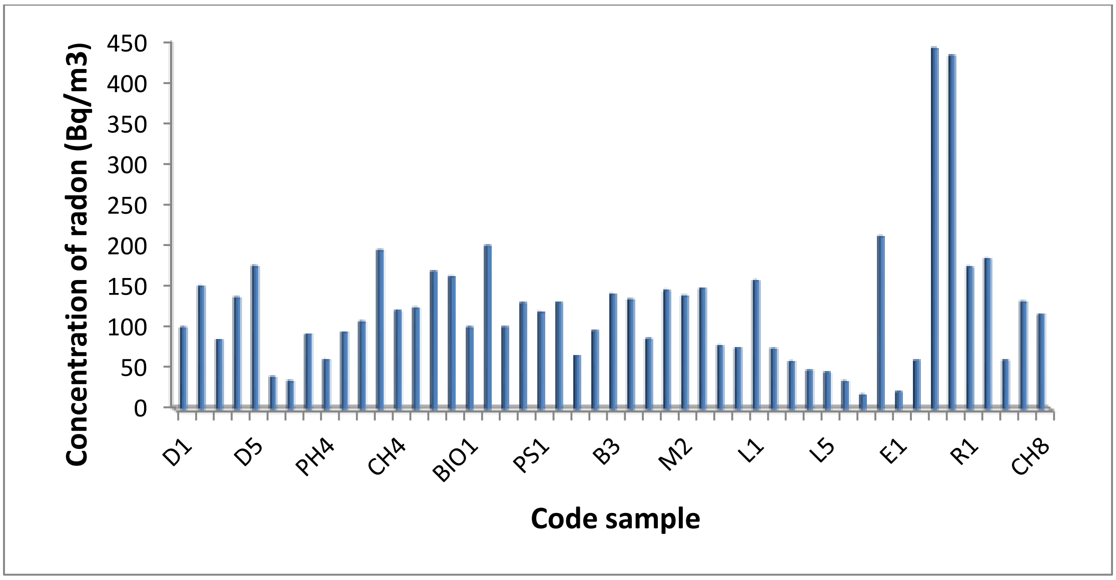


Figure (3): levels concentration of radon indoor college buildings.

The radon concentration (C_{Rn}) as observed from table (1) , for buildings inside college of education varies from (17.412 Bq/m^3) to (445.868 Bq/m^3) with average (123.8652 Bq/m^3) . The highest value was found in sample F1 which value of radon concentration was (445.868 Bq/m^3) and the lowest value was found in sample C1 which value of radon concentration (17.412 Bq/m^3) . All results of radon concentration were lower than the recorded value by [ICRP] except two samples F1and F2 were higher than the recorded value by [ICRP] (200-300)Bq/m^3[1] .

As observed from the table (1) the annual effective dose (AED) was calculated using equation (3) for buildings and was found in samples F1, F2 (11.248 mSv/y) (11.019mSv/y) respectively, they were higher than the allowable limits and all samples were within the allowable limit (3-10 mSv/y) recorded by (ICRP) [16] . The lung cancer cases per year per million person (CPPP) vary between value (7.90) and (202.47) , all the results in the table (1) for samples were within allowable limit (170-230) per million person recorded by (ICRP) [16]. The highest value of exposure to radon progeny (E_P) as observed in table (1) was found in samples F1and F2 which was (1.987 WLM/Y) and (1.946 WLM/Y) ,the lowest value was found in sample C1 which was (0.077 WLM/Y) , all the results of samples were within allowable limit recorded by (NCRP) which was range of (1-2) WLM/Y [17].The potential Alpha energy concentration (PAEC) as observed from the table (1) ,for samples the values were varied between (0.0018 WL) and (0.0482 WL) , all the result of samples were within allowable limit (53.33mWL) which was recorded by (UNSCEAR) [18] .

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