Determination of Radon Concentration In different Sample of water places in Karbala Using CR-39 Plastic Track Detector

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Abstract:

The study of determination Radon concentration in samples of water includes collecting (12) sample from different places in Karbala .
The nuclear track technique by CR-39 plastic track detector sheets is used in this research .
The concentration values were calculated through the comparison with standard samples which were prepared .
After exposing samples to the detectors for (45) day of gas radon , etching process made and scanning the detectors under the optical microscope. Results show higher concentration (5.6) Bq/m^3 in sample (Al aamel Quarter – end) and (5.2)Bq/m^3 in sample (Al aamel Quarter - start),while the low concentration was recorded (1.2)Bq/m^3 in sample (Tewerege bab – end) .A Comparison of results to permissible limits of radon in Water also are obtained.

Keywords

determination Radon, CR-39 plastic, chemical etching , track detectors .

الخلاصة

إن دراسة تحديد تركيز الرادون في نماذج من الماءِ شملت جمع (١٢) عينة من مناطق مختلفة لمحافظة كربلاء .
استخدمت تقنية عد الآثار النووية بواسطة كاشف الأثر النووي البلاستيكي
CR-39 في هذا البحث
تم حساب وتحديد تركيز الرادون بالمقارنة مع ماتعطيه النماذج القياسيةِ التي تم تحضيرها ، بعدها تم تَعْرِيض العيناتِ إلى الكاشف لـــــــ ٤٥ يوم إلى غاز الرادون ، ومن ثم تمت عملية القشط ، وبعدها الكاشف تحت المجهر البصري .
أظهرت النتائج أن أعلى تركيز كان (٥.٦) (لنموذج حي العامل- نهايته) و (٥.٢) (لنموذج حي العامل – البداية) ، بينما أقل تركيز كان (١.٢) لنموذج (باب طويريج – نهاية) ، وهذه التركيز ضمن الحدود المسموحة إذ ماقورنت بتركيز الرادون الطبيعي الموجود في الماء .

Introduction:

The use of the CR-39 plastic as a nuclear particle detector has become generalized in this fields of dosimeters , spectroscopy and environmental science due to its high sensitivity .
In the last two decades, there are a great deal of awareness about the health [1]. .
In this case , the CR-39 was used for determination of low concentration of radon in water solution .
Actually, many method exist for determination of low concentration or traces of radon . Some of these are very sophisticated and give high precision , but all of these methods require complicated and expensive instrumentation .
The general idea in this search is to show simple method for radon determination that does not require complicated instrumentation nor the use of nuclear reactor or neutron generators [2]. .
The solid state nuclear track detectors (SSNTDs) and specifically the polymers , combined with the techniques of chemical etching (CE) and electrochemical etching (ECE) create an ideal method for low radon concentration in detection .
The results obtained from this method show a high sensitivity, sufficient for radon

concentration determination as low as (1 p.p.m) .Linearity is shown between the radon concentration and the number of observed tracks , and the data are consistently reproduced . The relative low cost and the common use of the instrumentation required takes this method a tool that would be available to technological systems that have modest resources [3]. .
Radon, one of the heaviest gas on the earth , is produced because of spontaneous decay of Radium-226. There are two path-ways of radiation exposure from Radium-226 in building materials. Scientists found that (1mg) of Radium-226 can produce in about 1×10^{-4} ml of Radon gas in the natural situation of pressure and temperature [4]. The radiation from radon and its daughters produce risk of lung cancer by inhalation in air with high concentration over a period of time [5].

Experimental Procedure

Influence of Background was minimized by i) choosing films with low background track densities and ii) reducing the film area under investigation .Track development procedure for alpha tracks consisted of 45 day chemical etching (CE) at 70^{o}C in 6.25N KOH followed by 5 hours' CE at room temperature using the same echant .The CE step also incur-porates one advantage : it help to reduced number of background CE spots by converting sharp shallow surface defects (or pits) into blunt pits unsuitable for CE .

Appear table (1) follows different name place the samples which collected from places karbala were (12) samples .

Table (1)

Sample code	**Name of place**
S_1	Tewerege bab (end)
S_2	Tewerege bab (at first)
S_3	Al-Moalameen Quarter (end)
S_4	Al-Moalameen Quarter (start)
S_5	Sef Saad Quarter (start)
S_6	Sef Saad Quarter (end)
S_7	Al hor
S_8	Al hor Quarter
S_9	Al askary Quarter (end)
S_{10}	Al askary Quarter (start)
S_{11}	Al aamel Quarter (start)
S_{12}	Al aamel Quarter (end)

The samples with certain volume were put into a Petri dish. Sheets of 250 μm thick CR-39 plastic track detector supplied by Per shore Moldings LTD Co.UK. for recording tracks of radon in samples. The sheets cut into small pieces of 1×2 cm^2 areas, stored at normally lab conditions. Can technique, which found to be the most appropriate one and the most widely used due to its simplicity as well as the economy was used . The structure of Can technique shown in fig (1).these radon dosimetry composed of plastic cups 7cm in diameter and 8cm in depth. The cups enclosed upon the samples for 45 days in order to reach to the equilibrium situation .

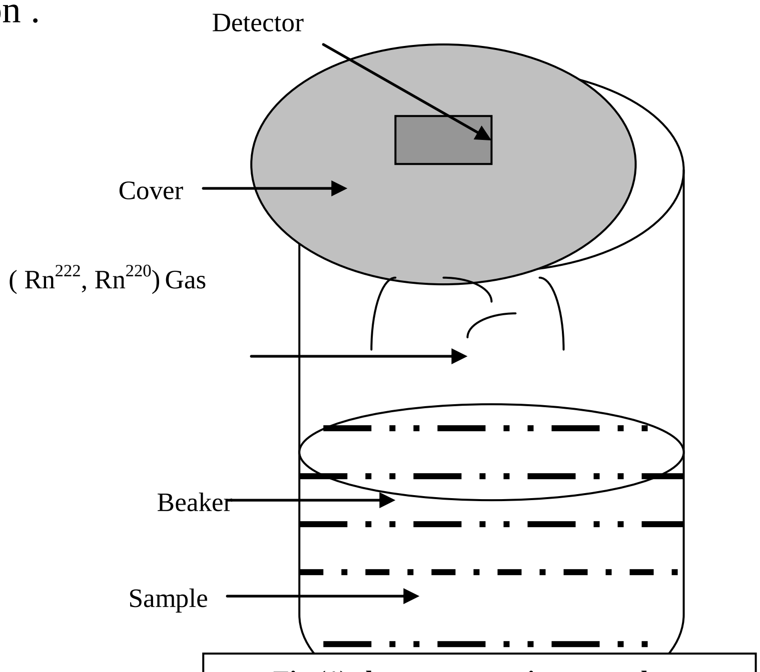

Fig (1) show mensuration procedure

between radon and other isotopes. After that, the cups were changed by cups containg the detector on the top and again enclosed onto the samples. After 45 day periods, the detectors collected and non-destroyed ones were analyzed.

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Using optical microscope of type Olombus, Japan, with 400x magnification, track were counted after etching process. The process under microscope show in fig (2)

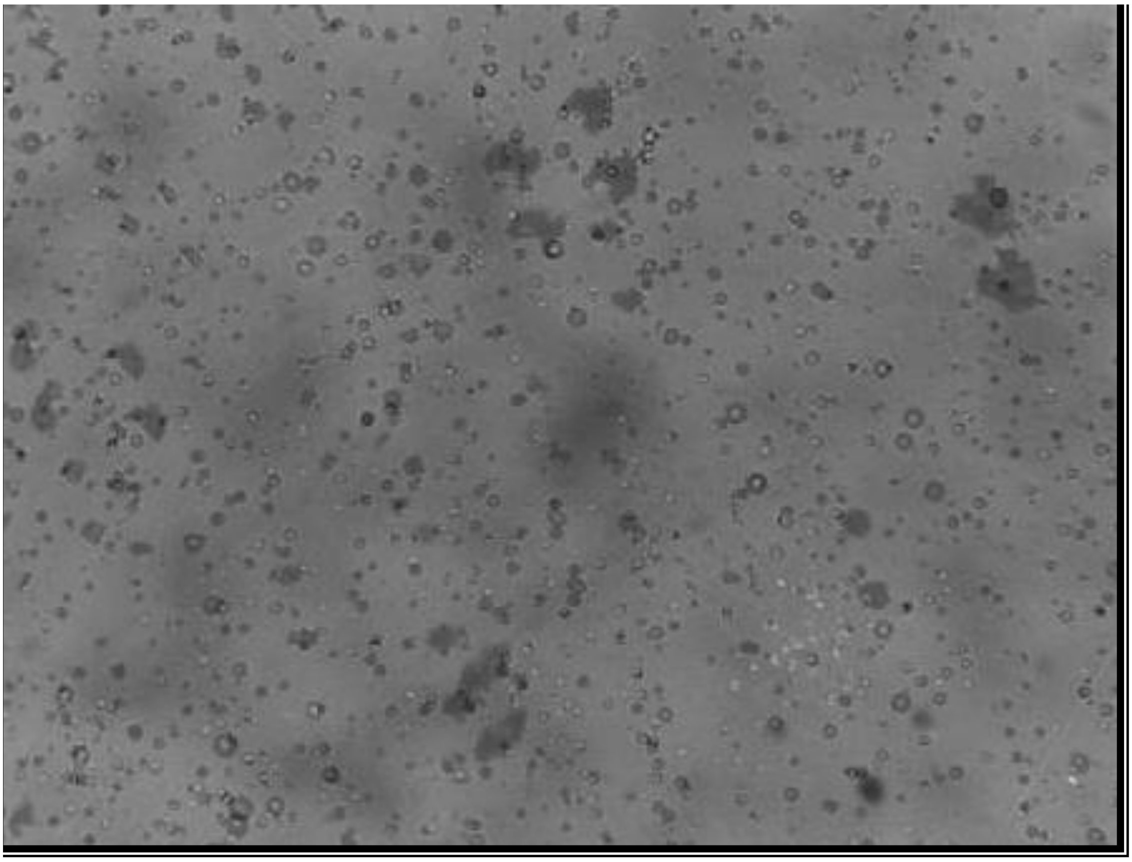

Fig (2) show photo form track sample radiation under microscope

To correlate the tract density on the detectors to radon concentration, standard samples were prepared using standard samples of water of international atomic energy agency (TAEA) .

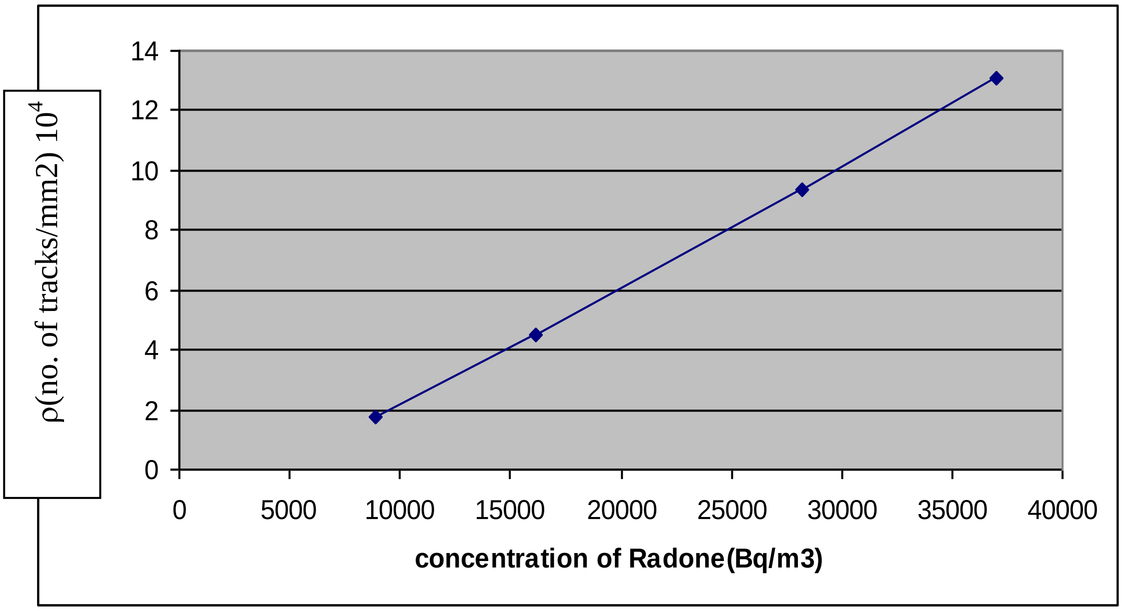

Fig (3) show density of the track and Radon concentration in the standard samples

show fig (3) From draw relation between track density of standard samples of water and Radon Concentration in same standard samples ter can be calculation Radon concentration of sample studied using the eq (1) [6,7] .

$$C_x = \rho_x \times \rho_s / C_s \qquad \text{...... .... (1)}$$

Where:

C_x = Radon Concentration in Samples (Bq/m^3).
C_s = Radon Concentration in standard samples of water (Bq/m^3).
P_x = Track density of samples (track/mm^2).
P_s = Track density of standard samples of water (track/mm^2).

From graph between P_S & C_S of standard samples of water , eq.(1) become

$$C_x = \rho_x / \text{slope} \quad \ldots\ldots\ldots\ldots\ldots.. (2).$$

The last eq .(2) were used to calculate radon concentration . In Bq/m^3 for samples were calculated and delivered in table (2). Moreover, comparison of radon concentration to permissible limits of radon in water [8] .

Table (2) Track density (P_x) & Concentration Rn^{222}

Sample code	**No. of track*10^{+1}**	**Track density (P_x) (rack/mm^2)*10^{+2}**	**Concentration Rn^{222}(C_x) (Bq/m^3) *10^{-1}**
S_1	1.95	3.12	1.2
S_2	3.57	5.72	2.2
S_3	4.71	7.54	2.9
S_4	5.36	8.58	3.3
S_5	5.68	9.10	3.5
S_6	6.01	9.62	3.7
S_7	6.50	10.40	4.0
S_8	6.66	10.66	4.1
S_9	7.15	11.44	4.4
S_{10}	7.96	12.74	4.9
S_{11}	8.45	13.52	5.2
S_{12}	9.10	14.56	5.6

Results & Discussion:

The final results of radon concentration (in Bq/m^3) in the (12)different water are listed in table (2). By comparison between the results obtained and the permissible limit of EPA for water, which were (100 Bq / m^3) [9,10] , there are two samples of higher percentage, which are samples (12) with (5.6) Bq/m^3 and sample (11) with (5.2) Bq /m^3 concentration .In addition to the natural water to contain on very low value to radiation material

Conclusions:

The best low radon concentration in water (due to the research) is the Tewerege bab (end) from Karbala Governorate while high concentration in Al-Amel Quarter (end)

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