International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Research Article

Radon and Thoron Concentration of Shut al- Hella's water in Babylon Governorate

Assia Hamed Al-Mashhadany[a*], Alia Ahmad Kadhem[a] and Sadiq Hassen Lefta[b]

[a]Department of Physics, College of Science, Baghdad University
[b]Department of Laser, College of Women Science, Babylon University

Accepted 20 July 2013, Available online 01 August 2013, **Vol.3, No.3 (August 2013)**

Abstract

Exposure to radon and its daughter (Po-218 and Po-214) is one of the important contributions to radiation doses to members of public. Radon and thoron concentrations in Shut Al- Hella's water, Babylon governorate, were measured by using [RAD7-H_2O] radon detector manufactured by DURRIDGE COMBANY Inc. The results show that the higher activity of radon was 0.723 Bq/l in location 13 and low activity are (0.180) Bq/L in location 22. Generally, the thoron concentration is considered negligible because of the short lifetime of the thoron (55.6 sec). The contribution of thoron and its progeny can be ignored.

Keywords: *Radon, Thoron, Detector*

Introduction

Radon is the greatest source of the public exposure to radiation. The alpha particles emitted from the inhaled ^{222}Ra and especially from two of its progenies ^{214}Po and ^{218}Po, have high damaging potential to the lung tissue and are considered to be causative agent for lung cancer in human (Aleksender Kandic *et al*,2010)

The concentration level of radon naturally dissolved in water show a wide range. In surface water such as in lakes and rivers, the radon concentration levels are generally with very low values, while in underground waters, it had high value. Therefore, monitoring of radon levels in water is necessary and there are many studies aimed to measure radon in various water types in many regions worldwide (C. Cosma, *et al*,2008).

Exposure to radon can be done by two main sources: (1) radon in the air in the air of homes (frequently called radon in indoor air) and (2) radon in drinking water. Radon can get into the in breathing air and into the drinking water. It is similar to carbonated soda drinks where carbon dioxide is dissolved in the soda and is released when you open the bottle. ***Radon and thoron level in water and health effects***

A radon concentration of 300 pCi/L has been proposed by the U.S. Environmental Protection Agency (EPA) as a limit for radon dissolved in

A National Academy of Science report, estimates that radon in drinking water causes about 168 cancer deaths per year: 89% from lung cancer caused by breathing radon released to the indoor air from water and 11% from stomach cancer caused by consuming water containing radon.

Using of water in the dwellings may result in an enhanced indoor radon concentration levels. Such an increase in the indoor radon levels depends on the total consumption of water in the dwelling, the dwelling size and the air ventilation rate. It has been estimated that 1000 kBq/m^3 of radon in tap water would on average result in an increase in the indoor radon concentration level by 100 kBq/m^3 (UNSCEAR, 1988).

Generally, the thoron concentration in dwellings is considered negligible because of the short lifetime of the thoron (55.6 sec). the contribution of thoron and its progeny can be ignored.

It is well known that the main hazard from radon or thoron is not due to the gases themselves but to the radioactive decay products of these gases (Natasa Todorovic *et al*,2012).

Recognize that for every 10,000 pCi/L in water about 1 pCi/L will be released in the air. Projected or estimated risks of developing lung cancer from radon contaminated water...

1,000 pCi/L............3-13 in 10,000
10,000 pCi/L............3-13 in 1,000
100,000 pCi/L.............3-12 in 100 (Barnet J. M *et al*,1995)

The radon concentration of drinking water is an important issue from the dosimetry aspect, because more attention is paid to the control of public natural radiation exposure. The radiation dose due to radon can be divided into two parts, the dose from ingestion and the dose from inhalation. The committed annual effective dose

*Corresponding author: Assia Hamed Al-Mashhadany

contribution of citizens, taking ^{222}Rn concentrations in account, was calculated according to the formula:

E =¼ K ×C ×KM ×t (1)

where ***E*** is the committed effective dose from ingestion (Sv), K is the ingesting dose conversion factor of ^{222}Rn [10^{-8} Sv Bq^{-1} for adults, and 2×10^{-8} Sv Bq^{-1} for children (UNSCEAR,1993)], C is the concentration of ^{222}Rn (Bq L^{-1}), KM is the water consumption (2l day^{-1}), t is the duration of consumption (365days) .For the dose calculations, a conservative consumption of 2l day^{-1} per year for ‘‘standard adult’’ drinking the same water and directly from the source point was assumed (UNSCEAR,1993).The radon concentration of drinking waters decreases during storage, processing, etc. ,so by the evaluation of dose, the consumption of interest is that of water taken directly from the tap. Exposures to radon come mainly from the inhalation of the decay products of radon, which deposit in homogeneously within the human respiratory tract and irradiate the bronchial epithelium .According to the UNSCEAR report (UNSCEAR, 1993), 1 Bq m^{-3} of radon in air, with an equilibrium factor of 0.4 and occupation factor of 0.8, gives an effective dose to the lung of 25 µSv $year^{-1}$. Assuming the ratio between the radon concentrations in air released from water to that in water to be 10^{-4} gives an effective dose to the lung of 25 mSv $year^{-1}$ [7].

Experimental Part

Babylon is one of largest governorate in the middle of Iraq is situated on the longitude of 44^0 $14'$ 42 east and45^0 $12'$ 18 west , as well as on the latitude of 42^0 $47'$ 51 north and 32^0 $67'$ 03 south, its population 1.8 million.

Most drinking water in the governorate of Babylon is taken of the Shutt al-Hela, in the current research, samples were taken directly from the Shut al-Hella, and the other section of the samples were taken from the tap. figure-2-

RAD7 detector

The RAD7 radon detector manufactured by Durridge company Inc. {Fig-1-) has been used for the radon and thoron concentration measurement in the water samples. The lower limit of detection (LLD) is less than 0.37 Bq L^{-} The equipment is portable and battery operated, and the measurement is fast. A number of factors affect the accuracy and precision of a radon in water measurement. Most critical among these factors is the sampling technique. Other factor is to include the sample concentration, sample size, counting time, temperature, relative humidity and background effects. Sampling technique is generally the major source of error in measuring the radon content of water. The water sample must be representative of the water being tested and such that it has never been in contact with air. A bowl is put up to the faucet so that the water over flowing the bowl prevents the water when leaving the faucet from touching the air and the vial is filled with water at the bottom of the bowl. In the measurement, a 250 ml vial was taken for radon concentration less than 100Bq L^{-1}. If the radon concentrations higher than 100Bq/l, a 40 ml vial is used (N. U. Khattak *et al*,2011).

When sampling a tap water, water was let run for 10 min before taking the sample, in order to let out the water from the possibly stagnant pipe section, and to obtain parameters characteristic of the fresh water. The sampling vial (volume 250 ml) was placed in the bottom of the bowl, and the tube end was put into the vial. The water flow for a while, keeping the vial full and flushing with fresh water. The vial was cap while still under the water.

A relative humidity showed the greatest impact on measurement error in the presented results. For accurate readings, the RAD7 should be dried out thoroughly before making the measurement. If the RAD7 is thoroughly dried out before use, the relative humidity in side the instrument will stay below 10% for the entire 15 min of the measurement. If not, then the humidity will rise during that the RAD7 is counting and the pump is stopped, and may rise above 10% before the end of the measurement period. High humidity reduces the efficiency of collection So a rise in humidity above 10% over the last 10 min of the counting period will not have a significant effect on the accuracy of the result. On the other hand, if the humidity rises above 10% before the end of the first counting cycle, there will be an error whose size is in determinate (RAD7H2O).

The most significant background effect in the RAD7H_2O are counts from radon daughter sand traces of radon left from previous measurements. The RAD7 has the unusual ability to tell the difference between the ‘‘new’’ radon daughters and the ‘‘old’’ radon daughters left from previous tests. Even so, a very high radon sample can cause daughter activity that can affect then next measurement.

For the batch analysis of water samples. A vial containing a water sample is set up in a closed air loop with the RAD7. A preset protocol controls the RAD7 to make the measurement fully automatic. The RAD7 pump operates for five minutes to aerate the sample, distributing the radon that was in the water throughout the loop. The RAD7 waits a further five minutes while the ^{218}Po count rate approaches equilibrium and then counts for four five-minute cycles. The radon concentration in the water is calculated directly. The RAD H_2O accessory has been in use by testers and laboratories throughout the world for more than a decade.

The RAD7H2O method employs a closed loop aeration scheme whereby the air volume and water volume are constant and independent of the flow rate. The air is recalculated through the water and continuously extracts the radon until a state of equilibrium develops. The RADH_2O system reaches this state of equilibrium with in about 5 min after which no more radon can be extracted from the water. The extraction efficiency, or percentage of radon removed from the water to the air loop, is very high, 99% for a 40 mL sample and 94% for a 250 ml sample. The radon content of the water, at the time of the analysis, is the mean value shown in the print out. This value takes in to account the calibration of the RAD7, the size of the sample vial and the total volume of the closed air loop, as set up (RAD7H_2O). If a sample is analyses at a later time (rather than immediately), the sample’s radon

Table 1 Concentration of radon gas in Shut- al-Hella's water.

±S. D	Mean	Fourth reading	Third reading	Second reading	First reading	Sequence
0.682	0.417	0.724	0.433	0.222	0.22	w_1
0.658	0.615	0.288	0.869	0.435	0.435	w_2
0.251	0.507	0.869	0.869	0.724	ND	w_3
0.601	0.27	0.433	0.217	0.72	0.72	w_4
0.931	0.424	0.579	0.579	0.433	0.433	w_5
0.559	0.579	0.724	0.579	0.435	0.425	w_6
0.237	0.614	0.289	0.867	0.439	0.434	w_7
0.299	0.579	0.869	0.579	0.29	0.579	w_8
0.299	0.65	0.724	0.29	0.864	0.864	w_9
0.615	0.145	ND	0.29	ND	ND	w_{10}
0.464	0.397	0.579	0.29	0.432	0.432	w_{11}
0.251	0.941	0.869	0.869	0.724	1.3	w_{12}
0.118	0.289	0.29	0.143	0.435	0.233	w_{13}
0.721	0.181	0.29	0.145	0.145	0.144	w_{14}
0.313	0.723	0.435	1.16	0.579	0.72	w_{15}
167	0.144	288	ND	290	ND	w_{16}
167	0.289	435	145	145	432	w_{17}
83	0.362	435	290	290	432	w_{18}
145	0.072	ND	ND	290	ND	w_{19}
139	0.181	ND	290	290	145	w_{20}
72	0.036	ND	ND	145	ND	w_{21}
83	0.217	145	240	145	288	w_{22}
72	0.036	ND	ND	145	ND	w_{23}
138	0.325	240	145	435	432	w_{24}
37	0.145	ND	579	ND	ND	w_{25}

concentration will decline due to the radioactive decay. It is necessary to correct the result for the sample's decay from the time the sample was drawn to the time the sample was counted (S. M. Musavi Nasab *et al*, 2011)

Since the detection efficiency of the RAD7 decreases as humidity increases due to the neutralization of polonium ions by water particles. An air filter at the entrance of the RAD7 prevents dust particles and charged ions from entering the radon chamber, which would contaminate the alpha detector. The internal air pump in the RAD7 re-circulates the air at a flow rate of about 1 L min-1, purging radon in the water to achieve a rapid equilibrium of radon between water and air (Barnet J. M *et al*, 1995)

Fig. 1 RAD7H2O system

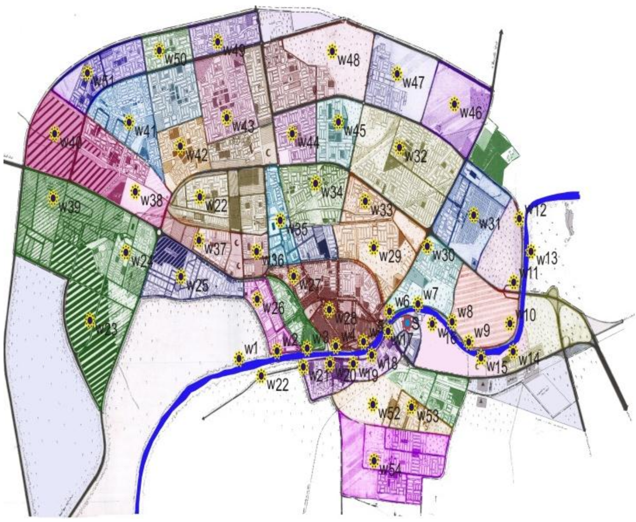

Fig. 3 The map represented the sites which in Babylon

Result and Discussion

The results of radon content in water are shown in Table (1). The ^{222}Rn concentration in drinks water is not regulated, but the USA Environmental Protection Agency (EPA) has proposed a maximum concentration level (11 Bq L^{-1}) or (300 pCi L^{-1}) our results show that () of samples water excess of the EPA's proposed limit. However, the average ^{222}Rn concentration of each sample of water was below the EPA's proposed limit.

Table 2 Percentage of radon gas of the water in some sites of Babylon

±S. D	Mean	Fourth reading	Third reading	Ssecond reading	First reading	Region	Sequence
0.674	0.605	0.54	0.724	0.29	0.29	Hay- Al-Cenaay	1
0.478	0.759	0.145	0.724	1.3	0.864	Nader- Al- Thaltha	2
0.128	0.398	0.579	0.145	0.435	0.432	Nader- Al- Thania	3
0.983	0.723	0.869	0.724	0.576	0.576	Nader-AL-oula	4
1.04	0.831	1.01	0.869	0.869	0.576	Al- Tajai	5
0.145	0.217	0.29	0.29	0.29	ND	Residential Buildings (1)	6
0.237	0.651	0.579	0.869	0.579	0.579	Hay-Al-Atibaa	7
0.12	0.723	0.869	0.724	0.724	0.579	Al-Nasseg	8
0.201	0.227	0.338	0.338	0.23	0.236	Al-Askan	9
0.248	0.471	0.435	0.29	0.145	0.283	Agriculture land	10
0.755	0.686	0.579	1.01	0.579	0.579	Al- Thubat	11
0.638	0.725	0.145	ND	ND	0.144	Al-Askari	12
0.983	0.687	0.579	0.579	0.869	0.869	Al-Akramen	13
0.182	0.348	0.579	0.143	0.435	0.432	Newab Al-Thubat	14
0.83	0.369	0.435	0.29	0.435	0.29	Al- Muhandisen	15
0.657	0.47	0.724	ND	0.432	0.432	Al- Tuhmazia	16
0.273	0.687	0.29	0.724	0.869	0.864	Alshuhadaa	17
0.217	0.688	0.579	1.01	0.579	0.579	Residential Buildings (2)	18
1.055	0.94	1.8	0.724	0.869	0.29	Al-Gameya	19
0.699	0.108	0.435	0.869	0.869	ND	Al-Murtatha	20
0.892	0.604	0.435	0.869	869	ND	Mustafa Ragib	21
0.381	0.978	1.3	1.16	1.01	0.435	Al-Tenyia	22
0.31	0.868	1.16	0.435	1.01	0.864	Al-Asatetha	23
0.464	1.5	1.8	1.74	1.74	0.809	Al- AlAskari	24
0.083	0.362	0.435	0.29	0.29	0.432	Al- Muhariben	25
0.248	0.615	0.29	0.869	0.724	0.576	Al- Hukam	26
0.248	0.615	0.29	0.869	0.724	0.579	Al-Karama	27
0.658	0.277	0.179	0.864	ND	0.72	Kadhia	28
0.159	0.11	0.338	ND	ND	0.102	Al- Shawi	29
0.722	0.18	0.145	0.288	0.144	0.144	Al- Jamhuria	30
0.808	0.687	0.579	0.579	0.724	0.869	Al-Gamain	31
0.299	0.904	1.3	0.869	0.579	0.864	Jabaween	32
0.24	0.614	0.29	0.724	0.579	0.864	Gubran	33
0.185	1.05	1.3	0.869	1.01	1.01	Muhaizim	34
0.932	0.361	0.145	0.435	0.29	0.29	Al-Thawra	35
0.248	0.471	0.35	0.724	0.579	0.144	Al-Teyara	36
0.246	0.47	0.579	0.143	0.435	0.72	Hay-Al- Gazaer	37
0.949	0.614	0.724	0.435	0.579	0.145	Bakarli	38
0.247	0.833	0.579	0.869	0.724	1.16	Al- Wardyia	39
0.947	0.614	0.579	0.724	0.724	0.432	Hemaier	40
0.247	0.833	0.579	0.869	0.724	1.16	Al-Kulag	41

Table 3 Percentage of radon gas of the water in some sites of Babylon

±S. D	Mean	Fourth reading	Third reading	Second reading	First reading	Region	Sequence
1.15	1.16	1.5	0.869	1.01	1.16	Al-Kefil	1
0.959	o.650	0.724	0.29	0.724	0.864	Al- Kasim	2
0.237	0.579	0.579	0.869	0.29	0.579	Al-Hamza	3
0.494	0.0725	0	0.145	0.145	0	Al- Iscandaria	4
0.668	0.108	0.145	0.145	0	0.144	Al- Musaib	5

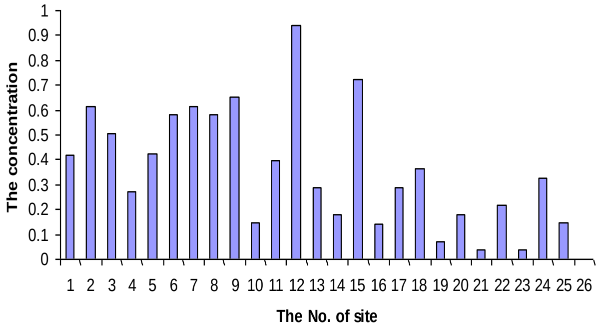

Fig. 2 Diagram represented the concentration of radon in water of Shut-al- Hella's water/ Babylon

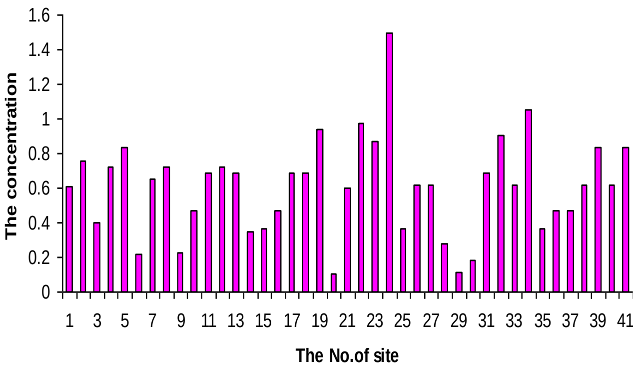

Fig 3 Diagram represented the concentration of radon in water of some sites in Babylon

Fig. 4 Diagram represented the concentration of radon in water of some sites in Babylon

Discussion

In this job, some samples taken directly from variable sites (Fig -2) of Shut al- Hella's water for determine the concentration of radon, the obtaining results as following . The highest concentration. The value in the site (W_{12}) equal (0.941) Bq/L , while the lowest value in the site (W_{23}) equal (0.036) Bq/L.

Other samples taken from variable regions governorate of Babylon see also (Fig-2).

The highest concentration. The value in the Al-Askari region equal (15) Bq/L , while the lowest value in the Al-Murtatha region (0.108) Bq/L.

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