International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Measurement of Indoor Radon Concentration in Dwellings of Koya Using Nuclear Track Detectors

Zakariya A. Hussein

Department of Physics, Faculty of Sciences and Health, Koya University, Erbil, Iraqi Kurdistan

Abstract: ***Exposure to natural sources of radiation, especially ^{222}Rn and its short-lived daughter products has become an important issue throughout the world because sustained exposure of humans to indoor radon may cause lung cancer. Therefore, indoor radon concentration has been measured 42 homes of Koya in Erbil, Iraqi Kurdistan. CR-39 (NTDs) nuclear track detectors were exposed for 60 days for the measurement of indoor radon levels. The average indoor radon concentration have been measured which are found to be in the range 22.45 ± 1.86 to 75.84 ± 3.75 Bq/m^3. The mean annual estimated effective dose received by the residents of the studied area was estimated to be 1.24 mSv. The annual estimated effective dose is less than the recommended action level (3-10 mSv).***

Keywords: CR-39 detectors, Indoor radon, Effective dose and Lung cancer

1. Introduction

Radon is a naturally occurring radioactive noble gas. It is found in soil and rocks and moves up from the ground to the outdoor air and into houses through cracks and other holes in the foundations, etc (1). It is produced by the decay of natural uranium (^{238} U) in rocks and soils throughout the earth's crust wherefrom a fraction of radon may escape into the atmosphere. In the outdoors, it is quickly diluted and is of no further concern from radiological protection point of view. However, in confined spaces such as dwellings, radon may accumulate to harmful levels (2,3).

^{222} Rn is an alpha emitter that decays with a half-life of 3.8 days into a short-lived series of progeny. A certain fraction of radon progeny may attach to aerosol particles. By inhalation, these particles may be deposited in lungs thereby exposing sensitive tissues with alpha radiation. Consequently, it may lead to lung cancer and has been identified to be the second leading cause of lung cancer (4). Radon and its short-lived decay products are the most important contributors to human exposure to ionizing radiation from natural sources. This contribution represents 50% of the total dose (5). The Radon concentration in air varies in accordance with location, high level of the houses, material of the houses built, different room in the same house, and ventilation rate (6).

In this present work, beside of measure indoor radon concentration and annual effective dose, we have measure most of important that related to estimate a risks of inhalation of radon gas by the persons inside the homes. As well as, and to find lung cancer per year pear 10^6 persons.

2. Materials and Methods

2.1 The Characteristic of Dwelling in Koya

The town Koya is located in the Erbil Governorate of Iraqi Kurdistan. Most of the dwellings in the studied areas are concrete houses, which are partially ventilated. These houses were built using cement, sand, bricks limestone and concrete. The walls of the dwelling were covered with gypsum and the floor material was covered with ceramic tile. These building materials Contributes to the increase indoor radon concentration

2.2 Passive radon dosimeter

The passive technique (can technique) using the CR-39 NTDs has been utilised for the comparative study of the indoor radon (^{222} Rn) level in the dwellings of Koya. Radon activity concentrations were measured mainly using the passive closed-and-open can techniques (cylindrical can made of high grade plastic having diameter of 6 cm, height of 7 cm and thickness of 0.5 mm). Each can was equipped with a polymeric nuclear track detector CR-39 NTDs each with size (1.5 x 1.5) cm^2 fixed at its bottom (7).

2.3 Distribution of radon dosimeters

A total of 252 radon dosimeters distribution for all houses. All the dosimeters were suspended in the most frequently used room, the 'sitting room' of the dwellings of interest at a height of more than 2 m above the level of the ground. The detectors were exposed during 60 days. After the exposure time 60 days, the detectors from all cans were retrieved. For the revelation of tracks, the detectors were chemically etched in 6 N NaOH at temperature 70 ± 1 ^{0}C. The etched tracks were counted using an optical microscope at × 400 magnification.

3. Results and Discussion

The average indoor radon (^{222} Rn) concentration levels have been measured in 42 homes of Koya, Erbil, Iraqi Kurdistan. The results obtained are summarised in Table 1.The average indoor value in the studied areas varies from lowest radon concentration of 22.45 ± 2.86 Bq/m^3 in Raparin region, and the highest value 75.84 ± 12.75 Bq/m^3 was found in the Zanko region as shown in Figure 1. This may be due to the difference in the concentration of radioactive elements, uranium and radium in the soil, ventilation rate and building material of the study area. The rates of indoor radon gas in studied areas are less than the accepted level approved by IAEA 148 Bq/m^3 (8). The average effective dose, potential alpha energy exposure (PAEE) and Lung cancer per year pear 10^6 persons summarised in Table 2.

The estimated annual effective dose received by the residents of the studied areas varies from 0.6 ± 0.01 to 2.12 ± 0.08 mSv. The annual estimated effective dose is less than the recommended action level 3-10 mSv/y (3). The radon induced lung cancer risk for dwellers in Koya was found and ranges from 8.36 ± 1.04 to 28.34 ± 2.12 per 10^6 persons. Table 3 shows that the Average indoor radon concentration in dwellings of different.

Table 1: Average indoor radon concentration in different location of Koya

No. of Location	Location name	NO. of House	Ninimum radon concentration (Bq/m^3)	Maximum radon concentration (Bq/m^3)	Average radon concentration+SD (Bq/m^3)
1	Raparin	3	15.33	26.62	22.45±2.86
2	Dldar	3	28.44	38.36	34.12±2.08
3	Harmuta	3	42.64	50.14	47.16 ±5.94
4	Kakon	3	32.14	38.66	36.78±3.88
5	Sayran Village	3	36.86	44.26	41.38± 6.34
6	Qandil	3	40.15	48.26	45.82±6.92
7	Zanko	3	62.45	85.92	75.84±12.75
8	Azadi	3	30.18	37.92	35.12± 2.74
9	Gashtyari Village	3	50.24	58.48	55.72±7.85
10	Rezgary	3	26.54	30.14	30.12±2.14
11	Hamamuk	3	41.22	50.14	46.77± 6.56
12	Nali	3	35.78	42.38	39.88±2.64
13	Qalat	3	44.68	54.16	50.18±9.14
14	Chwarbax.	3	27.55	32.86	29.14± 2.38

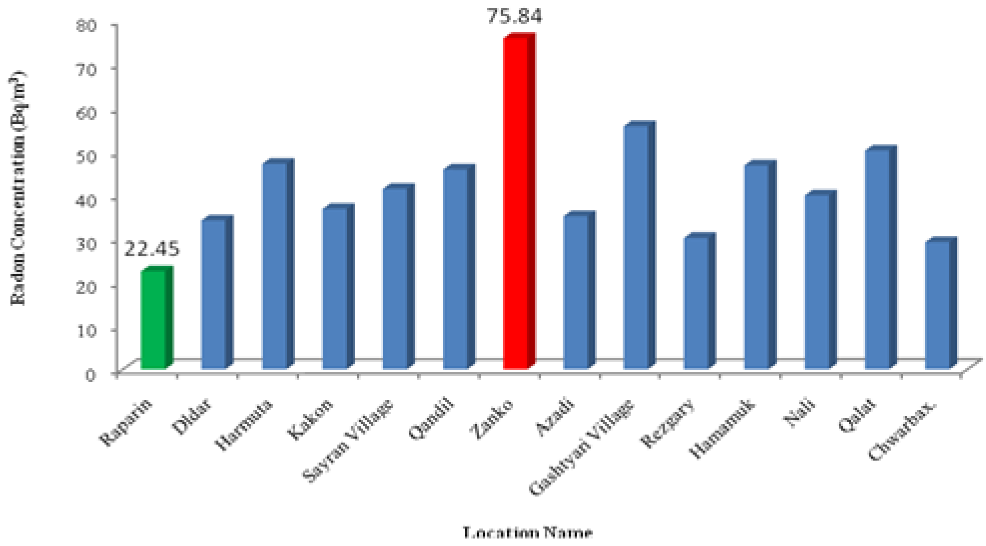

Figure 1: Radon concentration inside different location of Koya

Table 2: Average effective dose, potential alpha energy exposure and lung cancer per year pear 10^6 persons in different location of Koya

No. of Location	Location name	Average effective dose (mSv/y)	Potential alpha energy exposure (PAEE)	Lung cancer per year pear 10^6 persons
1	Raparin	0.6±0.01	2.34±0.11	8.36±1.04
2	Dldar	1.12±0.03	3.34±0.12	12.08±1.06
3	Harmuta	1.46±0.02	5.94±0.86	18.66±1.76
4	Kakon	1.24±0.07	3.85±0.55	13.14±1.12
5	Sayran Village	1.38±0.05	4.88±0.62	14.85±1.45
6	Qandil	1.42±0.06	5.52±0.72	16.04±1.92
7	Zanko	2.12±0.08	10.74±1.82	28.34±2.12
8	Azadi	1.22±0.04	3.74±0.26	12.95±1.78
9	Gashtyari Village	1.88±0.02	8.02±0.94	22.67±2.08
10	Rezgary	0.9±0.05	3.05±0.64	11.42±1.24
11	Hamamuk	1.45±0.06	5.78±0.32	17.65±2.04
12	Nali	1.32±0.01	4.24±0.48	13.76±1.56
13	Qalat	1.72±0.09	7.52±0.22	20.82±2.14
14	Chwarbax.	0.8±0.05	2.84±0.74	10.45±1.06

Table 3: Average indoor radon concentration in dwellings of different counties

Countries	Indoor radon concentration Bq/m^3	Reference
Pakistan	111.34	(2)
Hong Kong	48	(9)
Serbia	35	(10)
Spain	400	(11)
Bangladesh	38	(12)
Turkey	52-360	(13)
Hungary	483	(14)
Brazil	5-200	(15)
India	213	(16)
Canada	49.1	(17)

4. Conclusion

Indoor radon concentrations (^{222}Rn) were measured in42 houses for different location in Koya. The highest and lowest average indoor radon concentration was found in Raparin and Zanko, respectively, this depended for the concentration of radioactive elements, uranium and radium in the soil , ventilation rate and building material of the study area. The average annual effective dose from radon concentration and lung cancer risk was found 1.75 ± 0.08 mSv. Thus, health risks of exposure dose of indoor radon were evaluated by measuring cancer per million per person.

References

[1] Badhan, K., Mehra, R. and Sonkawade, R.G. (2011). Studying the variation of indoor radon levels in different dwellings in Hoshiarpur District of Punjab, India. Indoor Built Environ, 000, 1–6.

[2] Akram, M., Khattak, N. U., Iqbal, A., Qureshi, A. A., Ullah, K. and Qureshi, I. E. (2005) Measurement of radon concentration in dwellings of Skardu city-Pakistan. Radiation Measurements, 40, 695 – 698.

[3] ICRP (International Commission on Radiological Protection). (2000), Lung cancer risk from indoor exposure to radon daughters, Publication 66.

[4] Brown, J. M. C., Solomon, S. and Tinker, R. A. (2011). Development of an energy discriminate CR-39 nuclear track etches dosimeter for Radon-220 gas measurements. Journal of Environmental Radioactivity, 6, 1-5.

[5] Chen, J., Moir, D. and Whyte, J. (2012). Canadian population risk of radon induced lung cancer: a re-assessment based on the recent cross-Canada radon survey. Radiation Protection Dosimetry, 1–5.

[6] WHO (World Health Organization) (2009). WHO Hand book on Indoor radon; a public health perspective.ISBN 978 92 4 154767 3.

[7] Ismail, A. H. and Jaafar, M. S. (2011). Design and construct optimum dosimeter to detect airborne radon and thoron gas: Experimental study. Nuclear Instruments Methods in Physics Research B, 269(4), 437-439.

[8] IAEA (International Atomic Energy Agency). (1997). Sources and Measurements of Radon and Radon Progeny Applied to Climate and Air Quality Studies: A survey, TECDOC-934.

[9] Yu, K. N., Cheung, T., Guan, Z. J., Mui, B. W. and Ng, Y. T. (2000). ^{222}Rn, ^{220}Rn and their progeny concentrations in offices in Hong Kong. Journal of Environmental Radioactivity, 48, 211-221.

[10] Banjanac, R., Dragic, A., Grabez, B., Jokovic, D., Markushev, D., Panic, B., Udovicic, V. and Anicin I. (2004). Indoor radon measurements by nuclear track detectors: application in secondary schools. Physics, Chemistry and Technology 4, 93-100.

[11] Sánchez, A. M., Pérez, J. d., Sánchez, A. B. and Correa, F. L. (2012), Radon in workplaces in Extremadura (Spain). Journal of Environmental Radioactivity, 107, 86-91.

[12] UNSCEAR. (United Nations Scientific Committee on the Effects of Atomic Radiation) (2000). Sources and effects of ionizing radiation. ANNEX A. Dose assessment methodologies, Report I, 18-82.

[13] Celik, N., Cevik, U., Celik, A. and Kucukomeroglu, B. (2008). Determination of indoor radon and levels in Giresun, Turkey. Journal of Environmental Radioactivity, Volume 99, Issue 8, Pages 1349–1354.

[14] János, S., Zorán, G., András, V. and Tibor, K. (2006). Radon concentration in houses over a closed Hungarian uranium mine. Science of the Total Environment, 367 653–665.

[15] Magalhães, M. H., Amaral, E. C. S., Sachett, I. and Rochedo, E. R. R. (2003). Radon-222 in Brazil: an outline of indoor and outdoor measurements. Journal of Environmental Radioactivity, 67, 131–143.

[16] Kumar, R., Mahur, A. K., Singh, H., Sonkawade, R. G. and Swarup, R. (2010), Radon levels in some dwellings around the international monument Taj Mahal, Agra using SSNTDs. Indian journal of pure & applied physics, 48, 802 – 804.

[17] Chen, J., Moir, D. and Whyte, J. (2012). Canadian population risk of radon induced lung cancer: a re-assessment based on the recent cross-Canada radon survey. Radiation Protection Dosimetry, 1–5.