RADON DOSIMETRY USING CR_39 AS A TRACK DETECTOR

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Abstract

Solid state nuclear detector (CR-39) was used to obtain the concentration level of radon and its daughters, by using (Ra-266) of (10.54mCi) activity. It was employed for radon concentration and potential alpha energy exposure level. It is found increasing in track density with (absorbed dose, WLM, radon concentration in (PCi/liter), and potential alpha energy (PAEC)). The calibration curves were drawn by taking the linear part from the above curves. There is decreasing in absorbed dose with distance from the source. The linear response determine the detector range of (300-3X10^4 Bq/m³), and the calibration factors was obtained for calibration (0.2 ± 0.085 track/ mm^2 per Bq/m^3).

Introduction

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 50% of natural public exposure dose rate and prolonged exposure to high levels of radon can cause lung cancer [1]. In recent years, interest in this subject has been increasing rapidly in Korea because of news that the radon concentration of underground water in some regions and air of some Seoul subway stations is higher than action guideline level of other countries [2-4]. Measurement 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 [5].The environmental radon concentration is a function of time and climate conditions. To monitor radon, both active and passive techniques have been developed. Active methods are usually used for short-term measurements of radon and for detailed investigations of individual sites under inspection. Passive methods are more suitable for the assessment of radon exposure over long time scales and can be used for large-scale surveys at moderate cost.

For that reason, many countries have performed large-scale radon surveys using passive monitoring devices, have assessed the public exposure dose rate from radon, and have adopted appropriate actions for protection against radon [6-9]. Therefore, the construction of reliable and inexpensive radon monitoring system to assess the radon exposure should be done first in Korea. In this work, radon cup using solid-state nuclear track detector (SSNTD), which have the ability to integrate over multiple day-long intervals of time at dwelling and buildings developed along with a track counting system. Additionally, the optimum etching condition is also found. The proposed system can be used for large-scale surveys of environmental radon[10]. Radon gas is naturally occurring radioactive gas produced by the natural radioactive decay of uranium and thorium chain. Rn_222($T_{1/2}$=3.8days) is a daughter product from the decay of radium Ra_226. Thoron Ra_220($T_{1/2}$=56S) is a daughter of thorium, Th_232,which is present in large amount in the earth's crust than radon[11-13].

Public exposure to radon and its radioactive daughters present in the environment results in the largest contribution to the effective dose received by human beings. Several countries have initiated large-scale measurements. Prevailing indoor Rn_222 levels in houses and reported levels range from a low of (9Bq/m^3) to a high value of order of (200Bq/m^3). Large scale measurements have since been carried out to identify dwelling having concentration in excess of (190Bq/m^3), which is the intervention level suggested by the U.S Environment Protection Agency (EPA)[6]. EPA has suggested the intervention is required if the radon level is above (190Bq/m^3) for the estimation of the effective dose equivalent from Ra_222 daughters in (dose=33μSv/Bq/m^3) [14]. Table (1) shows the conversion factors, which are used in present work.

Table (1)
Conversion factors [15,16].

SI Units	Traditional unite conversion
Concentration (Bq/m^3)	**PCi/liter= 37Bq/m^3**
Potential alpha energy (PAEC)	WL=1.3X10-^{5}MeV/liter =2.08X10-^{7} J/m^3
Exposure rate	**WLM=4.11 J/m^3** WL=200 PCi/liter

The track detector inside the housing is CR_39]. The CR_39 plastic detector used in the present study is sensitive to alpha energies up to (40MeV) [14,15].

Experimental Part

In the present study strips of CR_39 films (Perhore Moulding, U.K, 300 μm thick) were exposed to the Ra_226 source for a known period of time, during which time alphas originating from Ra_222 and its daughters would leave tracks on it. The film was exposed to (300-3X10^4 Bq/m3) range of radon concentration. After retrieving the film, it was etched chemically in (6.25N) NAOH solution at (60^{0}C) for (5 hr.). The tracks were counted using an optical microscope having a magnification of 500 X.

جدول رقم (2)
يبين الجرع الاشعاعية المراد تشعيع الافلام بها وزمن التشعيع.

No. of film	R(cm)	T(hr)	D(mR)
1	170	4	10.84
2	125	4	20
3	79.2	4	50
4	64.5	4	75
5	56	4	100
6	39.7	4	200
7	27.9	4	400
8	122.6	96	500
9	86.7	96	1000
10	61.4	96	2000
11	43.4	96	4000
12	33.5	96	8000
13	27.4	96	10000

Results and Discussion

The calibration experiments were carried out to evaluate the relationship between the track density measured and the radon concentration as well as WL concentration. The results were presented in Figs. (3, 5, 7, 9). The calibration factor obtained from calibration experiments is (0.2 ± 0.085 track/ mm^2 per Bq/m^3) which were in a good agreement with other investigations [3,6]. There were increasing of track density with radon concentration. By selecting the linear part from the curves we determined the response range of our detector for the high doses [17] Figs.(2,4,8,10]. The dose is inversely proportional with radiation source distance Figs.(11,13),therefore the track density is directly proportional to the dose and inversely proportional to the distance from the source Figs.(12,14).

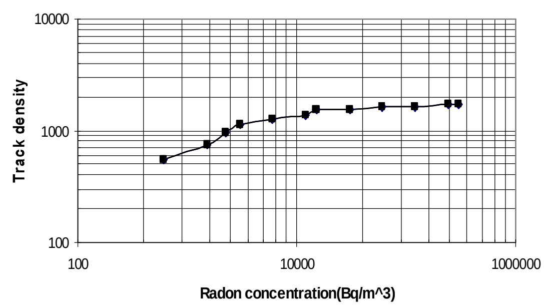

Fig. (1) : The relationship between the track density and the radon concentration.

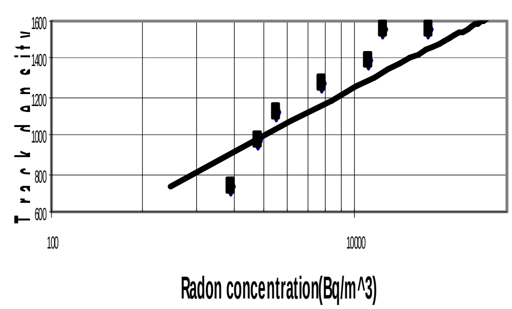

Fig. (2) : The relationship between the track density and the radon concentration.

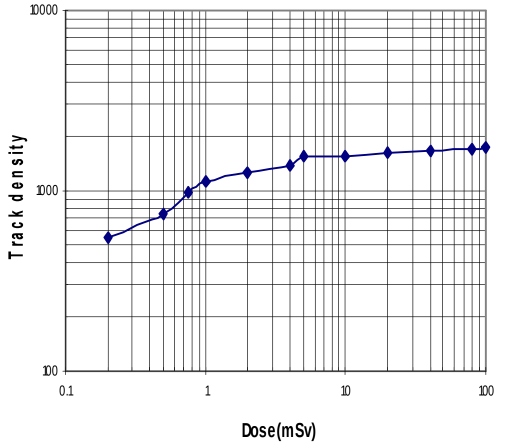

Fig. (3) : The relationship between the track density and the absorbed dose.

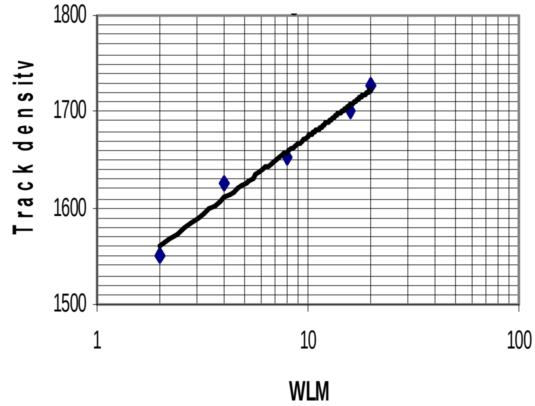

Fig. (6) : The relationship between the track density according to the WLM.

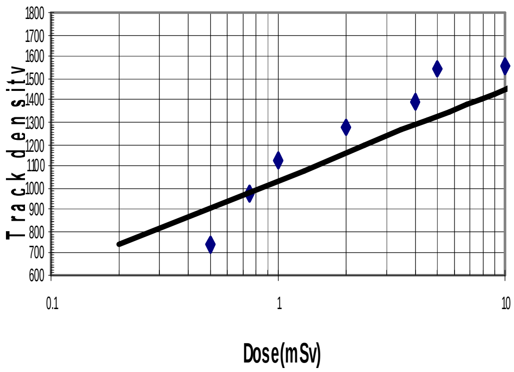

Fig. (4) : The relationship between the track density and the absorbed dose.

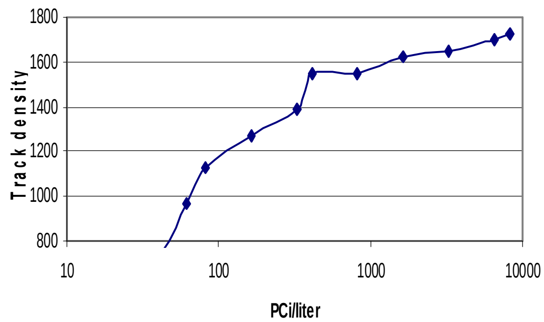

Fig. (7) : The relationship between the track density and the radon concentration.

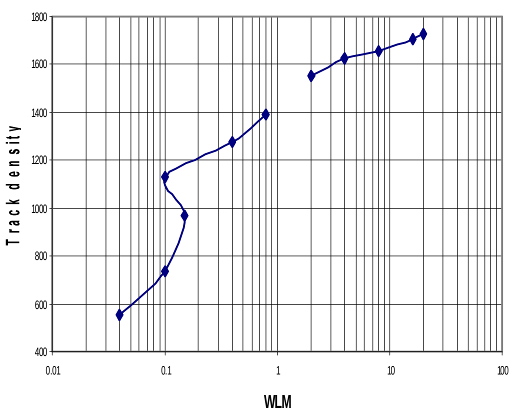

Fig. (5) : The relationship between the track density according to the WLM.

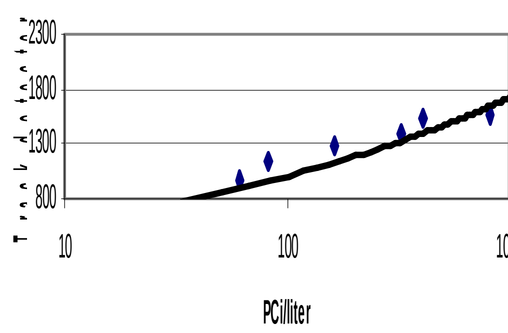

Fig. (8) : The relationship between the track density and the radon concentration.

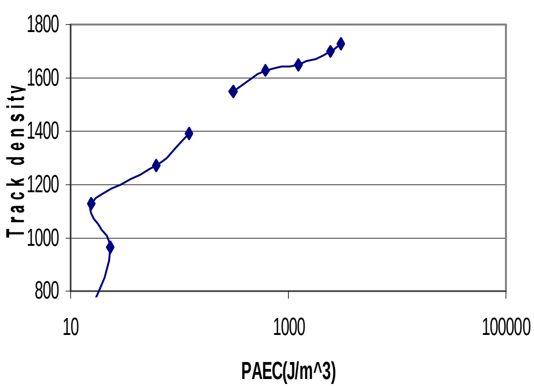

Fig. (9) : The relationship between the track density and PAEC.

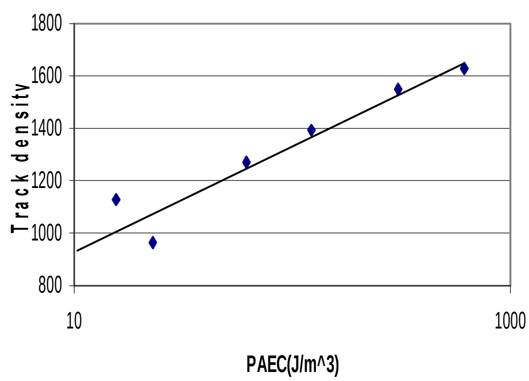

Fig. (10) : The relationship between the track density and PAEC.

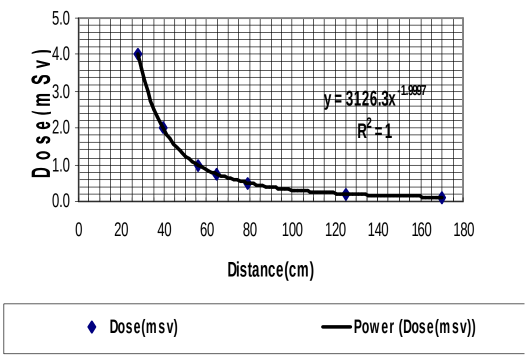

Fig. (11) : The relationship of absorbed dose according to the distance from the source.

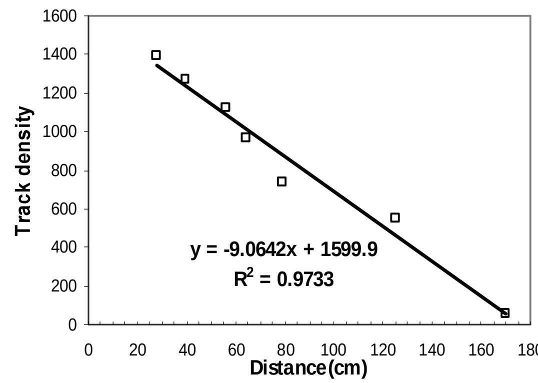

Fig. (12) : The relationship of absorbed dose according to the distance from the source.

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الخلاصة

استخدم الكاشف النووي الصلب (CR-39) للحصول على مستويات تركيزالرادون ووليداته باستخدام (Ra-266) وقد استخدم للحصول على مستويات للتعرض لتركيز الرادون و لطاقةاشعة الفا .ذي النشاط الاشعاعي (10.54 mCi) وجد تزايد في كثافة الاثر بازدياد(الجرعة الممتصة ، WLM ، تركيز الرادون(PCi/liter)، وطاقة اشعة الفا (PAEC)).رسمت منحنيات المعايرة و بأخذ الجزء الخطي من المنحنيات اعلاه.هناك تناقص في الجرعة الممتصة مع البعد عن المصدر.أن الاستجابة الخطية تحدد مدى الكاشف (300_3X10^4 Bq/m³) ، وتم الحصول على عامل المعايرة للتجربة (0.2 ± 0.085 track/ mm^2 per Bq/m^3) .