MEASUREMENT OF RADON IN DWELLING WITH LR-115 POLYMERS TRACKS DETECTORS IN DIYALA CITY (IRAQ)

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ABSTRACT

The natural background radiation which affects human beings can be divided into two types, external radiation and internal radiation. The total equivalent dose affecting to the population is greater than all other sources. The most important of these natural sources is the radon and its daughter hazard. The investigation in Diyala city (Iraq) shows that the radon concentration is 31 Bq m^{-3} which is higher than that observed in Karbala city 14 Bq m^{-3} (Al-khalifa et al 1993) and in An Nasiryah city 15 Bq m^{-3} (Al-khalifa , 2006). Interpretation of this measurement interms of building material as well as the emanation of radon from ground surface is also discussed.

الخلاصة

هناك أنواع مختلفة من الأشعة الطبيعية التي تؤثر على الإنسان فمنها الأشـعة الكونيـة والأشـعة المنبعثة من الأرض ومن المواد الطبيعية الموجودة فيها. وأهم هذه الأشعة هي الرادون التي يسـبب مـرض سرطان الرئة في الإنسان إثناء تواجده في محل سكناه نتيجة لاستنشاقه لكونه غاز. في هذا البحث تم دراسة تركيز الرادون في بعض الدور والمباني السكنية في محافظة ديالى (العراق) باستخدام تقنية كاشفات الأثـر للمواد الصلبة SSNTD وكانت النتيجة 31 Bq cm^{-3} وقورنت النتائج مع الدراسات التي أجريت في محافظة الناصرية 15 Bq cm^{-3} وكربلاء 14 Bq cm^{-3} وفسرت نتائج هذا البحث بالنسبة إلى مواد البناء المختلفة التي بنيت منها المباني والدور السكنية وكذلك بالنسبة إلى تأثير انبعاث الرادون من سطح الأرض.

INTRODUCTION

Radon is the heaviest member of the noble gases and is 7.7 times heavier than air, its density is 9.71 $g.\ell^{-1}$. Gaseous and liquid radon are colourless. It is more soluble in liquid organic compounds than water. Its solubility increases with decreasing of temperature.

The first four decay products of the radon isotopes have half-periods of less than 30 min (^{218}Po, ^{214}Pb, ^{214}Bi and ^{214}Po). These short-lived decay products commonly called "radon daughters" are responsible for a large portion of the α-particle dose delivered to the lung, if they inhaled with air. The long-lived daughters will be eliminated from the lung before any significant numbers of disintegrations of these isotopes has occurred. After it becomes obvious that there was a correlation between the lengthy exposure to high concentration of radon in uranium mines and an increase in the incidence of lung cancer in miner (Lovett, 1969), interest moved to the measurement of natural actively inside houses where the whole population of the earth are expanded and affected by it. The interest in building material and levels of radon and its daughters inside houses was investigated by (Abu-jarad et al 2003).

In Sweden it was realized that the concentration of radon and its daughters presented a serious problem. This is due to two reasons. The first reason was in order

to save energy the average rate of air exchange in newly houses decreased over the last 40 years resulting in corresponding increase in radon concentration. The second reason for the increase in radon concentration is the increased use of aerated concrete based on alum shale. This contained a high content of ^{226}Ra in which the average actively varies between (20 pci g^{-1}) and (65 pci g^{-1}). The use of this building materials has stopped since 1975. (Durrani and Bull, 1987).

Generally all building materials contains uranium and radium, so the exhalation of radon from these to the inside of the house is often the major source of radon inside the house. Soil under the house may be a significant source of radon inside a house if it contains relatively high levels of uranium and radium.

In the investigation the extreme sensitivity and cheapness of Solid State Nuclear Track Detector (SSNTD) have been used here in measuring radon and its daughters. This insulating solids which will store and register linear arrays of damage due to the passage of highly ionizing individual particles. In polymers the damage is due to irradiation effect of broken molecular chains and production of free radicals which increasing degradation of polymer chains. The models of track formation have been reviewed by Fleischer et al (1975).

EXPERIMENTAL TECHNIQUE

For radon and its daughters Solid State Nuclear Detectors (SSNTD) has been used in this investigation. This simple technique of particle track etching for radon dosimetry has been used due to several reason, that the advantage of using SSNTD, over other materials, arises from the following facts for example its cheap. No need for electric devices to be used during exposure, long periods of counting with large scale measurement are possible, without significant background of electronic noise and almost insensitive to backgrounds radiation such as β, γ and x-ray radiation.

Kodak LR-115 type II have been used as a detector to determine the average value of exposure for radon and its daughters in dwelling. The film is manufactured by Kodak-Pathe, France. The film has two layers. One support layer and one layer of cellulose nitrate.

The open naked strips of film was hanged by threads in the living room and bedroom for 120 days from the 5th of August to 3rd of December. After exposure the films are chemically etched in sodium hydroxide at 6.25N and 56.5°C for one hour (Al-khalifa et al, 1993). After etching the alpha particle tracks per film area is manually counted by light microscope type "Leize".

RESULTS AND DISCUSSION

To carry out the investigation, 100 houses were selected, Fig.(1) shows the location of radon measurement sites, their locations are situated in different locations not far from each other. The results are shown in Table-1-. The distribution of these measurements is shown in Fig.2. The arithmetic mean is 31 Bq cm^{-3} which is higher than that measured in Karbala 14 Bq cm^{-3} (Al-khalifa et al, 1993) and in An Nasiryah city 15 Bq cm^{-3} (Al-khalifa, 2006) in Iraq.

In this investigation two points arise that are worth noticing:

1- The effect of the ground or soil emanation in increasing the radon daughters concentration inside first floor rooms in the houses is shown clearly in Table-1- where the highest activity in the dwelling build from dry soil, there is no source for this activity other than the building material (dry soil). Despite the

higher ventilation rate in the first floor (windows most of the time open), the activity inside the first floors rooms is more than in the second floor ones.

2- The second point is illustrated in two different houses in which the rooms in second floor were similar except that the wall construction in one was thermiston and in the other was block. This shows that the Block bricks emanate more radon inside the room and in this case it will be the main source of the activity inside the room and hence we recommended to build the house by thermiston in order to reduce the hazard of radiation.

Floor	Building Material	Radon Concentration Bq cm^{-3}
1	**Concrete**	**31 ± 4**
1	**Block + Concrete**	**22 ± 2**
1	**Dry soil**	**50 ± 4**
2	**Bricks**	**15 ± 2**
2	**Thermiston**	**6 ± 1**
2	**Block**	**37 ± 4**

Table -1-

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IRAQ
TURKEY
SYRIAN ARAB REPUBLIC
ISLAMIC REPUBLIC OF IRAN
SAUDI ARABIA
KUWAIT
JORDAN
Hakkâri
Orūmīyeh (Umia)
Mīāneh
Mīāndowab
Zanjān
Al Qāmishlī
Zākhū
DAHŪK
Dahūk
'Aqrah
Rāyāt
Al Mawṣil (Mosul)
Sinjār
Tall 'Afar
NĪNAWĀ
ARBĪL
Arbīl
Ar Raqqah
Al Qayyarah
Kūysanjaq
Makhmūr
Al Ḥaḍr
AS SULAYMĀNĪYAH
As Sulaymānīyah
Sanandaj
Halabjah
Dayr az Zawr
AT TA'MĪM
Kirkūk
Bayjī
Tāwūq
Hamādān
Abū Kamāl
Euphrates
'Ānah
ṢALĀḤ AD DĪN
Sāmarrā'
Qaṣr-e Shīrīn
Khanaqīn
Kermānshāh
Al Qā'im
Al Ḥadīthah
DIYĀLĀ
Ba'qūbah
Borujerd
'Akāshāt
Al Walid
Al Ḥabbānīyah
Ḥīt
Ar Ramādī
Baghdad
BAGHDAD
Īlām
Khorramābād
Mehrān
Ar Ruṭbah
AL ĀNBAR
Al Falujah
Trebil
WĀSIT
Dehlorān
Karbalā'
BĀBIL
Al Ḥillah
Shaykh Sa'd
Al Kūt
Alī al Gharbī
Dezfūl
KARBALĀ'
Al Ḥayy
MAYSĀN
Al 'Amārah
Nukhayb
An Najaf
Ad Dīwānīyah
Abū Ṣukhayr
AL QĀDISĪYAH
Qal'at Sukkar
Qal'at Ṣāliḥ
Judayyidat 'Ar'ar
Qaryat al Gharab
DHĪ QĀR
Ahvāz
Ar'ar
AN NAJAF
AT Qumah
An Nāṣirīyah
As Samāwah
Khorramshahr
Abādan
As Salmān
Jaflbah
Al Basrah
AL BAṢRAH
AL MUTHANNÁ
Umm Qasr
Al Faw
Makhfar al Buṣayyah
Rafḥā
Al Jahrah
Kuwait
Persian Gulf
Al Aḥmadī
Ḥafar al Bāṭin
National capital
Governorate capital
Town, village
Airport
International boundary
Governorate boundary
Expressway
Main road
Secondary road
Railroad
0 50 100 150 200 150 300 km
0 50 100 150 200 mi
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
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Fig. (1)

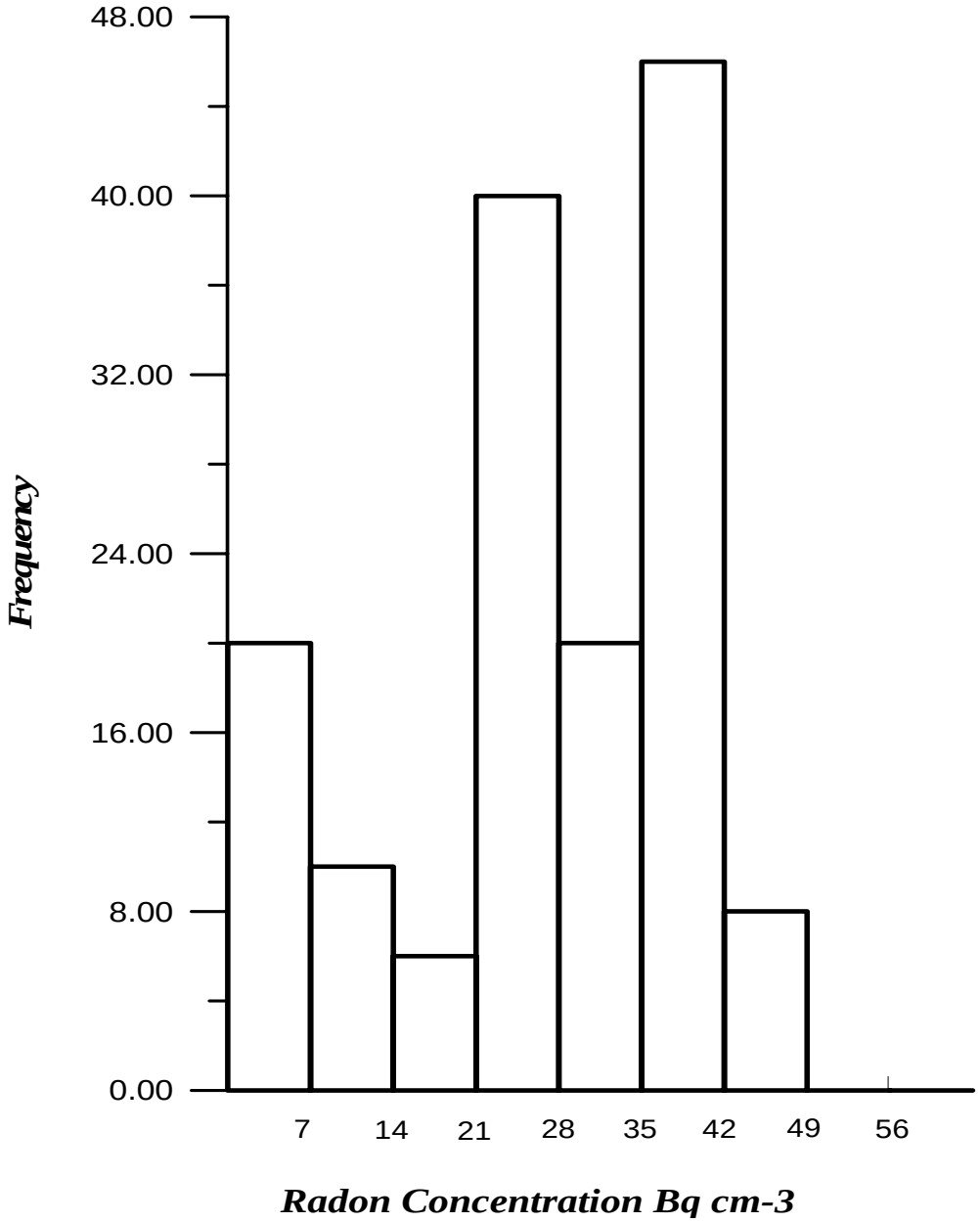
48.00
40.00
32.00
24.00
16.00
8.00
0.00
Frequency
7
14
21
28
35
42
49
56
Radon Concentration Bq cm-3

Fig. (2)

FIGURE CAPTURES:

Table -1- ; The results of measurements of Radon concentration in dwelling for different floors as well as different building materials.

Fig.(1) ☐ Localization of radon measured sites.

Fig.(2) ; The Frequency distribution of the concentration of radon in different houses in Diyala city (Iraq).