

MEASUREMENT OF INDOOR RADON CONCENTRATIONS IN AL-TAHSEENYAH AND KUT AL-HIJAJ REGIONS IN BASRA GOVERNORATE USING SSNTDS DETECTORS

ARKAN Y. YOUSIF¹, JABBAR H. JEBUR² AND RUSUL I. NOORI³

¹Southern Technical University, Basra Technical Institute, ²Basra University, College of Education for Pure Science,

³University of Oil and Gas-College of Industrial Management for Oil and Gas, Iraq

(Received 10 May, 2021; accepted 23 June, 2021)

ABSTRACT

The inhaling of indoor radon gas have been well known as the most important health risks all over the world. In the current study, series of measurements deals with this gas were done in groups of homes in two regions located in Basra governorate center (Al-Tahseenyah and Kut Al-Hijaj). The CR39 nuclear track detector has been employed in cup technique to evaluate track density of alpha radiation which is emitted by the gas and its progeny. Measurements were started at the first of March and ended at the last of May. Results obtained varied from 24 ± 6 Bq/m³ to 34 ± 8 Bq/m³ and from 4 ± 1 Bq/m³ to 20 ± 5 Bq/m³ for ground and first floor levels respectively belongs to Al-Tahseenyah selected houses. For Kut Al-Hijaj region, the results ranged from 24 ± 5 Bq/m³ to 28 ± 7 Bq/m³ and from 6 ± 1 Bq/m³ to 19 ± 5 Bq/m³ for ground and first floors respectively. Data extracted shows that ground floors have higher radon concentrations with respect to first floors for all houses investigated.

KEY WORDS : Indoor radon, CR39, Lung cancer, Ground and first floors, Basra governorate.

INTRODUCTION

Natural radiations regarded as the greatest source of radiation exposing all over the world. Radon gas beside its produced short-lived progeny are considered to be the major, significant contributor resources of ionization radiation identified in the surrounded environment, they may be responsible about occurring bad influence on human lungs. Radon is a natural inert radioactive odorless and tasteless emitted from decay of Uranium, with a density of 7.5 times more than that of air. The gas can be dissolved in water and easily spread with other gases and water vapor (Forkapic *et al.*, 2006). Due to relatively longer half-life of 3.82 days, the most interested radon isotope is ²²²Rn which decays and yielded a series of short lived particulate daughter products (²¹⁸Po, ²¹⁴Po and ²¹⁰Po) (Durrani and Bull, 1987).

Individuals may spend further than eighty

percent of their times indoors, so the external and internal radiation exposure from construction substances initialize exposure cases. It was deduced by National Council Report (NRC, 1999) that about 4% of dying because lung cancer may actually be excluded if indoor radon levels was maintained below the number 148 Bq/m³, where a linear relation between cancer hazard and radon exposure was marked. Literatures survey indicates that radon may be causative for about 7 % lung cancer cases in Germany, 20 % in Sweden and 10-15 % in United States of America (Battawy *et al.*, 2013). Human skin is ideal shield to avoid alpha particles released from the (three) polonium isotopes during disintegration property of ²²²Rn series, but these isotopes are very dangerous when they enter the body, then decay inward the lungs. Background rates of the gas in outdoor air are commonly quite low (about 0.003 pCi/L of air), while indoor sites like houses, schools and office constructions, limits of 1.5 pCi/L of air are

recorded (Durrani and Bull, 1987).

Maximum part of our time is spending inside homes or establishments, thus the evaluation and parentheses of radon concentration are very important tasks. The major normal source of the gas are soils, foundation substances and natural energy resources employed for cooking like coal and gas, which combine trace amounts of ^{238}U . Estimation of radon concentration in buildings is important to predict the residents exposure. The gas cannot easily go outside due to the sealing ways designed to preserve energy from surrounding and interference reduction of outward air. Radon concentrations are commonly greatest in buildings crypts and basements, where these zones are poorly ventilated and lying near the gas origin (Hamori and Koteles, 2004).

The Environmental Protection Agency (EPA) recommended 4pCi/L as an "action level" for radon gas levels inside constructions. In general it is possible to minimize of indoor concentration to 4pCi/L or less according to ALARA principle (ALARA, 2012). The ICRP lately recommended 300Bq/m^3 as a extreme limit for indoor radon concentration in dwellings and workplaces, depending on the magnitude of maximum edge for the single dose primary level of radon exposure of 10mSv/y (ICRP, 2011). International literature search has been accomplished in different countries to seek radon concentration in different kinds of houses, universities, factories, rural areas and hospitals (Shakir Khan *et al.*, 2005; Al-Jarallah *et al.*, 2008; Battawy *et al.*, 2013; Milad 2013 and Al-Khalifa *et al.*, 2014) and others.

This study has been carried out in Basra governorate center. Houses in Al-Tahssenyah and Kut Al-Hijaj regions have been chosen randomly as the region of interest. Nuclear track detection technique using CR39 film was applied during this study due to its simplicity, availability, long term integrated readout and good sensitivity toward α particles emitted by indoor gas radon and its progeny.

MATERIALS AND METHODS

Cup mode dosimeter (Figure 1) was installed in twenty detached, multi story and deferent construction styles houses. These houses were selected for this investigation from the two mentioned regions (illustrated on the map of Basra governorate as in Figure 2, were built around 20

years or more by various materials such as cement, sand blocks, bricks and concrete. Most of these items are predicted to participate considerably resources of indoor radon. Derelict places or little used for a long time of occupancy were chosen so as to minimize the ventilation. Dosimeters were hung at elevation of about 2m from the ground, and 1m from roof and walls to keep out the contribution of radon gas released from the houses materials directly. Solid state nuclear track films type CR 39 of size $(1.5 \times 1.5)\text{cm}^2$ fixed on thick flat cards were subjected in (bare mode). Forty detectors were placed for 90 days starting from 1st of March till the end of May 2019. The detectors were etched chemically after eliminating from exposure in 6.25N NaOH solution at 7°C for 7 hours, then dried after rinsed by distilled water. The tracks were evaluated by employing an optical microscope with a magnification power of 400X. The gas levels in Bq/m^3 is calculated from the equation: $C = \frac{\bar{n}}{t \cdot K}$. Where, \bar{n} is referring to the track density in Tr/m^2 , while, t is the time of exposure, and calculated by day unit. K represent the calibration factor which is used as $K = 0.188 \pm 0.00433\text{ Tr/cm}^2 \cdot \text{d per Bq/m}^3$ according to



Fig. 1. The cup mode dosimeter employed in this study



Fig. 2. The locations of studied regions on the governorate center map

Catalano *et al.* (2012).

RESULTS AND DISCUSSION

The track density in Tr/cm² and indoor radon concentrations in Bq/m³, which are measured by CR39 detector using cup mode were listed in Tables (1 and 2) for Al-Tahseenyah and Kut Al-Hijaj regions respectively. Average values of track per unit area were calculated from the mean of individual numbers of track per unit area. The significant radon

concentrations ranges from 24±6 Bq/m³ to 34±8 Bq/m³, with average value of 29±7 Bq/m³, and from 4±1 Bq/m³ to 20±5 Bq/m³, with average value of 13±3 Bq/m³ in ground floor living rooms and first floor bed rooms respectively for Al-Tahseenyah region. Maximum, minimum and average values of radon concentrations were obtained in the same manner for Kut Al-Hijaj region in the center of Basra governorate. These data ranged between 24±5 Bq/m³ and 28±7 Bq/m³ for ground floor living rooms, with average value of 25±6 Bq/m³, while changed from 6±1 Bq/m³ to 19±5 Bq/m³ for first floor bed rooms with average value of 14±3 Bq/m³. Extracted results revealed decreasing in the average radon concentrations with the floor level increase as shown in Figures (3 and 4) for both regions under investigation. This disproportion might be ascribable to (how near or how far) the floor with regard to base, because soil represent the considerable provenance of indoor gas. In addition to some more causes, for example the famous truth that (upper floors are finest aerated with respect to lower floors) subjected to dust, aerosols, and another kinds of contamination.

Table 1. Track density and radon concentrations in Al-Tahseenyah region

House No.	Ground floor living rooms		First floor bed rooms	
	Track density Tr/cm ²	Radon concentration Bq/m ³	Track density Tr/cm ²	Radon concentration Bq/m ³
1	512±14	30±7	250±16	15±4
2	531±32	31±8	281±18	13±3
3	493±23	29±7	225±39	12±3
4	518±31	33±8	243±14	14±2
5	406±20	24±6	125±24	7±2
6	425±19	25±6	62±29	4±1
7	437±27	26±5	93±20	6±1
8	462±26	27±7	306±15	18±4
9	568±12	34±8	318±20	19±5
10	537±6	32±6	343±21	20±5
Max.	568±12	34±8	343±21	20±5
Min.	425±19	24±6	62±29	4±1
Avr.	489±21	29±7	225±22	13±3

Table 2. Track density and radon concentrations in Kut Al-Hijaj region

House No.	Ground floor living rooms		First floor bed rooms	
	Track density Tr/cm ²	Radon concentration Bq/m ³	Track density Tr/cm ²	Radon concentration Bq/m ³
1	443±28	26±6	131±8	8±2
2	425±27	25±6	281±18	17±4
3	406±25	24±5	312±20	18±4
4	468±29	28±7	156±10	9±2
5	418±26	25±6	250±16	15±4
6	450±28	25±6	318±20	19±5
7	562±35	25±8	281±18	17±4
8	500±31	25±7	325±20	19±5
9	512±32	25±7	93±6	6±1
10	456±32	25±6	218±14	13±3
Max.	562±35	28±7	325±20	19±5
Min.	406±25	24±5	93±6	6±1
Avr.	464±29	25±6	237±15	14±3

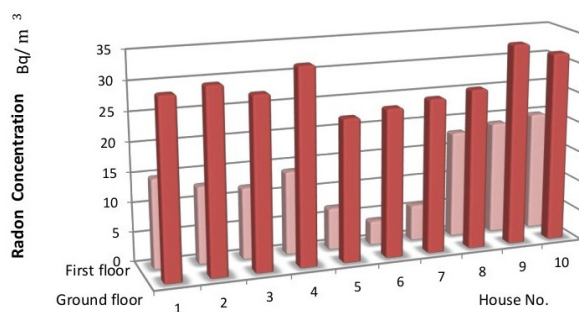


Fig. 3. Radon concentrations in Al-Tahseenyah region houses

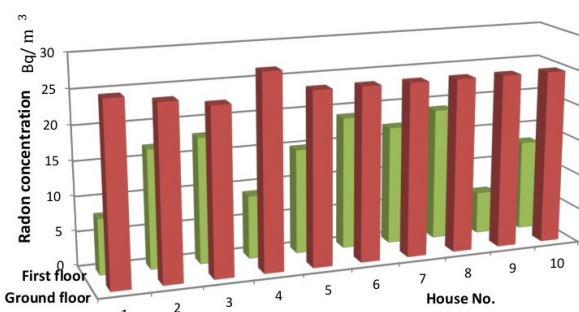


Fig. 4. Radon concentrations in Kut Al-Hijaj region houses

CONCLUSION

The results of indoor radon concentrations estimated using CR39 detector were presented in this study in 20 houses belongs to two regions in the center of Basra governorate. All these concentrations are in agreement with that reported by other researchers' and less than the upper limits recommended. So the occupants of these houses which are selected randomly in addition to their surrounded neighbors almost in save relatively. A relation between the indoor radon concentrations and floor level was noticed, where the highest results obtained in ground floors for all houses under investigation. Expand search's are prepared to calculate the upper limits in other regions in Basra.

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