Determination the Concentration of the Radon in some Drinking Bottled Water in Baghdad using LR-115 Detector

Essam Mohammed Rasheed*

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Abstract :

In the present study ten samples of bottled water from Baghdad conservative were taken to measure the concentration of radon gas by using nuclear track detector LR-115.The result obtained are varying from(0.033)to(0.007)pCi.$l^{-1}$and these values are very low than the allowed limits (5) pCi.l^{-1}, and specific activity from bottled water has been calculated which was vary from (0.00027)to(0.00126) Bq.l^{-1} and these values are very low than allowed limits (0.0123) Bq.l^{-1} that mean the bottled water was treated with good treatment to decrease the side effect of radon

Key words: radon, LR-115, track detector, inhalation, radiation, alpha particles.

Introduction:

A significant danger to human health arises from the inhalation of decaying products, which is carried by radon gas and aerosols into a person's lungs. The radiation dose to lung tissue is dominated by alpha particles emissions from the decay products, which then become attached to the lung; damage to sensitive cells is caused, and the probability of cancer developing increases [1]. When radon is permitted to accumulate in a building, e.g. in an internal radon vent pipe, a source of penetrating alpha particles radiation is created and serious adverse effects on human health may result. Typically, certain sections of a population are at greater risk of suffering harm to health from radon [2]. Exposure to elevated levels of the gas may also be implicated in the occurrence of other cancers, such as leukemia in children. The prolonged exposure to the radiation from any form of ionization activity, genetic and human fertility damage will also occur, thus impacting adversely on future generations [3]. In this study, sheets of LR-115 with thickness (90) 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 [4,5].

Collection of the samples

Ten samples of drinking bottled water are collected from the markets in Baghdad city as shown in Table (1).

*Department of physics, College of Science, Al-Nahrain University, Baghdad, Iraq

Table (1): The drinking bottled water samples code

Sample code	Date of production	**Name of sample**
S1	2/12/2010	al- lwlwah
S2	4/12/2010	hayat
S 3	7/12/2010	ala
S 4	9/12/2010	hana
S 5	9/12/2010	**furat**
S 6	10/12/2010	**athbaa**
S 7	12/12/2010	**lolav**
S 8	12/12/2010	**alaeen**
S 9	14/12/2010	mazy
S 10	14/12/2010	jeema

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

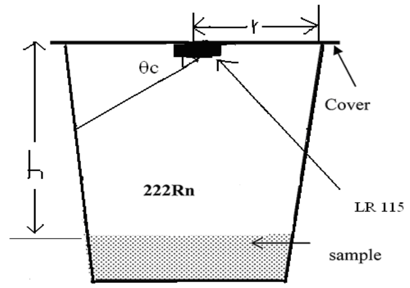

Fig. (1): LR-115 detector with sample in the container

Experimental details

(0.2) litter volume of water samples are stored for one month at normal laboratory conditions which are kept in plastic containers. This time is necessary to get a radiological equilibrating to the samples, before determining the concentration of natural radioactive material for the sample.After two months of the exposure, LR-115 detectors were etched for (2.30) hr by using chemical etching (NaOH) solution with (6.25N) at 55^{o}C, 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 observed using LR-115 track detector as shown in Figure (2).

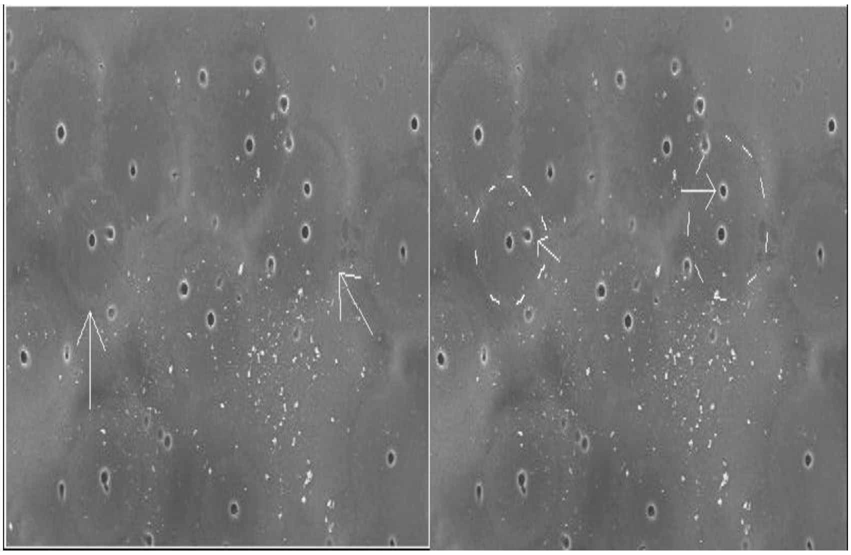

Fig. (2): Image of LR-115 after etching

Results :

The concentration of radon begins to increase with time (t) according to the equation (3) [6,7]:

$C_{Rn} = C_{Ra} (1- e^{-\lambda t})$…………..(3)

Where λ is the decay constant of radon and C_{Ra} is the effective radium content of the sample ($Bq.l^{-1}$), since the plastic track detector LR-115 measures the time integrated value of the above expression, the total number of alpha disintegrations in unit volume of tube with calibration factor K during the exposure time (t), hence the track density is given by:

$\rho = (K * C_{Rn} * T_{eff})$ ……………(4)

The radon concentration C_{Rn} of integrated radon exposure inside the tube was obtained from the track density of the detector, by using the calibration factor K= (0.034± 0.002) $tracks.cm^2/d.(Bq.m^3)$ and T_{eff} which is the effective exposure time and equal to :

$T_{eff} = t - \tau (1- e^{-\lambda t})$ ……………..(5)

Where τ is the mean life of radon (5.5) days,

In our study the actual exposure time (t) is 60 days and the effective exposure time is $T_{eff} = 56.5$ days.

It is clear that the effective radium content of the sample can be calculated from the flowing formula:

$C_{Ra} = (\rho / K * T_{eff}) * (h * A/V)$ ..(6)

Where,

A: is the area of the cross – section of the tube in m^2 and equal to (0.00785) m^2.

h: is the distance between the detector and the top of the sample and equal to (0.17) m. V: is the volume of the sample in liter and in our study equal to (0.2) liter. All of these procedures are completed at normal condition ithout using heating or cooling. The radium concentration of drinking bottled water samples is shown in Table (2) and Figure (3)

Table (2): Radium concentration of drinking bottled water samples

Sample code	ρ tracks/cm^2	$C_{Ra} * 10^{-3}$ $Bq.l^{-1}$
S1	350.09	1.26
S2	197.23	0.71
S 3	98.61	0.35
S 4	175.04	0.63
S 5	91.22	0.32
S 6	76.42	0.27
S 7	234.22	0.84
S 8	101.08	0.36
S 9	263.80	0.95
S 10	253.94	0.91

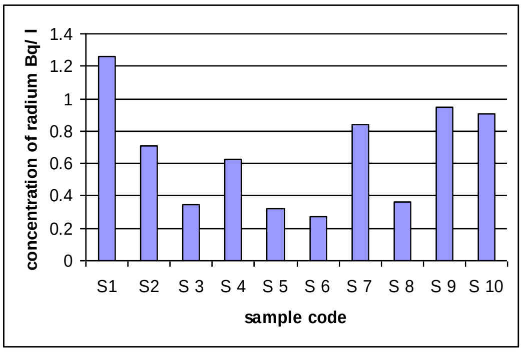

Fig. (3): Radium concentration of drinking bottled water sample

To determine the concentration of radon we used the flowing equation:

$C_{Rn} = C_{Ra} (1- e^{-\lambda t})$ ……….(7)

The concentration in samples in ($Bq.l^{-1}$) are shown in Table (3) and Figure (4) .

Table (3): Radon concentration of drinking bottled water samples

Sample code	C_{Rn} ($Bq.l^{-1}$) $* 10^{-3}$
S1	1.25
S2	0.70
S 3	0.34
S 4	0.62
S 5	0.31
S 6	0.26
S 7	0.83
S 8	0.35
S 9	0.94
S 10	0.90

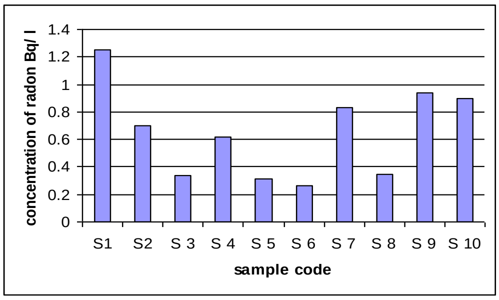

Fig. (4): Radon concentration of drinking bottled water samples

Discussion:

From table (2) the radium concentration of drinking bottled water samples vary from ($0.27*10^{-3}$)$Bq.l^{-1}$ to ($1.26*10^{-3}$)$Bq.l^{-1}$, the minimum of radiumconcentration was ($0.27*10^{-3}$) $Bq.l^{-1}$ in sample (S6) athbaa, and the maximum of radium concentration was ($1.24*10^{-3}$) $Bq.l^{-1}$ in sample (S1) al-lwlwha, these results are quite low compared with the allowed limit ($12.3*10^{-3}$) $Bq.l^{-1}$ [8] .From table (3) the radon concentration of drinking bottled water samples that vary from (0.007-0.033) $pCi.l^{-1}$. The minimumof radon concentration was (0.007) $pCi.l^{-1}$in sample (S6) athbaa and the maximum of radon concentration was (0.033) $pCi.l^{-1}$in sample (S1) al-lwlwha, these results are very quite low compared with the allowed limit (5) $pCi.l^{-1}$ [9].The reason of lowest concentration of radon in the collected samples is because most of water samples are pure and clean without any clay or sediment and these samples are treated with good process by using ozone and UV to get high purity of water.

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تحديد تركيز الرادون في المياه المعدنية في بغداد باستخدام كاشف الأثر LR-115

*عصام محمد رشيد درويش**

*جامعة النهرين /كلية العلوم /قسم الفيزياء

الخلاصة:

استخدمت في هذه الدراسة عشرة نماذج من المياه المعدنية ضمن محافظة بغداد من اجل قياس تركيز الرادون الذي له الأثر الكبير في مجال النشاط الإشعاعي. تم استخدام كاشف الأثر النووي LR-115 لقياس تركيز الرادون للماء. وقد أظهرت النتائج التي تم الحصول عليها أن تركيز الرادون في المياه المعدنية قد تراوحت بين (0.033 – 0.007) بيكو كيوري/ لتر وهذه النسبة اقل بكثير من النسبة المسموح بها وهي (5) بيكو كيوري/ لتر وتضمنت الدراسة أيضا حساب قيم الفعالية النوعية للمياه المعدنية وكانت تتراوح بين (0.00126 – 0.00027) بيكريل/ لتر وهي اقل من القيمة المسموح بها وهي (0.0123) بيكريل/ لتر مما يدلل أن هذه المياه المعدنية تم معالجتها بصورة جيدة للتقليل من الأضرار الجانبية للرادون .