Measurement the concentrations of the Radon for drinking water samples in Kut city

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قياس تراكيز غاز الرادون لعينات مياه الشرب في مدينة الكوت باستخدام الكاشف LR-115

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المستخلص

في هذا البحث تم أخذ عينات من مياه الشرب في مدينة الكوت لقياس تراكيز غاز الرادون فيها باستخدام كواشف الحالة الصلبة للمسار النووي LR-115 (SSNTD) النوع الثاني. والنتائج التي تم الحصول عليها هي مختلفة بين 213.2-760.3 بيكريل / م^3، و هذه القيم هي ضمن الحدود المسموح بها عالميا وتم احتساب جرعة الاستشاق في مياه الشرب التي كانت تتراوح 6.03 – 19.18 ملي سيفرت / سنة بمتوسط 11.22 ملي سيفرت / سنة.

الكلمات الرئيسية: غاز الرادون، كاشف LR-115، جسيمات ألفا.

Abstract

In this research ten samples of Drinking water from AL-Kut city, were possess to measure the concentration of radon gas using Solid State Nuclear Track Detectors (SSNTD) LR-115 type II .The result marks obtained are different from 213.2-760.3 Bq/m3, and these values are within the allowed limits, and exhalation dose from drinking water has been calculated which was different from 6.03-19.18 mSv/y with an average of 11.22 mSv/y.

Key words: LR-115 detector, ^{222}Rn, alpha particles.

Introduction

The radon isotopes are produced from the decay of the natural radio nuclides ^{235}U, ^{232}Th and ^{238}U mainly because of their short half-life are not as important as ^{222}Rn. ^{222}Rn can be considered to be of the most dangerous radioactive elements in the environment. Its character as a noble gas allows it to spread through the atmosphere (1). The main natural sources of indoor are soil, building materials (sand, rocks, cement, etc), water born transport, natural energy sources like (gas, coal, etc) which contains traces of ^{238}U (2). The indoor radon consecration depends mainly on radon exhalation from surrounding materials. ^{222}Rn and is airborne daughters can cause a significant internal health hazard (for example lung cancer) especially when uranium or radium content in the soil is high or when the radon and its daughters are concentrated in enclosed area and in particular in dwelling. Several reports have appeared in literature demonstrating that residential radon may be responsible for 7% of lung cancer in Germany, 4% in Netherlands, 20% in Sweden and (10-15%) in the united states (3). Measurement of indoor radon it's rather important because the radiation dose to human constitutes more than 60% of the total dose, including that from the natural sources (4). Several techniques have been used to measure radon and is daughters concentration. Solid state unclear track detectors, such as LR-115 and CR-39, have been widely used for the measurement of time integrated radon levels in dwellings under different conditions (5). In this study, sheets of LR-115 type II with thickness (100) μm type II detector have been used are supplied by Kodak Co. France. LR-115 type II is a thin film of cellulose nitrate ($C_6H_2O_9N_2$), the color of LR-115 track detector is bold red and insensitive for electrons and electromagnetic radiation. The technique is based on a high-resolution scan of the plastic that creates a digital image where tracks appear as bright spots on a dark grey background. To calculate the exposition, the number of detected tracks needs to be corrected for the etching characteristics, and a correction is made using the average track diameter as a parameter instead of the residual thickness (6, 7).

Collection of the samples

Samples of drinking water were taken from the houses in Kut city as shown in Table (1).

Table (1): The drinking water samples code.

Sample code	Date of sample collection	Location
W 1	11/22/2014	AL-kareemya
W 2	11/22/2014	AL-jihad
W 3	11/26/2014	AL-Anwar
W 4	11/26/2014	AL-jawadain
W 5	11/30/2014	AL-shuhadaa'
W 6	11/21/2014	AL-hawraa'
W 7	11/21/2014	Damok
W 8	11/21/2014	AL- falahya
W 9	11/21/2014	AL-iza AL-jdeeda
W 10	11/22/2014	AL- jaa'farya

Sheets of LR-115 were cut into small pieces each of (1×1) cm^2 area, then the track detector LR-115 type II puts into inner cover side of cylindrical container for one months to registries α–particles tracks that emitted from radon gas as shown in Figure (1).

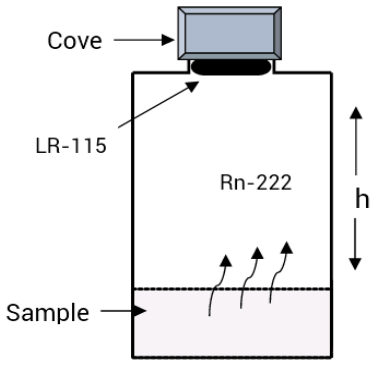

Figure (1): LR-115 detector with sample.

Experimental details

Samples Water Drinking were stored for one month at normal laboratory conditions which are kept in plastic bottle. After Upon completing the period of exposure, LR-115 detectors were etched for (60 minutes) by using chemical etching (NaOH) solution with (2.5N) at 55ºC in water bath, the etched detectors were washed by distilling water then dried and count the number of tracks under an optical microscope. The tracks in these samples that spotted using LR-115 track detector as see in Figure (2).

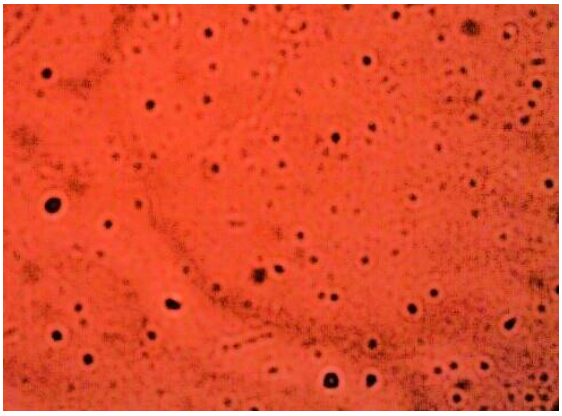

Figure (2): Tracks of LR-115 after etching.

The corrected tracks were converted to radon and thoron gas concentrations using the following equations (8):

$$C_R\ (Bq/m^3) = \rho / K.t \ldots\ldots\ (1)$$

The calibration factor was calculated by measuring the concentration of Rn-222 gas emitted from Ra–226 radioactive sources with Alpha-Guard devise ($C_{Rn\text{-}222}$ = 21.075 $Bq.m^{-3}$ for 1 h period of measuring). Then, by estimated the tracks numbers for CR -39 SSNTD for 24 h of the Rn-222 gas (for the

same Ra-226 source), one can estimate the calibration factor K.

$$\mathbf{K} = \frac{\rho}{C_{Rn-222}} = \mathbf{0.201661}$$

The Calibration Factor K= density of tracks / concentration of Rn-222 measure with alpha guard devise. The radon activity measured by alpha gurad is 21.075 Bq.m^{-3} for 1 h. Annual effective doses have been calculated using the UNSCEAR model (9):

$$E = C \times F \times H \times T \times D \quad \ldots\ldots\ldots\ldots \quad (2)$$

where **C** is the ^{222}Rn concentration (Bq.m^{-3}), **F** is equilibrium factor (0.4), **H** is the occupancy factor (0.8 was estimated for this work), **T** is hours in a year (8760 h/y) and **D** is the dose conversion factor (9.0 × 10^{-6} mSv.Bq.m^{-3} h).

Result and Discussion

The overall results of radon for 10 samples of drinking water in houses of Kut city were given in the Table (2). The average radon concentration for water samples was 444.915 Bq.m^{-3} and this value within the allowed level 11100 Bq.m^{-3} sated by the Environmental Protection Agency (EPA) of the United State of America (9). The value is found also to agree with the action level of 200-600 Bq.m^{-3} as recommended by International Commission of Radon Protection (10). While the maximum concentration of ^{222}Rn was 760.35 Bq.m^{-3} appeared in W6 sample was more than the action level as recommended by ICRP and the minimum concentration was 213.23 Bq.m^{-3} for W2 as shown Fig. (3).

The concentration of radon emitted from water samples depend on ^{226}Ra concentration, also result in lack of water storage leads before using it in the public network of water to increase the concentration of radon. On the other hand increase the storage period lead to lower radon and to the disintegration of radon and daughters water during the storage period (11). The average value of the annual effective dose (E_{ff}) obtained for drinking water samples set was 11.22mSv/y. The maximum value was 19.18 for W6 sample and the minimum value was 5.38 for W2 sample.

Table (2.): Radon concentration of drinking water samples.

No. Code	C_{Rn} (Bq.m^{-3})	*EEC*	WLM	E_{ff} (mSv.y^{-1})	ELC
W1	238.85	95.54	1.329	6.03	3616
W2	213.23	85.29	1.187	5.38	3228
W3	500.56	200.23	2.786	12.63	7577
W4	258.41	103.36	1.438	6.52	3912
W5	220.93	88.16	1.227	5.56	3336
W6	760.35	304.14	4.231	19.18	11510
W7	690.1	276.04	3.841	17.41	10446
W8	519.57	207.83	2.892	13.11	7865
W9	577.15	230.86	3.212	14.56	8736
W10	470.54	188.21	2.619	11.87	7123
Ave.	444.915	177.97	2.476	11.22	6735

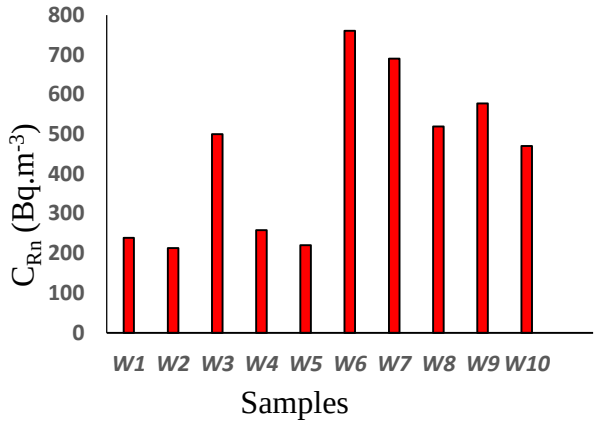

Figure (3): Radon concentration of drinking water sample.

Conclusions

- Concentrations of radon in water samples under study in the city of Kut from Wasit province reached (444.915 Bq.m^{-3}) for samples used.
- Clear from this study that the highest concentration of radon was in AL-hawraa' (W6) (760.35 Bq.m^{-3}) and less concentration in AL-jihad (W2) (213.23 Bq.m^{-3}).
- The results obtained are below permissible international border.
- Found that the annual effective dose is 11.22 mSv/y.
- The method of measuring radon by using Solid State Nuclear Track Detector (SSNTD) LR-115 type II is a high efficiency as well as easy and not expensive.

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