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Indoor Radon Concentrations Measurements for Selected Dwellings in Some Baghdad Districts – Iraq

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Abstract

In this work, measurements of indoor radon concentrations were completed for selected dwellings in Baghdad governorate using DURRIDGE RAD7 detector. The spectra measured by this detector demonstrated that, the radon concentrations were changed from 89 Bq/m^3 (Hay Ur district) to 191 Bq/m^3 (Al-Mansour district) with an average value of 123.3±24.3 Bq/m^3 which is below the recommended range (200-300 Bq/m^3) given by (ICRP, 2009). All other studied parameters such as EP, PAEC, AED and CPPP their values were less than or corresponding to the allowed worldwide average values.

Keywords: Radon Concentrations, Dwellings, Baghdad, RAD7 detector.

الخلاصة

في العمل الحالي تم إيجاد تراكيز غاز الرادون لمنازل مختارة في محافظة بغداد وذلك باستعمال كاشف RAD7. وقد بينت النتائج بان تراكيز الرادون قد تراوحت بين 89 Bq/m^3 (منطقة حي اور) الى 191 Bq/m^3 (منطقة المنصور) وبمعدل 24.3±123.3 Bq/m^3 وهو اقل من المدى (200-300 Bq/m^3) الموصى به من قبل (ICRP, 2009). كل الاعلومات الأخرى التي تمت دراستها مثل EP، PAEC، AED و CPPP قد وجدت بانها اقل من او ضمن القيم العالمية المسموحة .

Introduction

Radon and its descendants discharged amid uranium mining, uranium processing and from process tailings are related with nuclear fuel cycle. Fundamentally it is associated with the reactor operation and with the fuel reprocessing[1].

The nearness of fly fiery debris in construction materials may increase the indoor exposures of gamma radiation from ^{226}Ra, ^{232}Th and ^{40}K founded in the coal ash., The exposures reduction value is caused by the inhalation of radon exuding from the building material, for example, cement[1].

Radon-222 exists normally in the earth crust and it is a basic rate of dose to human from all naturally radiation sources. Wilkening *et al.* calculated the average exhalation ratio of ^{222}Rn from the soil and it was equal to 1.6×10^{-2} Bq $(m^2\ s)^{-1}$[2]as well as it was concluded the mean effective dosage from ^{222}Rn to be 1.15 mSv a^{-1} [3].

In this work, the indoor radon measurements were done for selected dwellings in some Baghdad districts using RAD-7 detector.

Experimental Technique

DURRIDGE RAD7 was utilized to quantify indoor air radon concentration. RAD7 is an electronic radon specifier with time controlling and spectral analyzer. It has a passivated ion-implanted planar silicon identifier. This device was manufactured by DURRIDGE Company Inc. Boston Road Billerica, MA, USA.

Inside RAD-7, there is a hemispherical shape with a silicon solid-state detector. A diagram of the calculation instrument and the detector is shown in Figure 1. In the course of the filter, the air is interred in the instrument by using a pump and goes to the detector. A high voltage of (2-2.5) kV was applied in order to accelerate the positive ions to the detector. When the radon nuclei decay inside the instrument to the positive ion ^{218}Po, it should be accelerated to the detector[4].

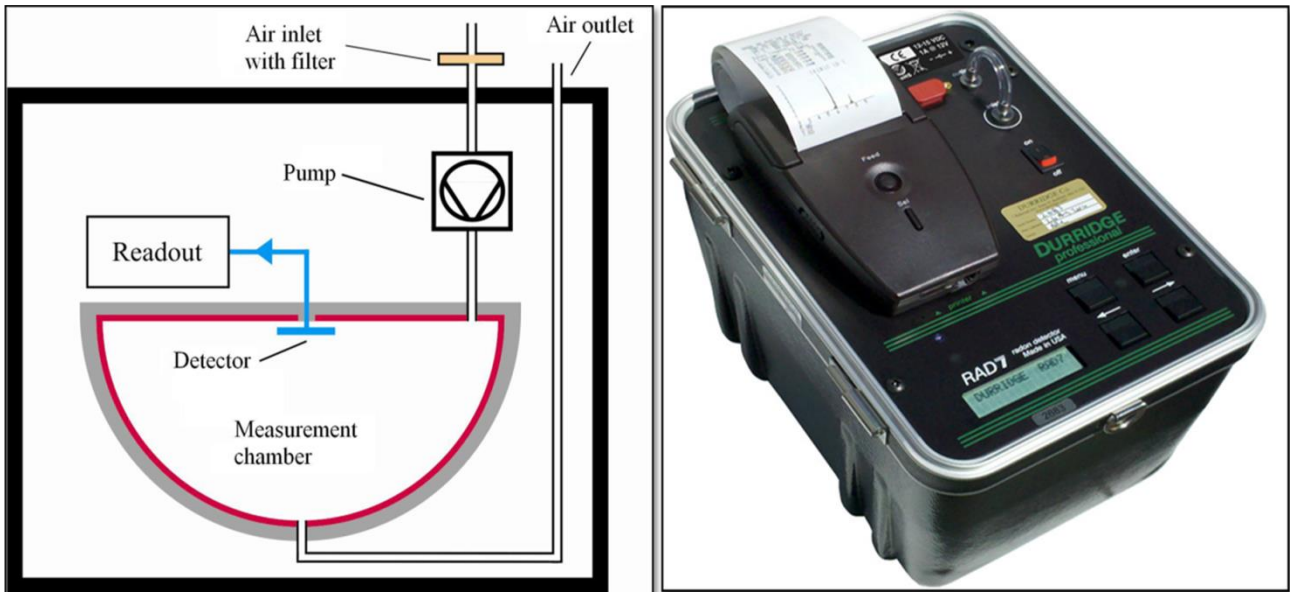

Figure 1: RAD-7 detector. The left side of the figure shows the diagram of the calculation instrument and the right side shows the detector.

In the present work, the following parameters were determined.

1- Potential Alpha Energy Concentration (PAEC), can be estimated by using the relation[5-7]:

$$\text{PAEC (WL)} = C_{Rn} \times F/3700 \quad (1)$$

Where F is the equilibrium factor between radon and its progeny, where it is equal to (0.4) [1] and (C_{Rn}) is the radon gas concentration in (Bq/m^3) units.

2- Exposure to radon progeny (E_P), which was obtained from the relation[8]:

$$E_P\ (\text{WLM}\ Y^{-1}) = \frac{8760 \times F \times n \times C_{Rn}}{170 \times 3700} \quad (2)$$

where (n =0.8), (8760) and (170) represent the total amount of hours in one year and in the working month, respectively.

3- The annual effective dose (AED) can be estimated from the relation[9-11]:

$$\text{AED}\left(\frac{\text{mSv}}{y}\right) = C_{Rn} \times H \times D \times 8760 \times F \quad (3)$$

Where (H=0.8) represents the occupancy factor, and ($D=9\times10^{-6}$ (m Sv)/(Bq.h.m^{-3}) is the dose conversion factor.

4- The lung cancer cases per one year per 10^6 person (CPPP), can be estimated by using the equation [12, 13]:

$$(\text{CPPP}) = (18 \times 10^{-6}\ \text{mSV}^{-1}.\text{y}) \times \text{AED} \quad (4)$$

Results and Discussion

In this research, the indoor air radon concentrations were measured in 10 unique dwellings in Baghdad governorate. Table 1 outlines the results for these measurements. It is show, the maximum average radon concentration can be observed in (AL-Mansour district) and it is equal to 191 Bq/m^3, while, the minimum value can be observed in (Hay Ur district) (see chain 4 of the table1) and it is equal to 89 Bq/m^3, with a mean value of 123.3±24.3Bq/m^3. Figure 2 shows the radon gas concentration is below the minimum value of the preferred range (200- 300 Bq/m^3)[14].

The maximum value of potential alpha energy concentration (PAEC) is 20.649 mWL and it was observed in (AL-Mansour district) (see chain 6 table 1), in the other hand, the minimum value of PAEC was observed in (Hay Ur district) and its magnitude is 9.622 mWL with a mean value of 13.15±2.69 mWL. So all results of PAEC indoors dwellings do not reach the preferred value of (53.33 mWL)[15].

The maximum value of the exposure to radon progeny (E_P) is 0.852 $WLMY^{-1}$, it was observed in (AL-Mansour district) (chain 6 table 1), the minimum value of (E_P) is 0.397

$WLMY^{-1}$ it was observed in (Hay Ur), with a mean value of $0.55\pm0.1 WLMY^{-1}$. All results of (E_P) reach the minimum value of the preferred range (1-2 $WLMY^{-1}$)[14].

From Table 1, the annual effective dose (AED) exposed by the occupants of the studied dwellings varied from 2.243mSv/y (Hay Ur district) to 4.813 mSv /y (AL-Mansour district) with a mean value of 3.107±0.6 mSv/y which was laid in the preferred range (3-10 mSv/y)[16].

Radon prompted lung tumor cancer danger for dwellings in the selected districts in Baghdad governorate (CPPP) were found it is varying from 40.37 (Hay Ur district) to 86.638 (AL-Mansour district) with an average value of 55.929±11.05 per 10^6 human beings (see table 1). These results do not reach the minimum value of the preferred range (170-230) per 10^6 human beings[16].

All the results of the present work were found to be higher than their corresponding results given by Mansour *et al.*[17], where they used CR-39 solid-state nuclear track detector in their work.

Table 1: District, coordinates, mean of C_{Rn}, PAEC, E_P , AED and lung cancer/10^6 person in air for selected dwellings in Baghdad governorate studied in the present work.

No.	District	Coordinates	Mean of C_{Rn} (Bq/m^3)	PAEC (m WL)	E_P ($WLM\ Y^{-1}$)	AED (mSv/y)	Lung Cancer /10^6 person
1	AL-Zafraniya	33.251454° E 44.503446° N	152	16.432	0.678	3.830	68.947
2	AL-Shaab	33.426536° E 44.417137° N	134	14.487	0.598	3.377	60.782
3	AL-Habibiya	33.361775° E 44.441134° N	105	11.351	0.468	2.646	47.628
4	Hay Ur	33.408796° E 44.412370° N	89	9.622	0.397	2.243	40.370
5	AL-Karada	33.291589° E 44.422118° N	114	12.324	0.508	2.873	51.710
6	AL-Mansour	33.277534° E 44.227642° N	191	20.649	0.852	4.813	86.638
7	AL-Kadhimiyah	33.359848° E 44.315606° N	98	10.595	0.437	2.470	44.453
8	AL-Mahmudiyah	33.066321° E 44.352902° N	117	12.649	0.522	2.948	53.071
9	AL-Hurriya	33.353612° E 44.319081° N	95	10.270	0.424	2.394	43.092
10	AL-Dora	33.254234° E 44.393232° N	138	14.919	0.615	3.478	62.597
Ave.			**123.3±24.3**	**13.15±2.69**	**0.55±0.1**	**3.107±0.6**	**55.929±11.05**
Min.			**89**	**9.622**	**0.397**	**2.243**	**40.37**
Max.			**191**	**20.649**	**0.852**	**4.813**	**86.638**
Worldwide average			**200-300[14]**	**53.33[15]**	**1-2[14]**	**3-10[16]**	**170-230[16]**

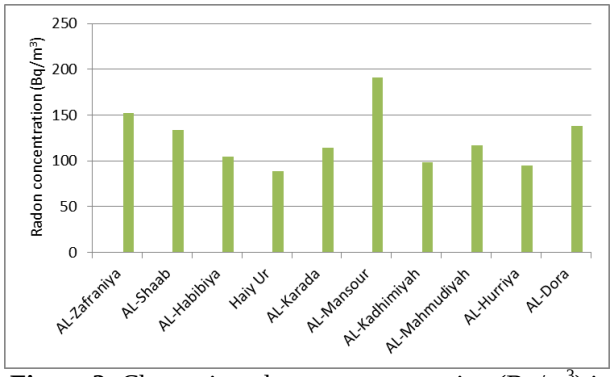

Figure 2: Change in radon gas concentration (Bq/m^3) in indoor air dwelling studied in the present work.

Conclusion

The results in the present work give an additional database of indoor air radon levels in Baghdad governorate by using RAD7 detector. In the present study, it is shown that the studied districts have no dangerous effects on health if it is used for living, concerning the hazardous health effects of radon.

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