Determination of radon gas concentrations in cement samples by using nuclear track detector (CR-٣٩)

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Abstract

In the present work, we have measured the radon gas concentration in nine cement samples available from the local markets, and from different countries like, (Iraq ,China , Egypt ,Lebanon, India ,Iran, AL-Saudia,Jordan and Turkyi) by using alpha-emitters registrations which are emitted from radon gas in (CR-٣٩) nuclear track detector.

The results obtained have shown that the highest average radon gas concentration in cement samples which was (١٩٩.٩٩ $Bq/m^{٣}$) origin Iran, while the lowest average radon gas concentration in cement samples which was (٧٩،٩٩ $Bq/m^{٣}$) origin Iraq .The present results show that the radon gas concentration in all cements samples is below the allowed limit from (International Commission of Radiation Protection) (ICRP) agency.

Introduction

Radon (^{٢٢٢}Rn) is a radioactive noble gas with a half- life of about (٣،٨٢ d). It is produced by the decay of naturally occurring radionuclide (^{٢٢٦}Ra), which is in turn is a decay product in the uranium (^{٢٣٨}U) series. Thoron gas (^{٢٢٠}Rn), which is a radon isotope, is a decay product in the thorium (^{٢٣٢}Th) series. The half- life of thoron is about (٥٦ s) which is much shorter than that of radon. Because of a such a short half-life of thoron, its emanation from building materials such as cement ,as well as, its infiltration from the ground and further migration is restricted to a few centimeters only .When radon is inhaled into the lungs it decays by means of alpha-emission which causes ionization damage when it strikes the lung tissues. Over time, this damage might cause lung cancer [١].

Since radon is a gas, it may escape into the air from the material in which it is formed, and since uranium and radium occur widely in soil, rocks and sand, radon gas is ubiquitous ,outdoors as well as indoors. The radon gas has been recognized as a radiation hazard causing excess lung cancer among underground miners [٢].

Radon is the largest and most variable contributor of public exposure to radiation, it is estimated that the annual effective dose by radon and its progeny from the inhalation of air is about (٥٠٪) of natural public exposure dose rate and prolonged exposure to high levels of radon can cause lung cancer [٣]. Measurements of radon exposure has gained added significance because of the increased potential for lung cancer caused by the combined effects of radon, air pollution, and smoking [٤]. Humans are continuously exposed in homes and at working places to some ionising radiation emitted by radon, thoron and their corresponding progenies coming from building materials .Materials obtained from the earth's crust, such as building materials, may also contain traces of (^{٢٣٨}U) .These radionuclides decay to radon (^{٢٢٢}Rn). Prolonged exposure to radon may increase the risk of lung cancer [٥] because it delivers (٥٥٪) of the total dose to the cells of the respiratory system [٦]. Due to the relativelty long half-life of radon gas, it can reach from the earth's crust or from the walls and floors of buildings into both outdoor and indoor air. In the case of indoor air, the risk of exposure to radon is higher, especially for buildings with poor ventilation systems, which may lead to a higher indoor concentration of radon. In the last twenty years, more attention has been paid to the measurement of radon exhalation from building materials in many countries worldwide.

The aim of the present work is to determine the radon gas concentration in different kinds of cement which was available in the local market, some of them were Iraqi made and the others from different countries by using alpha-emitters registrations which are emitted form radon gas in (CR-٣٩) track nuclear detector.

Experimental Part

The determination of the concentrations of alpha particles emitted from radon gas in cement samples were performed by using the nuclear track detector (CR-٣٩) of thickness (٢٥٠ μm) and area of about (١×١ $cm^{٢}$).The radon gas concentration in cement samples was obtained by using the sealed-cup technique as shown in Fig. (١).

After the irradiation time (one month), the (CR-٣٩) track detectors were etched in (٦.٢٥ N), (NaOH) at temperature of (٦٠ C^{o}) for (٦ h), and the tracks density were recorded using an optical microscope with magnification (٤٠٠ x). The density of the tracks (ρ) in the samples were calculated according to the following relation.

$$\text{Track density } (\rho) = \frac{\text{Average number of total pits (tracks)}}{\text{Area of field view}} \quad \ldots\ldots(١)$$

The radon gas concentration in the cement samples were obtained by the comparison between track densities registered on the detectors of the sample and that of the standard cement samples which are shown in Fig.(٢), using the relation:

$C_x = \rho_x . (C_s / \rho_s)$ …..... (٢)

Where :

C_x : alpha particles concentration in the unknown sample.

C_s : alpha particles concentration in the standard sample.

ρ_x : track density of the unknown sample (track/mm٢).

ρ_s : track density of the standard sample (track/mm٢).

Results and Discussion

Our present investigation is based on the study of nine samples from different kinds of cement which was available in the local market, some of them were Iraqi made and the others from different countries like, (Iraq ,China , Egypt ,Lebanon , India ,Iran, AL-Saudia, Jordan and Turkyi) and found the radon gas concentration by using alpha-emitters registrations which are emitted form radon gas in (CR-٣٩) nuclear track detector.

Table (١) present radon gas concentration for cement samples in different countries, we can show that , the highest average radon gas concentration in cement samples which was (١٩٩,٩٩ Bq/m٣) origin Iran, while the lowest average radon gas concentration in cement samples which was (٧٩,٩٩ Bq/m٣) origin Iraq,see Fig. (٣) .

The present results show that the radon gas concentration in all cements samples is below the allowed limit from (International Commission of Radiation Protection) (ICRP) agency which is (٢٠٠ Bq/m٣) in soil sample [٧].

It might be mentioned that ,thoron gas is an alpha emitter which is also present in cement environments, however ,the average diffusion distance of thoron gas is very small compared to that of radon, which means that the present results might also contained a small amount of thoron , and therefore might be considered roughly as an upper limit results which are still within the allowed limit of (ICRP) agency . Also it should be remembered that the half –lives of radon and thoron are (٣,٨٢ d) and (٥٦ s) respectively. However ,the present result might be more refined be using , for example ,a filter to separate radon gas from thoron gas [٨].

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Table (١) the radon gas concentration for cement samples from different countries .

No.of sample	Region		Samples					
			١	٢	٣	٤	٥	Mean
١	Iraq	(Bq/m^{٣}) Radon Concentration	٢٧,٥٨	٦٢,٠٦	٧٥,٨٦	٩٦,٥٥	١٣٧,٩٣	٧٩,٩٩
		Track density (Track .mm$^{-٢}$)	٤	٩	١١	١٤	٢٠	١١,٦
٢	China	(Bq/m^{٣}) Radon Concentration	٣٤,٤٨	٤٨,٢٧	٧٥,٨٦	١١٧,٢٤	١٣١,٠٣	٨١,٣٧
		Track density (Track .mm$^{-٢}$)	٥	٧	١١	١٧	١٩	١١,٨
٣	Egypt	(Bq/m^{٣}) Radon Concentration	٤٨,٢٧	٨٢,٧٥	١٤٤,٨٢	١٤٤,٨٢	١٥١,٧٢	١١٤,٤٧
		Track density (Track .mm$^{-٢}$)	٧	١٢	٢١	٢١	٢٢	١٦,٦
٤	AL-Saudia	(Bq/m^{٣}) Radon Concentration	٣٤.٤٨	٥٥,١٧	٨٢,٧٥	١٢٤,١٣	١٣٧,٩٣	٨٦,٨٩
		Track density (Track .mm$^{-٢}$)	٥	٨	١٢	١٨	٢٠	١٢,٦
٥	India	(Bq/m^{٣}) Radon Concentration	٥٥,١٧	٨٩,٦٥	١١٧,٢٤	١٤٤,٨٢	١٩٣,١	١١٩,٩٩
		Track density (Track .mm$^{-٢}$)	٨	١٣	١٧	٢١	٢٨	١٧,٤
٦	Lebanon	(Bq/m^{٣}) Radon Concentration	٦٨,٩٦	١١٠,٣٤	١٥١,٧٢	١٥٨,٦٢	١٧٩,٣١	١٣٣,٧٩
		Track density (Track .mm$^{-٢}$)	١٠	١٦	٢٢	٢٣	٢٦	١٩,٤
٧	Jordan	(Bq/m^{٣}) Radon Concentration	٧٥,٨٦	١١٧,٢٤	١٤٤,٨٢	١٦٥,٥١	٢٠٦,٨٩	١٤٢,٠٦
		Track density (Track .mm$^{-٢}$)	١١	١٧	٢١	٢٤	٣٠	٢٠,٦
٨	Turkyi	(Bq/m^{٣}) Radon Concentration	٦٨,٩٦	١١٧,٢٤	١٨٦,٢	٢٠٠	٢١٣,٧٩	١٥٧,٢٣
		Track density (Track .mm$^{-٢}$)	١٠	١٧	٢٧	٢٩	٣١	٢٢,٨
٩	Iran	(Bq/m^{٣}) Radon Concentration	١٣١,٠٣	١٥١,٧٢	٢٠٠	٢٤٨,٢٧	٢٦٨,٩٦	١٩٩,٩٩
		Track density (Track .mm$^{-٢}$)	١٩	٢٢	٢٩	٣٦	٣٩	٢٩

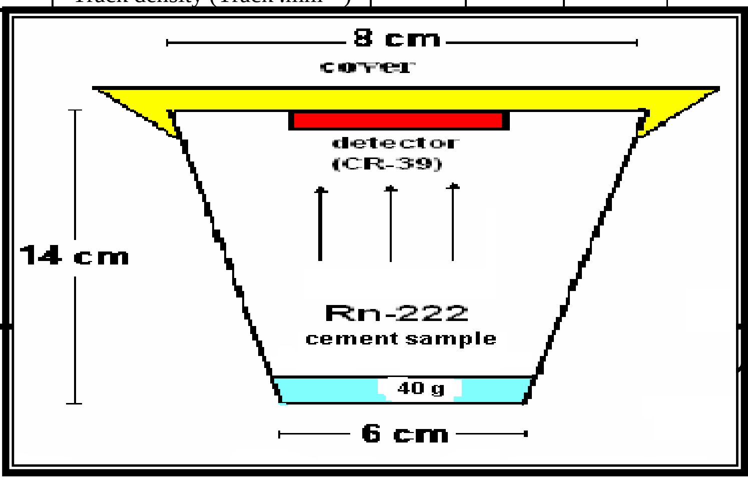

Fig. (١) A schematic diagram of the sealed-cup technique in cement sample.

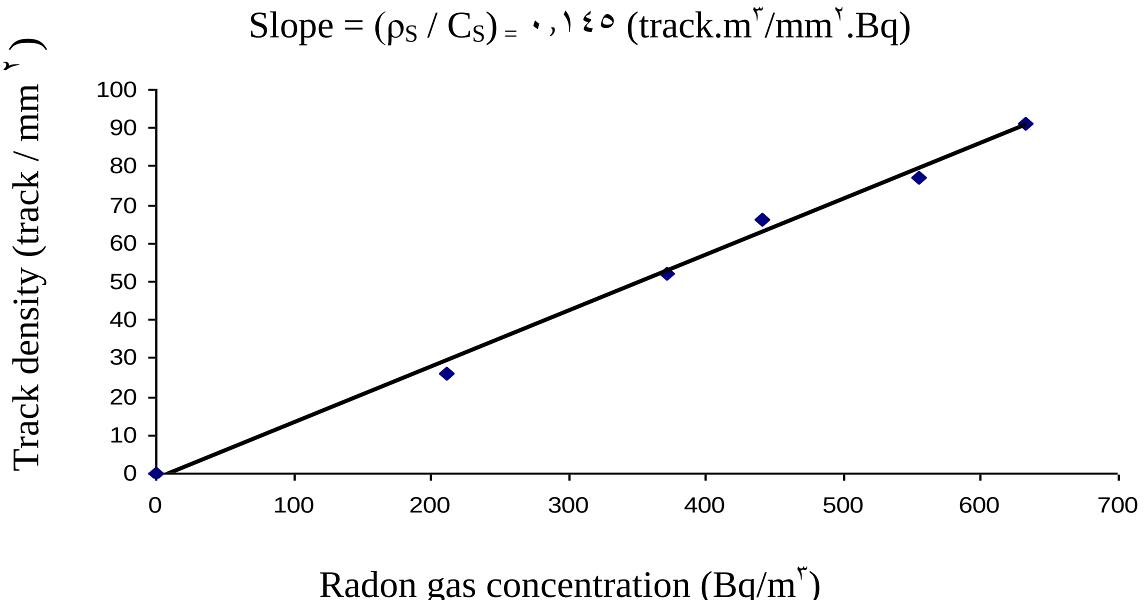

Fig.(٢) relation of radon gas concentration and track density in standard samples [٩].

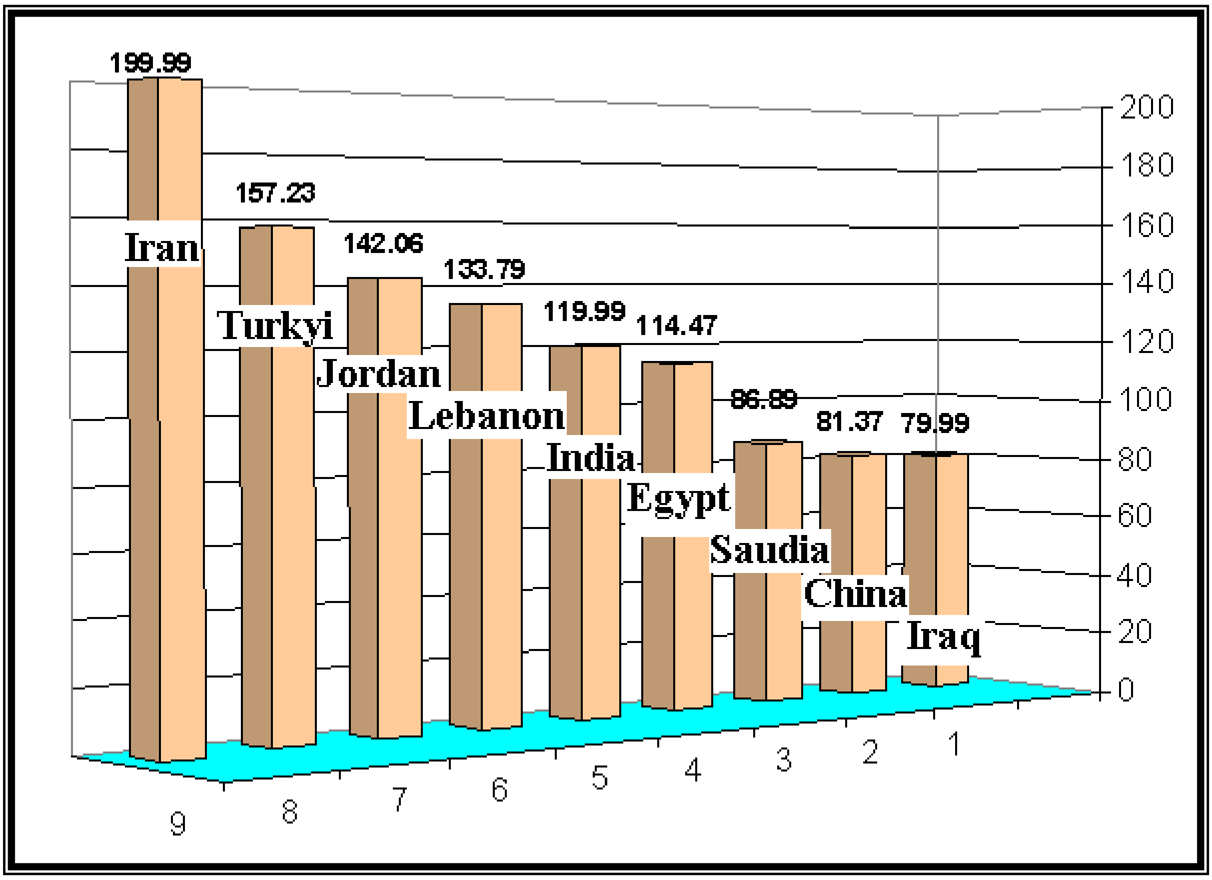

Fig.(٣) Radon gas concentration (Bq/m٣) in cement samples in all the standard samples.

حساب تراكيز غاز الرادون في نماذج الاسمنت باستخدام كاشف الأثر النووي (CR-٣٩)

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الخلاصة

في هذا البحث تم قياس تركيز غاز الرادون في تسعة نماذج من الاسمنت المتوفرة من الأسواق المحلية ولبلدان مختلفة (العراق, الصين, مصر , لبنان, الهند, إيران, السعودية , تركيا , الأردن) باستخدام تقنية عد آثار جسيمات الفا المنبعثة من غاز الرادون في كاشف الأثر النووي (CR-٣٩).

وقد أوضحت النتائج التي حصلنا عليها أن أعلى معدل لتركيز غاز الرادون في نماذج الإسمنت

($Bq/m^٣$ ١٩٩,٩٩) إيراني المنشأ, بينما كان اقل معدل لتركيز غاز الرادون في نماذج الاسمنت ($Bq/m^٣$ ٧٩,٩٩) عراقي المنشأ. النتائج الحالية تبين ان تركيز غاز الرادون في جميع نماذج الإسمنت كانت ضمن الحدود المسموحة للوكالة الدولية للوقاية من الإشعاع.