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MEASUREMENT OF RADON CONCENTRATION IN IRAQI AND IMPORTED CEMENT

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ABSTRACT:

The determination of the radon concentration that emitted from one of the important building materials which enter directly in our life, the cement ,is carried out by using Solid State Nuclear Track Detector (SSNTDs).The samples of cement from different origins {Iraq (*UM QASER, KOFA, ERBIL, SULAYMANIYAH) cement ,Iranian (SHAHREKORD, BOSHER,* SEPAHAN,*FARS) cement, Indian (SANGHI, HATHI), cement, Pakistani (EAGLE , CAMEL, FALCON) cement , Kuwaiti (Kuwait) cement, K.S.A.(* Al-QASEM *) cement and U.A.E. (*STAR, SHARJAH *) cement}* are collected. The results show that the average of maximum value of radon concentration was 37.188 Bq/m³ which emitted from *Pakistani cement,* and the average minimum value was 28 Bq/m³ which emitted from Iraqi cement. The range of the effective dose for workers in this field was from 0.1139 mSv/y to 0.2038 mSv/y and to the visitors of the locations of the production and stores of cement was from 0.0142 mSv/y to 0.0254 mSv/y.

INTRODUCTION:

Radon is a natural occurring radioactive gas which is a decay product of radium. It lies in the radioactive decay chain that begins with U-238 through a series to produce Ra-226 and subsequently Rn-222 gas and ending in Pb-206[1].Uranium found in soil, rock, granite, stone, water and building material [2,3], so one can say that radon may be found every where. The decay products of radon (Po-218, Po-214) are also alpha active and became airborne and attach themselves to the dust particles aerosols and water droplets in the atmosphere [3].

The exposure to high level of radon gas through breathing of air increases the risk of lung cancer, where alpha particles can cause damage to tissues as well as the DNA in the cells nuclei [4, 5]. Since cement is a commonly used building material, the natural level of radioactivity in it give rise to external exposure caused by γ-ray originating from the members of the uranium (U-238) and thorium (Th-232) and internal exposure mainly affecting the respiratory tract caused by the short-lived daughter products of

radon [6,7].However, the internal exposure to radon daughter products is more damage than that to radon gas itself because of their attachment on the lung tissue, while radon may exhaled.

In the present work, the concentration of radon gas emitted from cement of different origins is measured by using the Solid State Nuclear Track Detectors (SSNTDs) technique.

EXPERMANTAL:

For measurement of radon concentration in samples of cement, Solid State Nuclear Detectors (SSNTDs) type LR-115 (cellulose nitrate), manufactured by Kodak-Pathe, France, are used. The plastic track detector is cut into pieces of size 1 cm ×1 cm which are fixed inside plastic tubes of 5 cm in diameter and 10 cm in height. Each plastic tube contains a sample of cement of (87 gm) in the bottom as shown in Fig.(1).The samples of cement are collected from different types of Iraqi cement (different origins, trademark and factory) and group of imported cement to Iraq (Iranian, Indian, Pakistani, U.A.E., K. S. A. and Kuwaiti cement) .

After exposure time of 120 days, the LR- 115 detectors are collected and etched in 2.5 N of sodium hydroxide NaOH solution at a temperature 60 C° with etching time 90 min. At the end of etching process, the detectors were washed by distilled water and then dried. The count of alpha particles tracks achieved by using an optical microscope (type olompys) with magnification of (400 X).

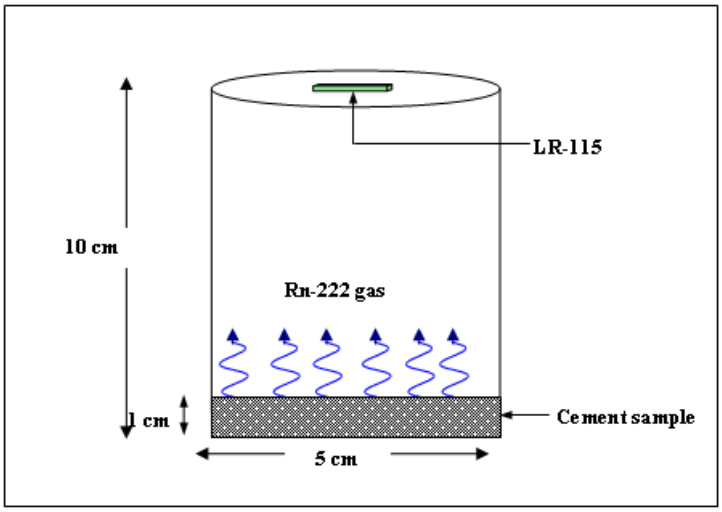

Fig. (1) The plastic tube used in this work.

RESULTS AND DISCUSSION:

The result of radon concentrations in cement samples were calculated by using the following relation [8].

$\mathbf{C}_{Rn}$ (Bq/m³) = $\mathbf{K}\ \boldsymbol{\rho}_c / \mathbf{T}_c$ …….. (1),

where $\mathbf{C}_{Rn}$ is the radon concentration by (Bq/m³) where 1Bq = dist/sec , **K** is the calibration factor by (Bq.d.m²/ Track.cm²), $\boldsymbol{\rho}_c$ is track density (T/cm²) where T is number of track , $\mathbf{T}_c$ is the exposure time for cement sample by days (d).

Table (1) shows the measured values of radon concentrations for different samples of cement Bq/m³ is appear in Pakistani cement of trademark *CAMEL*, and low concentration of radon gas 22.395 Bq/m³ in Iraqi cement of trademark *ERBIL*, while the results for the remainder samples of cement are ranged from 23.373 Bq/m³ to 38.104 Bq/m³ as shown in Fig. (2). However, where high value of radon concentration 40.069

the radon concentrations in all cement samples are found to be within the allowed values that given by International Commission of Radiation Protection (ICRP) agency which is 200-600 Bq/m³ for homes and 500 –1500 Bq/m³ for workplaces[9,10].

Table (1): The radon gas concentrations (Bq/m³) and working level month (WLM) for worker, visitor, and equivalent dose (mSv/y) for worker and visitor.

Sr#	Country	Cement Trademark	Label of Sample	Track Density (T/cm²)	Concentration of Radon (Bq/m³)	Working Level Month (WLM) for worker	Working Level Month (WLM) for visitor	Effective Dose (mSv/y) for worker	Effective Dose (mSv/y) for visitor
1	*IRAQ*	*UM QASER* *KOFA* *ERBIL* *SULAYMANIYAH*	I1 I2 I3 I4	152 167 114 137	29.855 32.801 22.395 26.909	0.03037 0.03337 0.02278 0.02737	0.00379 0.00417 0.00284 0.00342	0.1518 0.1668 0.1139 0.1368	0.0189 0.0208 0.0142 0.0171
	Average		I	143	28	0.02850	0.00355	0.1423	0.0177
2	*IRAN*	*SHAHREKORD* *BOSHER* SEPAHAN FARS	R1 R2 R3 R4	164 119 176 180	32.212 23.373 34.564 35.355	0.03277 0.02378 0.03516 0.03597	0.00409 0.00297 0.00437 0.00449	0.1638 0.1189 0.1758 0.1798	0.0204 0.0148 0.0218 0.0224
	Average		R	160	31.375	0.03192	0.00398	0.1595	0.0199
3	*INDEI*	*SANGHI* *HATHI*	D1 D2	182 194	35.747 38.104	0.03637 0.03877	0.00454 0.00484	0.1818 0.1938	0.0227 0.0242
	Average		D	188	36.926	0.03757	0.00469	0.1878	0.0234
4	*PAKSTAN*	*EAGLE* *CAMEL* *FALCON*	P1 P2 P3	190 204 174	37.319 40.069 34.176	0.03797 0.04076 0.03477	0.00474 0.00509 0.00434	0.1898 0.2038 0.1738	0.0237 0.0254 0.0217
	Average		P	189	37.188	0.03783	0.00472	0.1891	0.0236
5	*KUWET*	*KUWAIT*	K1	163	32.015	0.03257	0.00407	0.1628	0.0203
	Average		K	163	32.015	0.03257	0.00407	0.1628	0.0203
6	*K. S. A.*	Al-QASEM	S1	180	35.355	0.03597	0.00449	0.1798	0.0224
	Average		S	180	35.355	0.03597	0.00449	0.1798	0.0224
7	*U. A. E.*	STAR SHARJAH	U1 U2	177 149	34.765 29.266	0.03537 0.02977	0.00442 0.00372	0.1768 0.1488	0.0221 0.0186
	Average		U	163	32.015	0.03257	0.00407	0.1628	0.0203

The measurement of the exposure to radiation for the workers and visitors of the cement factories and stores is very important, and one can say that the exposure is mainly due to decay products of radon gas which may be inhaled by them. For that purpose, the radon concentration in Bq/m³ was estimated by working level (WL) unit. Progeny concentration in WL unit is obtained by dividing radon concentration in Bq/m³ by 3,700 and multiplying by equilibrium factor F which has been taken as 0.4, as suggested by UNSEAR,2000[10].

If a person is exposed for 170 h (1 month) to 1WL progeny concentration, the exposure is 1 Working Level Month (WLM). According to the ICRP-65 dose conversion convention, the effective dose per unit of exposure at work is 5 mSv per WLM [11].So that to calculate annual Working Level Month (WLM) and calculated the effective dose affecting both the workers and visitors to the locations of production or storing the cement one can use the following equation [12] :

$$WLM = \mathbf{C}Rn\ (Bq/m^3) \times F \times t\ /\ 3{,}700\ (Bq/m^3)\ \text{per WL} \times 170\ \text{h per WM} \quad \ldots\ldots\ldots\ldots (2),$$

where t is the time spent by a person in the location of production or storing the cement per year.

For worker who spent 8 h for five days in a week and for 40 week per year (1600 h /yr), while for visitors spent 1 h for five days in a week and for 40 week per year (200 h /yr). The values of WLM given in columns 7 and 8 in table (1) are calculated according to equation (2). Following the dose conversion convention of ICRP-65, the effective dose given in the last two columns of table (1) are estimated for each cement sample. In our results, the maximum value of effective dose received by workers was 0.2038 mSv/y and by visitors was 0.0254 mSv/y, which found in Pakistani cement of CAMEL trademark. On the other hand the minimum values were 0.1139 mSv/y and 0.0142 mSv/y for the exposure of workers and visitors, respectively, which found in Iraqi cement of ERBIL trademark. The International Commission of Radiation Protection ICRP-65 has recommended that remedial action against radon is justified above a continued effective dose of 3-10 mSv/y [13], while an action level within the range of 0.1423 mSv/y to 0.1880 mSv/y to workers and range of 0.0177 mSv/y to 0.0235 mSv/y to visitors. Thus, our measurement of radon concentrations that emitted from cement are below the recommendation of ICRP. The relationship between the effective dose and radon of concentration was found linear for workers and visitors as shown in Fig.[3]. .

CONCLUSION:

According to the results antecedent, one can conclude that the low average of radon gas concentration was equal to 28 Bq/m³ which was in Iraqi cement *(ERBIL cement*), and high average was 36.991 Bq/m³ in Pakistani cement (*CAMEL cement)*. Thus, all the results between the minimum and the maximum values were below the allowed by the recommendation of the International Commission of Radiation Protection (ICRP). In other word, the effective dose values are within the safety range for all samples of cement finally, the relationship between radon concentration and effective dose was found linear.

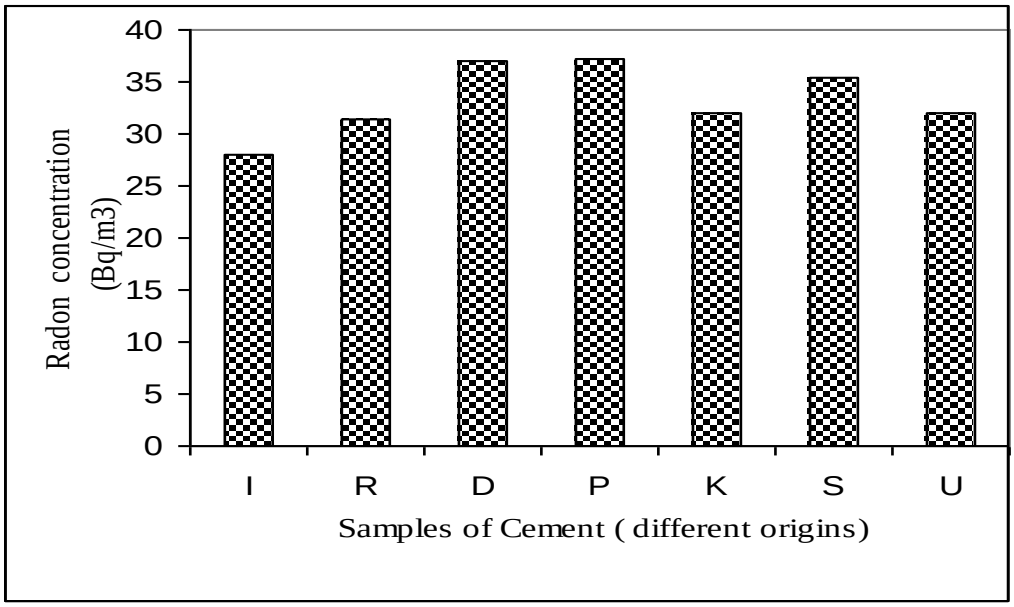

Fig. (2): Average of Radon Concentration (Bq/m3) to Different Samples of Cement .The labels I to U are given in the 4th column of table (1).

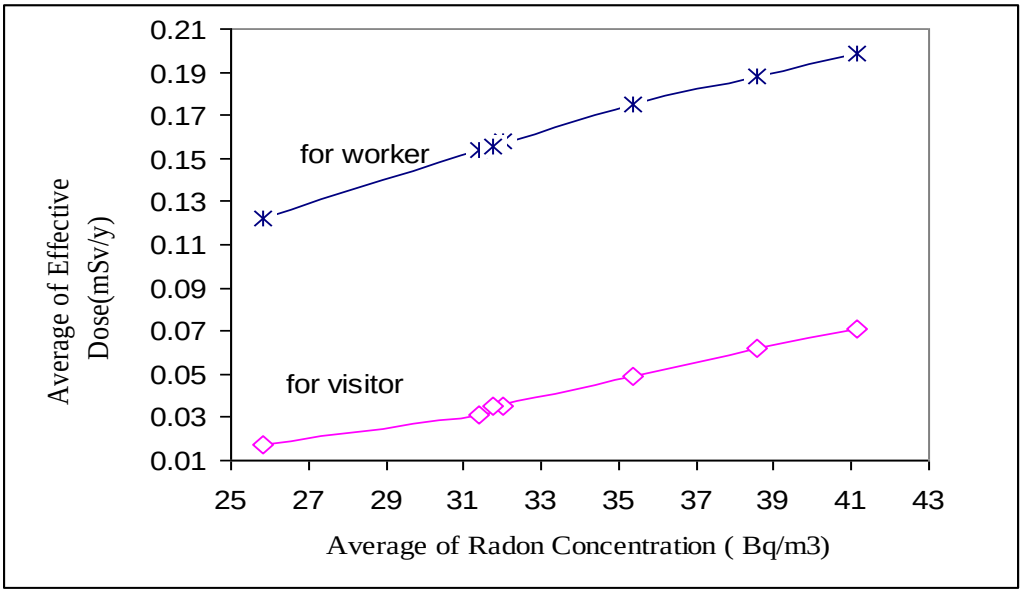

Fig. (3): Relation Between Average of Radon Concentration (Bq/m^3) and Effective Dose (mSv/y).

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الخلاصة:

الهدف من الدراسة هو تحديد تركيز غاز الردون−222 في واحد من أهم المواد التي تدخل الحياة مباشرتا.ألا وهو الاسمنت ,حيث جمعت نماذج الاسمنت من مناشئ اسمنت مختلفة؛ عراقية, إيرانية, هندية, باكستانية,كويتية, سعودية و إماراتية. النتائج اظهرت ان معدل اعلى قيمة لتركيز الرادون كانت 37.188 بيكرل لكل متر مكعب في الاسمنت الباكستاني ومعدل أقل قيمه لتركيز الرادون كانت 28 بيكرل لكل متر مكعب في الاسمنت العراقي. مدى الجرع المؤثرة للعاملين في هذا المجال كان من 0.1139 ملي سيفرت لكل سنة الى 0.2038 ملي سيفرت لكل سنة و لزائري مواقع أنتاج وتخزين الاسمنت فكانت من 0.0142 ملي سيفرت لكل سنة الى 0.0254 ملي سيفرت لكل سنة.