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Radon Concentration Measurement in Ainkawa Region Using Solid State Nuclear Track Detector

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Abstract

Radon is the air contaminant radioactive gas which people exposed to, is a reason for lung damages and lung cancer. The areas that are subject to high radon levels are found by radon concentration measurement. The radon activity concentration, annual effective dose, and potential alpha energy concentration (PAEC), were measured in houses of Ainkawa region using CR-39 solid state nuclear track detectors SSNTDs with the sealed-can technique. In the present paper the estimated values for radon activity concentration are in the range 55.99-112.8 Bq/m^3 with 84.30 Bq/m^3 as a mean value, the range of annual effective dose are 1.411-2.872 *mSv/y*, with mean value 2.124 *mSv/y*, and the potential alpha energy concentration range are 6.0533-12.323 *mWL* with mean of 9.1133 *mWL*. The mean value of the radon concentration is below of 100 Bq/m^3 the reference level of (WHO) World Health Organization, and well below of UK National Radiation Protection Board (NRPB) and European Commission Recommendation Level of 200 Bq/m^3.

Keywords: Radon concentration, annual effective dose, Ainkawa region, CR-39, potential alpha energy.

قياس تركيز الرادون في منطقة عينكاوة باستخدام كاشف الاثر النووي الصلب

هناء نافع عزيز ، مالك حسين خضر*، منى يوحنا صليوة ، سليمان يعقوب سليمان
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الخلاصة

الرادون هو غاز مشع وملوث للهواء ، هو المسبب الثاني لامراض الرئة وسرطان الرئة . المناطق المعرضة لمستويات عالية من الرادون وجدت من خلال قياس تركيز الرادون . تم قياس تركيز فعالية الرادون و الجرعة السنوية الفعالة وكذلك تركيز طاقة الفا الكامنة (PAEC) لبيوت في منطقة عينكاوا باستخدام كاشف الاثر النووي الصلب CR−39 بتقنية الاناء المغلق . في البحث الحالي القيم المحصلة لتراكيز فعالية الرادون تقع في المدى (55.99−112.8 Bq/m^3) وبمعدل (متوسط قيمة) مقداره 84.30 Bq/m^3 و مدى الجرعة السنوية الفعالة كانت ضمن (1.411−2.872 *mSv/y*) وبمعدل 2.124 *mSv/y* فيما كانت طاقة الفا الكامنة في المدى (6.0533−12.323 *mWL*) ومعدلها 9.1133 *mWL* ، ومعدل تركيز الرادون هو اقل من 100 Bq/m^3 الذي هو المستوى المحدد من قبل (WHO) منظمة الصحة العالمية وكذلك اقل بكثير من اللوائح الوطنية البريطانية للوقاية من الاشعاع (NRPB) والمستويات الاوربية التي حددت بالقيمة 200 Bq/m^3 .

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Introduction

Radon is an indoor air contaminant radioactive gas, it is health risk for a person exposed to because it is formed from uranium by normal radioactive decay, it is colorless, odorless, tasteless and radioactive naturally occurring gas. According to the kinds of soil and building blocks radon concentration has different variations, it exists around us in all places [1]. Indoor radon gas sources are soil, sand, and rock. Uranium higher quantities contained in soil certain types and bedrock. The permeability of the materials of ground specifies the inflow of radon gas, the radon exhalation rate of the soil and the difference in pressure between indoor air and soil air. The tissues or cells of respiratory tract deliver significant background radiation doses of inhaled radon progeny is accountable and dominant for about 55% of the total dose among all other sources [2,3].

The primarily way of people exposing to radon is breathing it in. Greater than 90% of entered radon in the stream of blood goes to lung and most of them breathed out. This shortly occurs after taken it in, some remained radon in lung decay radioactively, in this process the released radiation passes in sensitive tissues of lung, which leads to lung damage and cause of lung cancer. If some of radon remain and do not goes to lungs will go to different organs or fat where it decay [4, 5]. In outdoor air the radon background levels are quite low generally, 0.003 pCi/l of radon in outdoor air. In homes, office buildings, or schools as indoor locations, radon levels are higher generally than levels of outdoor, generally is about 1.5 picocurie per liter of air [6].

The International Cancer Research Agency (IARC) classifies radon as of human carcinogen.The concentrations of radon elevated by exposure to Long-term, the cancer risk of lung increased by residential radon. Radon is second cause for cancer of lung after smoking of tobacco [7-10]. As shown by studies 5–20% of all deaths by lung cancer attributed to radon inhalation and its progeny, in Europe 2% approximately of all cancer deaths is caused by radon [11].

Correspond to indoor annual average radon gas concentration, the Commission of Europe on the protection against exposure to indoor radon recommended reference levels sets of 400 Bq/m^3 for buildings that exist and 200 Bq/m^3 for constructions in future, concluded that exposure to radon for lung long term increases cancer risk. Statistically the risk increase is significant for indoor radon annual average concentrations below of 200 Bq/m^3 the recommended level [12,13].

The reference level of 100 Bq/m^3 is proposed by (WHO). In the UK, 200 Bq/m^3 of annual average recommended the homes Action Level for radon by (NRPB) the National Radiation Protection Board. The areas with 1% or more homes above the Action Level of Radon defined as Affected areas [14,15]. The areas that are subject to high radon levels are found by radon concentration measurement. It was measured using the widely used technique of CR-39 plastic Solid State Nuclear Track Detector (SSNTD), they are sensitively than glass and crystal, charged radiations all can be record, the damage positions type (tracks) and the shape on the detector depend on the incident particle charge, and its energy, mass and on the type of detector [16] the tracks can be determined by optical microscope after enlargement by etching process.

Materials and Methods

CR-39 polymer used as passive type alpha-track detectors by “Can technique”. Each piece was (1 X 1) cm square in size, fixed in sealed can and identified by code or number, a hole of diameter 1.5 cm on the cover filled with 1cm thickness of sponge piece to prevent short–life radon and impurities Figure-1. The study is required monitoring for long term, so these are suitable detectors. In the area of study placed the detectors in different houses and exposed for a period of 90 days (from 5 March 2017 to 3 June 2017).

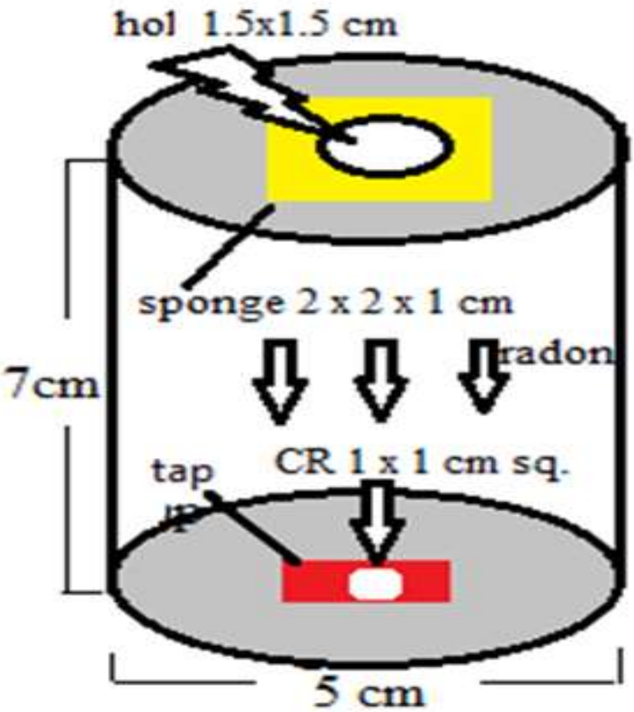

Figure 1- Radon monitors "Can technique".

After 90 days the detectors are removed and etched by NaOH at normality 6.25 N and heat 70 C^o in water bath to reveal the tracks. The detectors were washed and dried, by a microscope tracks counted. The concentration of radon C_{Rn} in Bq/m^3 was calculated from equation:

$$C_{Rn} = \frac{C_o\ T_o\ \rho}{\rho_o\ T} \quad (1)$$

where: T_o the exposure time of calibration (48 hours), C_o the calibration chamber radon concentration (90 kBq/m^3), ρ_o calibration dosimeters tracks density (33400 tracks/cm^2), ρ the measured calibration dosimeters tracks density in (tracks/cm^2), T the time of exposure in hr. [17].

The effective annual dose of radon H (in mSv/y) and its progeny can be calculate from:

$$H = C_{Rn} \times F \times O \times T \times D \quad (2)$$

where C_{Rn} the radon concentration average (Bq/m^3), F is factor of an equilibrium 0.4, O is factor for occupancy (UNSCEAR 2000 give its value 0.8), T (8760 h.y^{-1}) is a time and D is the factor of conversion (9 × 10^{-6} mSv.h^{-1} (Bq.m^{-3})$^{-1}$) [18].

Potential Alpha Energy Concentration (PAEC) measurements are necessary to effective dose estimate from ^{222}Rn progeny and its concentration in the present locations. PAEC be measured in terms of (WL) unit working level. The concentration alpha potential energy was calculated from equation: [19].

$$WL = \frac{F\ C_{Rn}}{3700} \quad (3)$$

Results and Discussion

By the end of the survey period, 30 samples in houses of Ainkawa region were calculated and analyzed Table-1.

Table 1-concentrations of indoor radon, annual effective dose, PAEC

S.n	location	ρ $Track / m^2$	C_{Rn} Bq / m^3	H mSv / y	PAEC mWL
1	Doside 1	1600	96.00	2.419	10.377
2	Doside 2	1360	81.60	2.056	8.8209
3	Shlama sch.	933.3	55.99	1.411	6.0533
4	Ainkawa mall	1346.6	80.79	2.036	8.7340
5	Marina 1	1146.6	68.79	1.733	7.4368
6	Vinos	1900	114.0	2.872	12.323
7	Mart Shmony 1	1866.6	111.9	2.822	12.106
8	Mart Shmony 2	1733.3	103.9	2.620	11.242
9	Darka 1	1400	84.00	2.116	9.0804
10	Darka 2	1133.3	67.99	1.713	7.3505
11	Thikrayat Hotel	1200	72.00	1.814	7.7832
12	Near 108 hospital	1466.6	87.99	2.217	9.5123
13	Karis	1666.6	99.99	2.519	10.809
14	Musatahat	1613.3	96.79	2.439	10.463
15	Industrial area	1640	98.40	2.479	10.637
16	AL-Askari Q.	1266.6	75.99	1.915	8.2151
17	near Catholic Univ.	1333.3	79.99	2.015	8.6477
18	Marina 2	1160	69.60	1.753	7.5237
19	Ashti	1480	88.80	2.237	9.5992
20	128	1000	60.00	1.512	6.4860
21	Kawapolos	1066.6	63.99	1.612	6.9179
22	108 A1	1493.3	89.59	2.257	9.6855
23	Harsham 1	1320	79.20	1.995	8.5615
24	Martshmony 3	1413.3	84.79	2.136	9.1666
25	108A2	986.6	59.19	1.491	6.3990
26	Rustom Palace	1440	86.40	2.177	9.3398
27	108 A3	1626.6	97.59	2.459	10.550
28	Doside 3	1386.6	83.19	2.096	8.9934
29	Harsham 2	1293.3	77.59	1.955	8.3883
30	MartShmony 4	1880	112.8	2.842	12.193
	Min	933.3	55.99	1.411	6.0533
	Max	1900	114.0	2.872	12.323
	Mean	1405	84.30	2.124	9.1133

The mean annual concentration of indoor radon gas for Ainkawa is 84.30 Bq/m^3. Analysis of measurements from of the detectors, the highest annual radon levels were registered in Vinos, Martshmony 4 (114.0 and 112.8 Bq/m^3 respectively) and the lowest at Shlama sch and 108 A2, (55.99 and 59.19 Bq/m^3 respectively), the effective annual dose in the range (1.411-2.872 *mSv/y*) with mean value 2.124 *mSv/y* and the potential alpha energy concentration range are (6.0533-12.323 *mWL*) with mean of 9.1133 *mWL*. The compression between the estimated results with some other surveys are listed in Table-2.

Table 2-comparing results with other surveys

N	reference	Survey location	C_{Rn} Bq/m^3	H mSv/y
1.	Present work	Iraq- Kurdistan-Erbil-Ainkawa	84.30	2.124
2.	(2016) ref.[20]	Iraq-Kurdistan region-Erbil city	56.2	1.14
3.	(2016) ref.[21]	Jordan- Amman city Al- Rusaifa city	44.8 187	
4.	(2016) ref.[22]	Saudi Arabia-Jeddah city	36.2	0.61
5.	(2011) ref.[23]	Canada-askatchewan Manitoba Nova Scotia Prince Edward Island	74.5 143 108 55.9	1.88 3.6 2.72 1.41
6.	(2005) ref.[24]	Europe-Austria Czech Republic Finland Luxembourg Sweden United Kingdom	97 140 120 115 108 20	

Figure-2 represents the values of radon concentrations, its vary from one sample (house) to another due to radon content in sample location. In Figure-3 a good positive correlation (1.00) has been obtained between the radon concentration and the effective annual dose, it is showed that as the content of radon increased, the annual effective dose as well as increase.

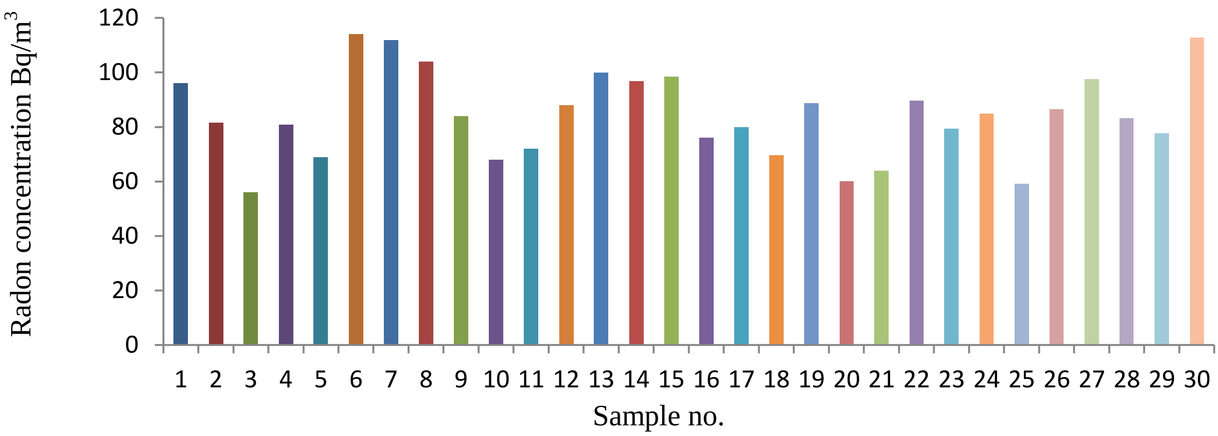

Figure 2-Radon concentrations

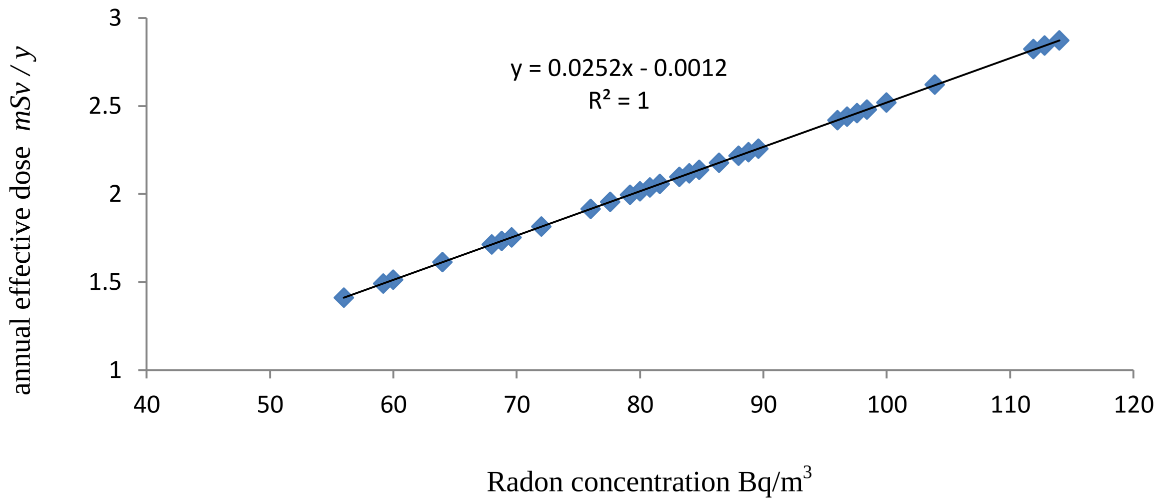

Figure 3-Relation between radon concentration and annual effective dose

Usually surveys of indoor radon measurements are carried out at level of ground floor inside the building which radon accumulates since it is heavier than air. In this survey the individual buildings mean annual concentrations used to identify areas with high radon levels. The mean annual concentration of indoor radon gas established for Ainkawa region is 84.30 Bq/m^3 below of 100 Bq/m^3 the reference level WHO. No concentrations higher than 200 Bq/m^3, no area can be classified in Ainkawa as radon-prone. The increasing movement and air exchanges by use of fans and air-conditioning lowers the radon indoor concentration. Radon are not high in the houses, no needs to be taken any action on material of building. No health major impact to have on outdoor levels of radon since known are to be low. The homes basement or foundation cracks may moves radon into homes which increased its amounts, may exposed to radon by water drinking obtained from radon contain home. Exposure levels although low, but still may lead to cancer of lung. There is no cancer risk in the area under investigation, is safe as for as health hazards and radiological risks due to indoor radon concentration in the houses.

Conclusions

Ainkawa region mean indoor annual concentration radon gas determined as 84.30 Bq/m^3 is below 100 Bq/m^3 the reference level WHO and NRPB criterion for identifying Radon Affected Areas 200 Bq/m^3. There are in this study some single houses exceeded this mean indoor annual concentration radon gas level recommended as reference level of WHO. No a rigid limit below reference level does specify there is no risk of cancer. Although low level exposures can still lead to lung cancer, no area in the Ainkawa can be classified as radon-prone. Effective ways of indoor air radon levels lowering is increasing building ventilation rate or air conditioning use. The area under investigation is safe as for as health hazards and radiological risks due to concentration indoor radon in the houses of Ainkawa.

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