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Measurement of Radon Concentration in Fly Ash Samples from Electric Power Stations in Iraq in The Middle & South by using Nuclear Track Detector CR-39

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Abstract

In this study, concentrations of Radon were measured for fifty two samples of Fly Ash taken from five thermal power plants in the middle and south of Iraq [Al-Rashed, Al-Dura, Al-Musaeb, Al-Naserya, Al-Basrah (AlHaretha)].

The radon concentrations in samples measured by registrat alpha-emitting radon (^{222}Rn) by using (*CR-39)* track detector, The concentrations values were calculated by a comparison with standard samples The results shows that the radon concentrations is between (91.931-30.645 Bq/m^3)

Keywords: Radon concentration, Fly Ash, nuclear track detector CR-39.

قياس تركيز الرادون من بعض عينات الرماد المتطاير من محطات توليد الكهرباء في وسط وجنوب العراق باستخدام كاشف الأثر النووي CR−39

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الخلاصة

تم في هذا البحث قياس تراكيز غاز الرادون لاثنان وخمسون عينة من عينات الرماد المتطاير المأخوذة من المحطات الحراريه الكهربائية في وسط وجنوب العراق (الرشيد، الدورة، المسيب، الناصرية، البصرة (الهارثة)) وتم ايجاد تراكيز الرادون Rn222عن طريق تسجيلِ اثار بواعث ألفا المنبعثة من غاز الرادون (222Rn) في كاشِف الأثر النووي (CR−39) تم تحديد التراكيز بالحسابات المعتمدة بالمقارنة مع العينات القياسية، ومن خلال النتائج المستحصلة وجد ان تراكيز الرادون تروحت مابين Bq/m3 (91.931−30.645).

Introduction

Radon is a gaseous element discovered by German physicist Friedrich Ernst Dorn in 1900. Radon is a colorless, odorless, tasteless inert gas. The atomic radius is 1.34 angstroms and it is the heaviest known gas (density = $9.73 g/l$), (about eight times denser than air). Because it is a single atom gas (not a molecule) it easily penetrates many common materials like paper, leather, low density plastic, most paints and building materials like gypsum board, concrete block, mortar, wood paneling and most insulations [1].

Radon has a heavily neutron-rich nucleus that makes it a radioactive element. It is an alpha emitter that decays with a half-life of 3.8 days. Radon gas is most important source of ionizing radiation

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among those that are of natural origin [1]. The most important isotope in terms of environmental effects is (^{222}Rn) which is formed from the α-decay of radium (^{226}Ra), which is a decay product of uranium (^{238}U).

Radon gas can diffuse or be transported to some distance through fissures in the rock structure and find its way into the soil and surrounding material. Therefore, radon measurement is the most promising method for detecting uranium deposits.

A can technique which used in this study based on the registration of alpha tracks from ^{222}Rn on alpha sensitive track detector that was developed for uranium or radon exploration. The detector is exposed to the soil gas to know length of time. The ^{222}Rn alpha tracks are registered on the detector. The alpha track density gives a measure of ^{222}Rn concentration in the soil. As it is a very simple technique, it can be implemented easily for field studies, since they do not require electronic system [2].

Nuclear track detector is one of the most popular detectors used to study the nature of damage product by heavily ionization radiation such as alpha particle or fission fragment, the technique of measuring the number of particle by observing their track in certain organic or inorganic materials has been used for the study of phenomena in such diverse fields as geology, astrophysics, and nuclear physics.[7] The technique based on the damage created in a solid along the path of heavily ionizing particle as it is a very simple technique, it can be implemented easily in field of studies, since it does not require electronic system.[3,4]

Experimental Part

1. Collection of Fly Ash samples

Fly ash samples were taken from twenty five locations from electric power plants , Then the samples were cleaned, dried in an oven at 70 ^{o}C for few hours about 7hours finally they were powdered and sifted by using special sieve 250 μm in diameter [8].

2. Irradiation of the detectors.

For measuring Radon ,each sample was taken with 100gm weight and placed in plastic can which have 7cm high and 5cm diameter . The dimensions of the can minimize the effect of Thoron gas.

Pieces of CR-39 track detectors 1× 1 cm area were fixed under the cover of plastic can and with thickness about 200µm,the detector thickness varies from manufactured to another one and its about 200 to 250 µm The exposure time was 30 days, as shown in Figure-1[9].

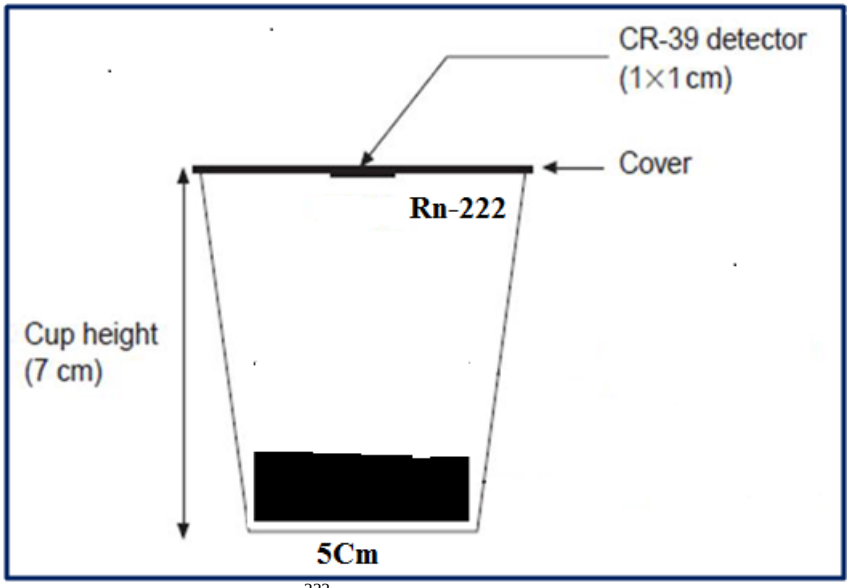

Figure 1- Radon gas (^{222}Rn) estimation by using (CR-39) detector.

3. Chemical etching and microscopic scanning

After the exposure time, the detectors were etched in a 6,25 N aqueous solution of NaOH maintained at 70 ˚C in a water bath for 7hrs, which was the normal employed etching time[8,9]. The detectors were then taken out from the etching, rinsed with distilled water and dried in air. The track density was recorded using an optical microscope with (400x) to account the number of tracks per cm^2 occured in each detactor an optical microscope with a CCD camera Figure-2.

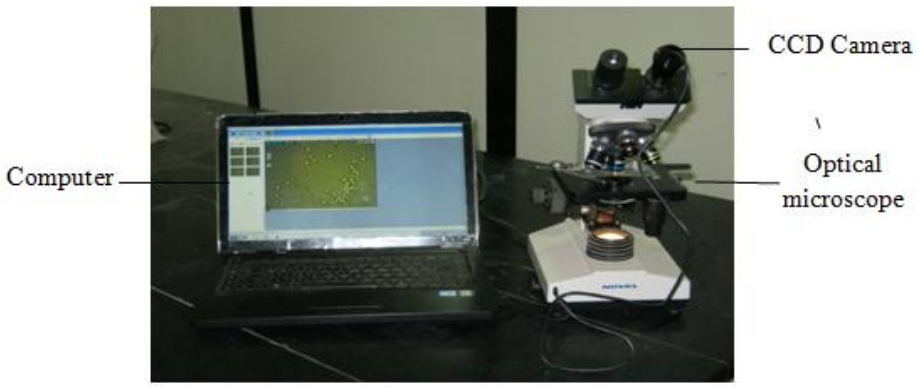

Figure 2- The track's image in the field view and the track counting system

Results and conclusion

Table-1 shows us Radon concentration in fly ash samples in thermal electrics power stations in the middle and south of Iraq.

Table-2 shows us thermal electrics power station The first power station starting from Al-Dura electrical thermal power station That we collected about **12** samples That we have begun in the table in **S1 to S12** then Al-Rasheed thermal power station which collected about **14** samples which have begun in **S13 to S26** samples then Al-Musaeeb thermal power station which collected about **11** samples which have begun from **S27 to S37** then Al-Basra thermal power station which called Al-Haretha which collected about **8** samples which have begun from **S38 to S 45** and finally from Al-Naserya thermal power station which collected about **7** samples which have begun from **S46 to S 52.**

From Table-1, we find that the maximum value of Radon was (1847.29064 Bq/m^3) in sample **S36** from Al-Musaeeb electric power plant and the minimum value of Radon was (64.0394Bq/m^3) in sample **S44** from Al-Basra(Al-Haretha) electric power plant.

We find that the Radon levels in the fly ash samples produced by thermal electric power station within the acceptable value from (S2 to S52) samples except samples (S1,S5,S7,S8,S9,S10,S12,S15, S18,S29,S32,S33,S37,S40,S42,SS44,S45and finally S49) That the convergence of the standard value of the specific from ICRP.

As a conclusion of this study radon concentration in this plants is within the normal level in some of it which around 11.8ppm which equaled to (200-800) Bq/m^3 [10].

Table 1- Radon concentration in fly ash samples

Code	ρ=Tracks/N(10)*A(0.0196)*T(30*24hr)	CRn=ρ/Ki(2.03)
S1fom Al-Dura	1600	788.1773399
S2	2100	1034.482759
S3	1700	837.4384236
S4	2400	1182.26601
S5	1000	492.6108374
S6	1900	935.9605911
S7	600	295.5665025
S8	700	344.8275862
S9	900	443.3497537
S10	1100	541.8719212
S11	2600	1280.788177
S12	1400	689.6551724
S13 from Al-Rasheed	3300	1625.615764
S14	2800	1379.310345
S15	800	394.08867
S16	2500	1231.527094
S17	1800	886.6995074
S18	200	98.52216749
S19	2000	985.2216749
S20	1200	591.1330049
S21	300	147.7832512
S22	750	369.4581281
S23	575	283.2512315
S24	1669	822.1674877
S25	2600	1280.788177
S26	1750	862.0689655
S27 from Al-Musaeeb	2115	1041.871921
S28	3125	1539.408867
S29	1450	714.2857143
S30	1992	981.2807882
S31	3300	1625.615764
S32	650	320.1970443
S33	1230	605.91133
S34	250	123.1527094
S35	1663	819.2118227
S36	3750	1847.29064
S37	340	167.4876847
S38 from Al-Basra (Haretha)	1810	891.6256158
S 39	300	295.566502
S40	562	276.8472906
S41	3400	1674.876847
S42	1350	665.0246305
S43	2200	1083.743842
S44	130	64.03940887
S45	1563	769.9507389
S46from Al-Naserya	2400	1182.26601
S47	1985	977.8325123
S48	3100	1527.093596
S49	1300	640.3940887
S50	2300	1133.004926
S51	3000	1477.832512
S52	2900	1428.571429

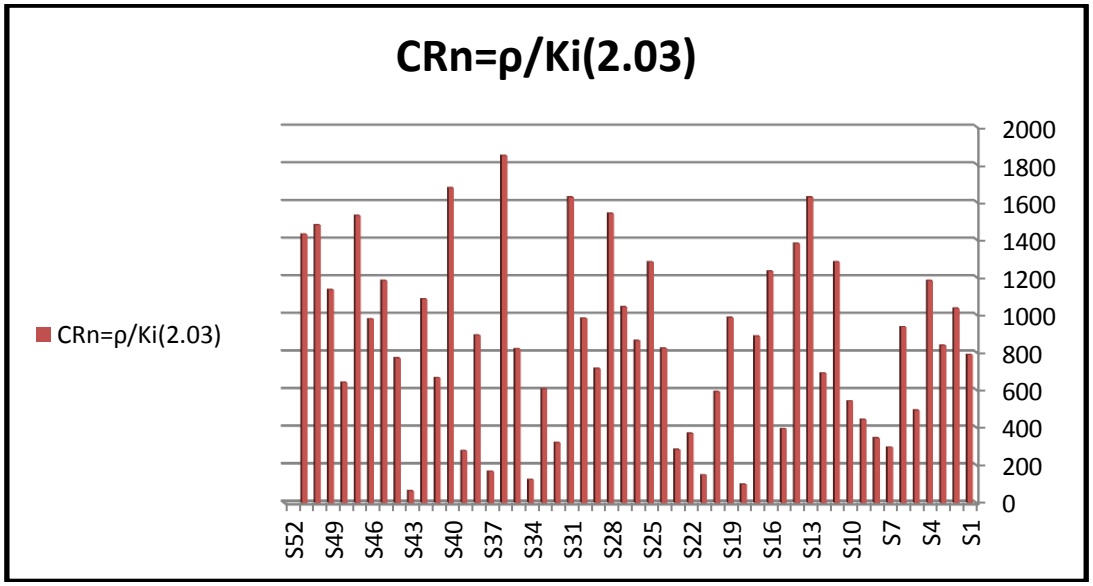

Table 2- Samples of Electric Power station in the middle & south of Iraq

S.No	AL-DURA from S1 to S12	South of Baghdad from S13 to S26	BASRA from S38 to S 45	NASERYA from S46 to S 52	Musaeeb From S27 to S 37
S1	From chimney unit 6 DPS	From unit 2 inside the chimney	From inside the oven below	Furnace No. 4 of the middle	air heater -B
S2	From the inside of Chimney 2	From the chimney 2	From the bottom of the oven	Furnace No.2 of the middle	air heater -A
S3	The outside of the atmosphere from chimney 1	from unit 3 Before entering the filter	From the bottom of the inside of the oven	ID FAN B+Y	from Chimney2
S4	Topside Of the chimney3	The second duct of unite 3	From the bottom of the oven from Externally	Furnace No. 4 of the middle Near the door	Canutat torches
S5	From inside Of the chimney 5 down of Circle	From chimney 4	A sample of the area 1,2,3	ID FAN B+Y Site 2	DECT torches back down
S6	From the outside near the Boiler	Before entering the Chimney	Floor furnace	Tracks Site 3	DECT torches down the front
S7	From inside the Boiler unite 4(fossil)	From the inside of the chimney (the gate)	The bottom of the oven from abroad	Tracks 4	G.R Fan Rotate the heated gases
S8	From precipitator (Economizer)	from unite 2 The foreign second gate	A sample of the area S H		Flattened rear Supreme torches
S9	From outside the precipitator	From the third baskets			Flattened the front torches Supreme
S10	From the right side	Before entering into the engine			The main gate of the furnace bottom of the oven(hoper)
S11	From the left side	After coming out of the engine			steem drum (Remnants drums)
S12	From the middle	from the chimney4 the right of unite 3			
S13		from the chimney4 the left of unite 3			
S14		from the chimney2 the center of unite3			

Reference:

1. Shakir Khan, M., Srivastava, D. S. and Ameer Azam. **2012**. Study of radium content and radon exhalation rates in soil samples of northern India. Environmental Earth Sciences,Environ Earth Sci DOI 10.1007/s12665-012-1581-7.
2. Deepak Verma, M. Shakir Khan and Mohd. Zubair. **2012**. Assessment of effective radium content and radon exhalation rates in soil samples J Radioanal Nucl Chem DOI 10.1007/s10967-012-1694- 1.
3. Rohit Mehra, Surinder Singh and Kulwant Singh.**2006**. A Study of Uranium, Radium, Radon exhalation rate and indoor radon in the environs of some areas of the malwa region, Punjab, International Society of the Built Environment, *Indoor Built Environ*, 15, pp: 499–505.
4. Munazza Faheem, Matiullah .**2008**. Radon exhalation and its dependence on moisture content from samples of soil and building materials, *Radiations Measurement*, 43, pp: 1458-1462.
5. Shakir Khan, M., Naqvi, A.H., Azam, A. and Srivastava, D.S.**2011**. Radium and radon exhalation studies of soil, *Iran. J. Radiat. Res.*, 8(4), pp: 207-210.
6. Narayanan K.K, Krishnan D. and Subba Ramu M.C.**1991**. Population exposures from natural and man-made sources of ionizing radiation in India. Indian Soc of Rad Phys, Report No. ISRP (K)-BR-3.
7. Kumar, R., Mahur, A. K., Sengupta, D. and Prasad, R.**2005**. Radon activity and exhalation rates measurements in fly ash from a thermal power plant. *Radiat. Measurements*, 40, pp: 638–641.
8. Somogyi G. **1986**. Track detection methods of radium measurements. Atomki pre print, *International Journal of the Physics Science*, E 25(28), pp:696-699.
9. Mahur, A.K., Khan, M.S., Naqvi, A.H., Prasad, R., Azam, A. **2008**. Measurement of effective radium content of sand samples collected from Chhatrapur beach, Orissa, India using track etch technique. *Radiat Meas* 43(Supplement1), pp:S520–S522.
10. Sen, J.K., Alam, M. M., Kabir, M. I., Asaduzzaman, K. and Rafiuddin M.**2006**.Measurement of alpha emmitter's concentrations in some soft drinks, Bangladesh. *Journal of Physics*, 2(1), pp: 35-50.