Measurement of Radon and Thoron Concentration in Environment of the College of Science for Women in Baghdad University

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Abstract

Presence of radon, thoron and their decay products in work place environment are considered a potential health hazard. Measurement of their levels is an important aspect to assess the threat they may pose to humans. Considering this their measurement from the building of collage of Science for Women, Baghdad University has been carried out using passive technique by using twin cups dosimeters. The indoor radon concentration varied from 17.37 Bqm^{-3} to 30.53 Bqm^{-3} with an average of 23.32 Bqm^{-3} while the thoron concentration in the same buildings varied from 6.1 to 32.87 Bqm^{-3} with an average of 18.98 Bqm^{-3} for a period from April to July 2015. The annual effective dose received by the inhabitants of these buildings varied from 0.74 to 1.47 mSv. The radon progeny levels in the buildings under study varied from 1.88 to 3.3 mWL with an average of 2.52 mWL, while the thoron progeny levels varied from 0.16 to 0.85 mWL with an average of 0.51 mWL for a period from April to July 2015.

Key words: *Radon; Thoron; progeny; SSNTD; dwellings; annual effective dose.*

I. INTRODUCTION

Uranium is abundant in nature and can be found in trace amount in most rock and soil. Therefore, most rock and soil also contain thorium and radium. Dueto differences in chemical forms, some limited separation can occur by thegroundwater movement and other natural processes. The decay of radium leads to radon.^{222}Rn is the single gaseous isotope among the fourteen principal decayproducts composing the 4n + 2 natural decay series beginning with^{238}U andending in^{206}Pb. There are 35 known radon isotopes (all radioactive) withatomic mass numbers ranging from 195 to 229. However there are three majorisotopes of radon –action ^{219}Rn with a half-life of 3.96 sec., thoron^{220}Rn witha half-life 55.6 sec., and radon ^{222}Rn with a half-life 3.824 days [1]. These threeisotopes of radon emit alpha particles of energy 6.82 MeV, 6.28 MeV and 5.48MeV, respectively.Because radon is a noble gas, a large share of it is freeto transfer awayfrom radium. Depending on various geological and geophysical aspects and features of building materials,radon can migrate into the indoor air, which can leadto an increase in radon concentrations [2]. Radon contributes about half of thebackground radiation to which we are all exposed [3]. The major sources of indoor radon are soils [4] and rocks source emanations, off-gassing of waterborneradon into a building, emanation from building materials, and entry of radon into astructure from outdoor air. Radon emanation from the soil depends upon its radiumcontent and mineralogy, porosity, grain size, moisture content and permeabilitythrough host rock and soil [5] and Sewage Sludge [6].Many researchers have reported the link between exposure to radon and its decay products in mining sites and an increased risk of lung cancer [7]. Due tothese stated adverse health effects of inhaled radon and its progeny, InternationalCommission on Radiological Protection (ICRP, 1993) has made recommendationsfor the control of this exposure in dwellings and work place [8].The studyis useful for the assessment of radiation dose received by the inhabitants and also for producing the radonmap of the country. Figures (1) and (2) represent the College of Science for women which is an important part of Baghdad University, located in the southeastern part of Jadiriyah in Baghdad, surrounded by the Tigris River from almost three sides as shown in figure (1), and for being one of the university colleges are crowded with buildings and people as the more than 1,000 people and because they inhabit the times in excess of 6 hours Day during office we decided to study the concentration of radon and thoron gas in it.The dosimeters have been located: 1) Inside the center of Ibn Sina,2) Entrance center of Ibn Sina, 3) Biological department store, 4) Biological department crypt, 5) Industrial Chemistry Laboratory, 6) Entrance of Physics Department, 7) Entrance of Biological department, 8) Entrance of Mathematical Department, 9) Chemistry department store entrance and 10) within. The dosimeters have been left in its locations for 100 days.

II. MATERIALS AND METHODS

There are several methods used for measuring the radon and its progeny elements in buildings but in this study the measurement of radon, thoron and their progeny levels has been done using twin cups dosimeters. In this technique, LR-115 type II, strippable plastic track detector films of size (1cm x 1cm) are used. Pristine LR-115 (cellulose nitrate, type-II, strippable, procured from DOSIRAD, France) is alpha sensitive plastic track detector.

Fig. 1: The Map Collage of Science for Women, Baghdad University.

Fig. 2: The Buildings in Collage of Science for Women, Baghdad University.

It is a 12 µm thick film red dyed cellulosenitrate emulsion coated on inert polyester base of 100 µm thickness. The speciallydesigned twin cup dosimeter used here consists of two chambers of cylindricalgeometry separated by a wall in the middle and each having a length of 4.5 cmand radius of 3.1 cm [9] as shown in Figure (3) and (4).

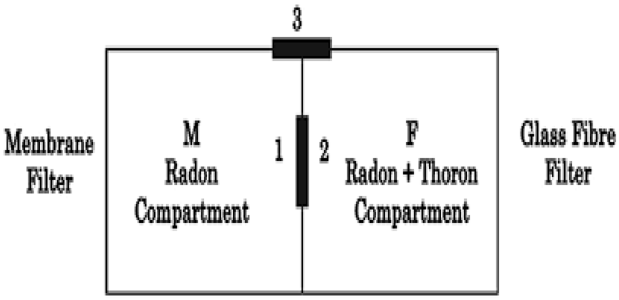

Fig. 4: Actual twin cup dosimeter

Also, there are large numbers offine holes at the ends i.e.holed ends are there so thatfree entry of air insidethe chambers is possible. This dosimeter employs three SSNTDs out of which twodetectors were located in each chamber and a third one was placed on the outersurface of the dosimeter. One chamber is fitted with glass fiber filter so that radonand thoron both can diffuse into the chamber while in other chamber, a semipermeable membrane made of latex or cellulose nitrate is used [9]. The membrane mode measures the radon concentrationalone as it can diffuse through the membrane but suppresses thethoron. The twincup dosimeter also has a provision for bare mode enabling it toregister tracks dueto radon, thoron and their progeny in total.

The plastic detectors LR-115 type II (1cm x 1cm) are located inthe twin cups dosimeters which provide three modes of exposure to determine radon, thoron and their progeny simultaneously [10]. The selection of the detector LR-115 is based on the fact that these detectors do not develop tracks originating from the alpha particles of the progeny deposited on them and hence ideally suited for air concentration measurements [11]. The dosimeters were suspended in the roomat a height more than 2 m above the ground level. In case of the still air, the diffusion length of thoron is 2-3 cm, so the contribution of thoron for track formation on dosimeter is negligible but in thepresence of convective transport of thoron due to natural intermixing of air, thethoron emitted from the wall is distributed in the whole room. The detectors were left exposed for a period of 100 day. At the end ofthe exposure time, the detectors were removed and subjected to a chemical etchingprocess in 2.5 N NaOH solutions at 60°C for 90 minutes. The detectors werewashed and immediately after the completion of washing, the red sensitive layerwas stripped for counting using optical microscope and CCD camera [12].

To determine the concentration ofRadon C_R. The thoron C_T and progeny levels of radon C_R(WL) and that of thoron C_T(WL) by using the following relations [13]:

$$C_R = \frac{TM}{tK_{RM}} \quad (1)$$

$$C_T = \frac{TF - K_{RF} C_R t}{t\, K_{TF}} \quad (2)$$

$$Progeny\ levels\ of\ Radon\ (WL) = \frac{C_R(Bqm^{-3})XFR}{3700} \quad (3)$$

$$Progeny\ levels\ of\ Thoron\ (WL) = \frac{C_T(Bqm^{-3})XFT}{3700} \quad (4)$$

Where:

TM= track density in membrane compartment in (track/cm^2).

TF= track density in filter Compartment in (track/cm^2).

t = total exposure time (day).

K_{RM}= Calibration factor for radon in membrane mode = 0.021 track cm^{-2}d^{-1} /Bqm^3.

K_{RF}= Calibration factor for radon in filter mode = 0.023 tr cm^{-2} d^{-1}/Bqm^3.

K_{TF}= Calibration factor for thoronin filter mode = 0.019 tr cm^{-2}d^{-1}/Bqm^3.

FR= Equilibrium factor for Radon having value of 0.4.

FT= Equilibrium factor for Thoron having value of 0.1

Indoor inhalation dose received due to^{222}Rn and its progeny, and ^{220}Rn and its progeny, has been estimated using the following relation .

$$D = \{(0.17+9FR)\ CR + (0.11+32FT)\ CT\} \times 7000 \times 10^{-6} \quad (5)$$

IV. Results and Discussion

The measurement of indoor radon and thoron concentrations in some building in college of science for women, Baghdad University were carried out by twin cup dosimeters. The results are listed in Table I for a period of April to July 2015.Table I provides the whole information of the study area regarding the radon, thoron and their progeny levels. It also shows the amount of dose received by the occupants of these buildings.The indoor radon concentrations in the collage of science for women are vary from17.37Bq/m^3 to 30.53Bq/m^3 with an average of 23.32 Bq/m^3 while the thoron concentration in same building varies from 6.09Bq/m^3 to 32.86Bq/m^3 with an average of 18.98 Bq/m^3. The radon progeny levels in the building under study varied from 1.88 to 3.3 mWL with an average 2.52 mWL, while the thoron progeny levels varied from 0.16 to 0.89 mWL with an average 0.51mWL.

Dose received by the inhabitants in the buildings under study as shown in fig. 5 varied from 0.74 mSv to 1.47 mSv with an average of 1.07 mSv. In all the buildings surveyed, the maximum dose received (2.30 mSv) is found less than the lower limit of the action level 3 mSv recommended by International Commission on Radiological Protection (ICRP) [14].

Table (1): The whole information of the study area regarding the radon, thoron and their progeny levels and the amount of dose received by the occupants of these buildings.

S	F	M	Out	CR (Bq. m^{-3})	CT (Bq. m^{-3})	D (mSv/y)	PCR	PCT
1	61	33	128	17.37	16.41	0.85	1.88	0.44
2	66	36	117	18.95	17.57	0.92	2.05	0.47
3	101	46	140	24.21	32.86	1.43	2.62	0.89
4	105	53	156	27.89	30.76	1.47	3.02	0.83
5	67	48	85	25.26	10.3	0.91	2.73	0.28
6	58	41	160	21.58	9.28	0.79	2.33	0.25
7	55	43	166	22.63	6.09	0.74	2.45	0.16
8	56	39	163	20.53	9.34	0.77	2.22	0.25
9	99	46	136	24.21	31.61	1.4	2.62	0.85
10	102	58	148	30.53	25.59	1.42	3.3	0.69
Av.				23.33	18.98	1.07	2.52	0.51

Where S refer to sample name, F for filter, M for Membering, PCR for Progeny levels of Radon CR in (mWL), PCT for Progeny levels of Thoron CT in (mWL).The variation found in theradon concentrationof different buildings may be explained due to different ventilation rates, the nature and type of building material used during construction and the variation inthe radioactive levels in the soil beneath the buildings.

International Commission on Radiological Protection (ICRP, 1993) recommended the action levels range as 200-600 Bqm^{-3} for buildings [13].Figures 6 and 7 shows that the Progeny levels of Radon CR in (mWL) andtheProgeny levels of Thoron CT in (mWL) as a function of dose received in mSv.

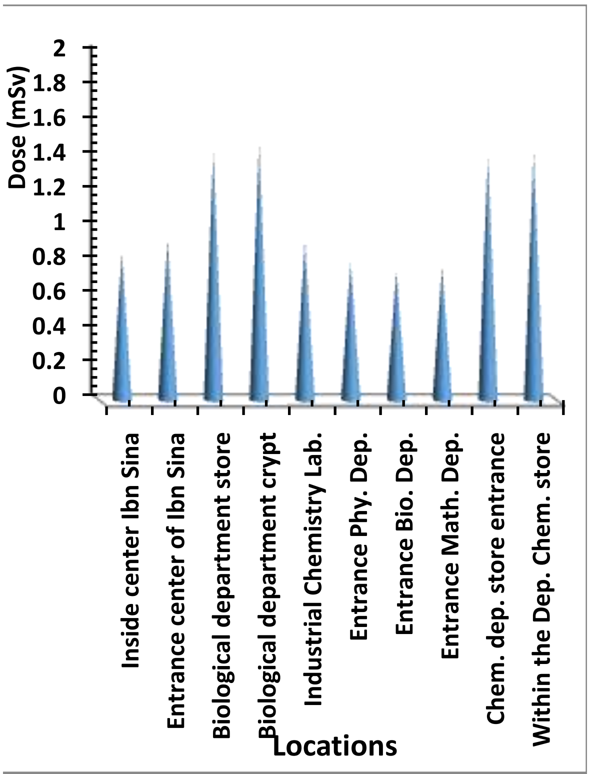

Fig. 5: Annual does (mSv) in all locations.

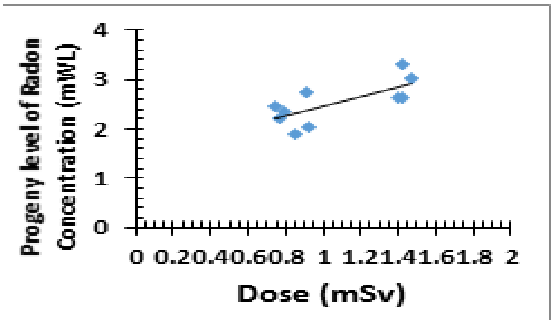

Fig. 6: Progeny levels of Radon Concentration (mWL) as a function of Annual Dose (mSv).

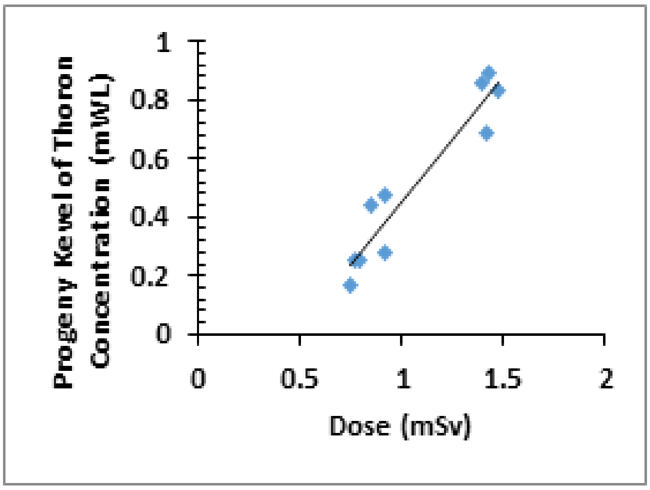

Fig.7: Progeny levels of Thoron Concentration (mWL) as a function of Annual Dose (mSv).

V. CONCLUSIONS

In the present study we have measured the values of radon, thoron and their progeny levels in the indoor environment of some building of collage of science for women in Baghdad University by using twin cups dosimeters. Annual effective dose has also been calculated for the occupants ofthese buildings. The conclusions of the present study are as follows :

1- The overall average value of radon in the present study is found to be 23.32$Bq/m^3$and is lower than the world average value of 40 Bq/m^3 of indoor radon level. The present values of indoor radon are lower than thereference level as recommended by ICRP. The overall average value of thoron was 18.98 Bq/m^3.

2-Theaverage value of radon progeny level of radon concentrations is found to be 2.52mWL.The average value of thoron progeny level of radon concentrations is found to be 0.51 mWL.

3- The values of received dose in dwellings of study area are found to be lower than the worldwide average radiation dose of 1.07 mSv. Theeffective dose received by the residents in the study area less than the range of 3-10 mSv per year as recommended by ICRP.

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