

Radon Concentrations and Radon Exhalation Rate in Some Samples of Fertilizers Used in Iraq

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Abstract:

In present study, radon concentrations were measured for some fertilizers samples. These samples were collected from local markets of Najaf province, Iraq. CR – 39 plastic track detectors were used as measurement device with cylindrical diffusion technique. Also, radon exhalation rate was estimated for all samples under study. The results demonstrate that, the value of radon concentrations were ranged from 1.39 Bq/m³ to 593.06 Bq/m³ with an average of 101.23 Bq/m³, while the values of radon exhalation rate were ranged from 1.01 mBq/m².h to 439.89 mBq/m².h with an average of 73.72 mBq/m².h. It is found that radon exhalation rate for all fertilizers samples were below the maximum permissible limit 57.6 (Bq/m².hour), so it can be concluded that the samples under study may have no health risks.

Keywords: fertilizers; radon; CR-39; exhalation rate; Iraq.

تراكيز الرادون ومعدل استنشاق الرادون في بعض نماذج الاسمدة المستخدمة في العراق

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الخلاصة:

في الدراسة الحالية تم قياس تراكيز الرادون لبعض نماذج الاسمدة. جمعت هذه النماذج من الاسواق المحلية لمحافظة النجف، العراق. استخدمت كواشف الاثر البلاستيكية CR-39 كجهاز قياس ذو تقنية الانتشار الاسطواني. كما تم تخمين معدل استنشاق غاز الرادون لجميع النماذج قيد الدراسة. بينت النتائج ان تراكيز الرادون كانت تتراوح من 1.39 بيكرل / م³ الى 593.06 بيكرل / م³ بمعدل 101.23 بيكرل / م³، بينما قيم معدل استنشاق غاز الرادون تراوحت من 1.01 بيكرل / م².ساعة الى 439.89 بيكرل / م².ساعة بمعدل 73.72 بيكرل / م².ساعة. لقد وجد ان معدل استنشاق الرادون لجميع نماذج الاسمدة كان اقل من اقصى حد مسموح 57.6 بيكرل / م².ساعة لذلك يمكن ان تكون النماذج قيد الدراسة ليس لها مخاطر صحية.

الكلمات المفتاحية: اسمدة؛ رادون؛ CR-39؛ معدل استنشاق؛ العراق.

1. Introduction

Potassium, Uranium and Thorium are mainly of interest natural radionuclides and the radionuclides that are created as their radioactive decay chains. Emanation of radon gas (e.g., Radon-222 and Radon-220 of half-life 3.8 days and 55.6 sec., respectively) into air occurs as a product of uranium ^{238}U and thorium ^{232}Th decay chains, respectively. Most of the hazards are result of the short lived decay products of radon by inhalation. The hazard of radon Emanates from its radioactive daughters, because they are attached, like dust do, using their physical properties, trapped in the lung and depositing their alpha-particle energies in the tissue, producing higher ionization density than beta particles or gamma-rays. Diseases of Lung cancer, skin cancer, and kidney cancer are the health effects caused by inhalation of radon-decay products [1].

The fertilizers are necessary in agriculture because they supply nutrients to the farming fields. Fertilizer use is a necessary factor for increasing agricultural production in Iraq and its utilization has increased suddenly in the last five decades. Fertilizers increase nutrient products and expanding responsive cultivated land in large parts of the country. All phosphate fertilizers are mainly consist of starting materials as Phosphate rocks. The phosphate industry is considered as an important contributor to national economies for several countries [2]. For getting high agricultural productivity, the present practice of replacing nutrients in soils and consequently supplying substances is done by the application of chemical fertilizers [3,4].

There are many chemical fertilizers used in agricultural soil in Iraq such as triple superphosphate (TSP), single

superphosphate (SSP), Di-Calcium phosphate (DCP), Di-Ammonium Phosphate (DAP), Urea, compound fertilizers and nitrogen, phosphorous and potassium (NPK) [5,6]. Natural radionuclides are there in phosphorus portion of the phosphate rocks [3,4].

The level of activity concentration of radionuclides in phosphate fertilizer and soil samples gives useful information in the monitoring of environmental pollution. For radiation protection purpose, the concepts of natural radiation are so necessary. Farmers and even the common people are affected by radionuclides present in phosphate fertilizers greatly. Relatively, the environment and agricultural lands are contaminated during cultivation as a result large concentrations of natural radionuclides present in phosphate fertilizers, and consequently, the farmers are affected because of the direct inhalation of dust of phosphate fertilizers on agricultural lands [7,8,9]. The aim of this study is to determine radon concentrations and radon exhalation rate in local and important fertilizer samples available in Iraqi markets using solid-state nuclear track detectors (SSNTD) type (CR-39).

2. Material and Methods

Twenty one of fertilizers samples were gathered from Iraqi markets for different types and countries as shown in Table (1).

Table 1. samples of fertilizers in present study

No.	S.C	Origin	Kind of fertilizer
1	F1	IRAQ	NPK
2	F2	TUNIS	DAP
3	F3	JORDAN	NPK
4	F4	IRAQ	K_2SO_4
5	F5	IRAN	OPROFERT SIMONIS
6	F6	LEBANON	SSP

7	F7	KSA	URA
8	F8	CHINA	CALCIUM NITRATE
9	F9	JORDAN	DAP
10	F10	FILANDA	HEDROCOMPLECS
11	F11	JORDAN	DAP
12	F12	RUSSIA	NPK
13	F13	INDENOSI	NPK
14	F14	IRAQ	SULFUR
15	F15	IRAN	PPC
16	F16	LEBANON	NSP
17	F17	CHINA	DAP
18	F18	IRAQ	NPK
19	F19	SPANSH	FERTIUM MAXIMA
20	F20	GERMANY	KEKKILA
21	F21	TURKY	HEDROCSIDE

They were mechanically crushed and sieved through of 0.8mm pore size diameter sieved for getting high homogeneity. They were dried by electric oven under temperature 50⁰ C for one day. Only fifteen grams of each Sample were placed in plastic cylinder containers closed tidily with plastic covers. Solid-state nuclear track detector (SSNTD) CR-39 of 1mm thickness was used. Figure of this track detector was square and its dimensions were (2cm x 2cm). Height of container was 9 cm and its diameter 5 cm . Height of sample was 1 cm in container, as in Figure (1). After the irradiation time ninety days, the CR-39 detector is scratched off using sodium hydroxide (NaOH) solution at (70⁰)C temperature for (5) hours [8,9,10].

Radon concentrations were calculated using following equation [11]

$$C_{eq} \left(\frac{Bq}{m^3} \right) = \frac{k \rho}{T} \dots \dots \dots (1)$$

where k is calibration factor which it is equal (0.5) KBq/m³.h⁻¹ per Track/mm², ρ is track density and T is the exposure time in (hour).

The radon exhalation rate of all fertilizers samples in terms of area expressed , E, was calculated too, where

E_A is characterized as the flux of radon noticed from the material’s surface and can be enumerated from Eq. below [12,13]:

$$E_A \left(\frac{Bq}{m^2 hour} \right) = \frac{C_{eq}.V\lambda}{A[T+\lambda^{-1}(e^{-\lambda T}-1)]} \dots (2)$$

Where C_{eq.} is the equilibrium radon concentration (Bq/m⁻³), λ is the decay constant of radon, V is the effectual volume of the container in (m³), and A is the area of cross-sectional of the container in (m²).

The tracks density was counted using the system is our TASLIMAGE software, developed by TASL. in lab. of nuclear physics, department of physic in Kufa university as shown in Figure (2).

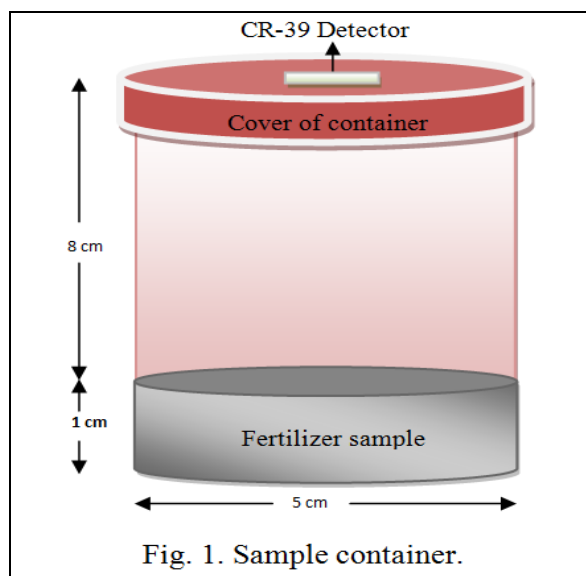


Fig. 1. Sample container.



Fig. 2. TASLIMAGE System.

3. Result and Discussion:

Twenty-one fertilizers samples were measured and calculated as in Table (2). The ²²²Rn concentration and track density in fertilizers samples are presented in Table 2. The minimum and maximum radon concentrations were found to be 0 Bq/m³ in DAP fertilizer (F₁₁ made in Jordan) and 593.06 Bq/m³ in DAP fertilizer (F₉ made in Jordan too) and Figure (3) is showing it. Upper density of track was in sample F₉, while lower density of track was in sample F₁₁ as shown in Figure (4).

Table 2. ²²²Rn Concentration (Bq/m³) and Alpha track densities measured in the fertilizers samples.

S.C	Track Density (Track.mm ⁻²)	²²² Rn Concentration (Bq/m ³)
F1	0043	009.95
F2	0011	002.55
F3	0048	011.11
F4	0037	008.56
F5	0056	012.96
F6	0292	067.59
F7	0006	001.39
F8	0368	085.19
F9	2562	593.06
F10	1194	276.39
F11	0000	BLD*
F12	1853	428.94
F13	0084	019.44
F14	0067	015.51
F15	0018	004.17
F16	0029	006.71
F17	0077	017.82
F18	0225	052.08
F19	0221	051.16
F20	0268	062.04
F21	1725	399.31
Min.	0000	BLD
Max.	2562	593.06
Ave.	437.33	101.23

BLD*: below limit detection

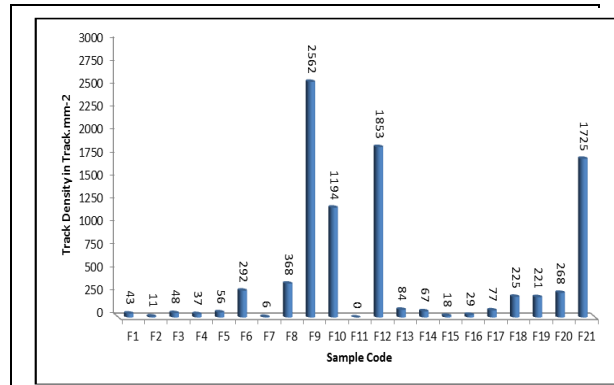


Fig. 3. Maximum and minimum concentration of ²²²Rn of fertilizers samples.

From the Figure (3), it is demonstrated that the higher concentration of ²²²Rn was in the sample F₉ (DAP) fertilizers.

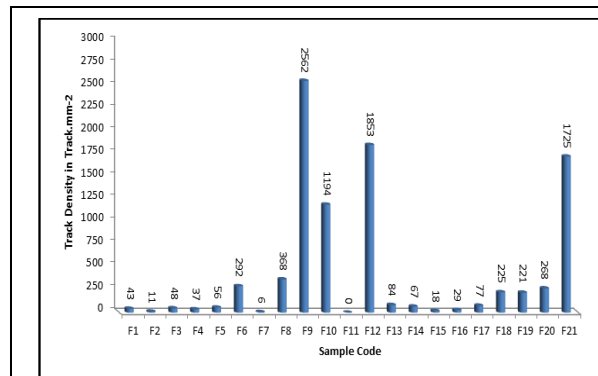


Fig. 4. Alpha track density measured in the fertilizers samples.

S.C	Origin	Kind of fertilizer	Track Density (Track. mm ⁻²)	²²² Rn Concentration (Bq/m ³)
F8	CHINA	CALCIUM NITRATE	0368	085.19
F2	TUNIS	DAP	662.50	153.36
F9	JORDAN			
F11	JORDAN			
F17	CHINA			
F19	SPANSH	FERTIUM MAXIMA	0221	051.16
F10	FILANDA	HEDROCO MPLECS	1194	276.39
F21	TURKY	HEDROCSI DE	1725	399.31
F4	IRAQ	K ₂ SO ₄	0037	008.56
F20	GERMANY	KEKKILA	0268	062.04
F1	IRAQ	NPK	450.6	104.30
F3	JORDAN			
F12	RUSSIA			

F13	INDENOSI			
F18	IRAQ			
F16	LEBANON	NSP	0029	006.71
F5	IRAN	OPROFERT SIMONIS	0056	012.96
F15	IRAN	PPC	0018	004.17
F6	LEBANON	SSP	0292	067.59
F14	IRAQ	SULFUR	0067	015.51
F7	KSA	URA	0006	001.39
Min.			0006	001.39
Max.			1725	399.31
Ave.			385.29	89.19

F12	428.94	312.37
F13	019.44	014.16
F14	015.51	011.29
F15	004.17	003.03
F16	006.71	004.89
F17	017.82	012.98
F18	052.08	037.93
F19	051.16	037.26
F20	062.04	045.18
F21	399.31	290.79
Min.		BLD
Max.		431.89
Ave.		073.72

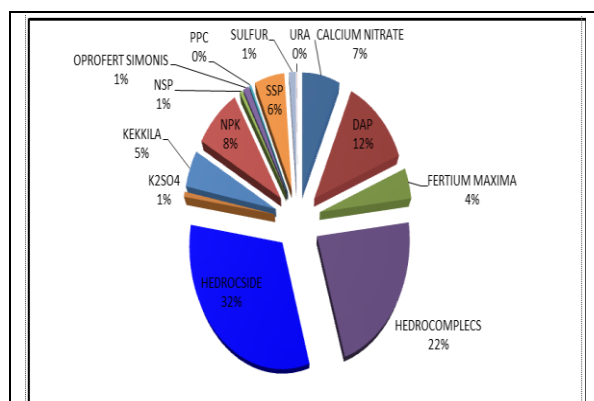


Fig. 5. Percentage contribution of ²²²Rn Concentration (Bq/m³) in average of each kind of fertilizers samples.

Figure (5) displayed that the highest rate of ²²²Rn Concentration was in sample F₂₁(Hedrocside) – Turkey origin – and this may return to element of Potassium who is there in one of its components (KOH) .

Table 4. Radon exhalation rate (mBq/m².hour) in fertilizers samples.

Sample Code	²²² Rn Concentration (Bq/m ³)	Radon exhalation rate (mBq/m ² .hour)
F1	009.95	007.25
F2	002.55	001.85
F3	011.11	008.09
F4	008.56	006.24
F5	012.96	009.44
F6	067.59	049.22
F7	001.39	001.01
F8	085.19	062.04
F9	593.06	431.89
F10	276.39	201.28
F11	000.00	000.00

For all fertilizers samples, the radon exhalation rate of, E, was calculated using equation of E in Table (4) too. The radon exhalation rate for the studied samples was also calculated. The values ranged from 0 (mBq/m².hour) in F₁₁ to 431.89 (mBq/m².hour) in F₉ with an average value of 73.72 (mBq/m².hour) as shown in Figure (6).

From figure (6), it is realized that the Radon exhalation rate for all fertilizers samples were below the maximum permissible limit 57.6 (Bq/m².hour) for exhalation [14].

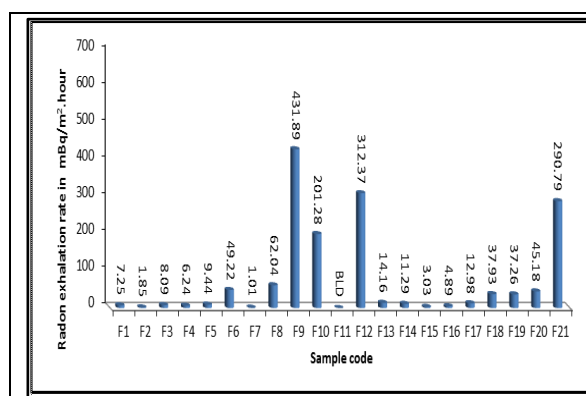


Fig. 6. Radon exhalation rate (Bq/m².hour) in fertilizers samples.

4. Conclusions

From present inquisition, we can conclude that: density of the alpha tracks for all fertilizers samples were varying with the nature of fertilizers added to the soil. It may be due to the changing of level

in radio nuclides in the fertilizers used for the growth of plants.

It can be deduced that the highest average radon gas concentration in fertilizer samples was existed in Di-Ammonium Phosphate sample (F₁₁), which was 593.06 Bq/m³ (made in Jordan), whereas the lowest average radon gas concentration in fertilizer samples was subscribed in Di-Ammonium Phosphate sample (F₉), which was 0 Bq/m³ (made in Jordan) too. The present results show that the Radon exhalation rate for all fertilizers samples were below the maximum permissible limit 57.6 (Bq/m².hour) for exhalation.

5. Reference

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