

Radon Concentrations Measurement for Drinking Water in Kufa City /Iraq Using Active Detecting Method

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Abstract:

In this research , radon concentrations in drink water samples were measured in Kufa city – Iraq by using a technique called DurrIDGE RAD7-H₂O with closed loop. The studied sites on the map of Kufa city were determined by using GIS program.

It was found that , the range of radon concentrations for the studied area between $(3.9 \pm 0.0432 - 226 \pm 8.876)$ Bq/m³, while the range of mean annual effective dose between $(0.54834 - 31.7756)$ μ S.y⁻¹.

When the results were compared of radon concentrations with the internationally recommended reference levels (World health Organization limit 500 Bq/m³) and the mean effective annual dose for radon in drink water normal limits of world (1 mSv/y), there were no indications of existence of radon problems in the water sources in this survey. therefore the drinking water in Kufa city is safe as far as radon concentration is concerned.

Keyword : Radon in drinking water, Kufa city/Iraq, RAD-7 detector

1. Introduction

²²²Rn's lifetime is considered long relative to the other isotopes and formed in the ground or building materials(Nero A.V., 1988). It has significantly more time to diffuse through the material into the indoor environment in buildings or the outdoor atmosphere. The radon formed relatively close to the earth's surface can diffuse through the soil or be driven by pressure gradients (Samuelsson C., Petterson H., 1984).

Radon is the second most important cause of lung cancer after smoking. Significant health effects have been seen in uranium miners who are exposed to high levels of radon. However, studies in Europe, North America and China have confirmed that lower concentrations of radon – such as those found in homes – also confer health risks and contribute substantially to the occurrence of lung cancers worldwide (Lubin C. , 2005, Krewski D.,2005 and Darby S. 2005). Radon is much more likely to cause lung cancer in people who smoke.

There are some scientists modernly using RAD-7 detector to measure concentration of radon water. Somashekar R.K. et al. in (2010) (Somashekar R.K. et al. 2010) studied the distribution of radon ²²²Rn activity concentration in groundwater samples and their annual effective dose exposure in the Varahi and Markandeya command areas. Radon measurement was made using DurrIDGE RAD-7 radon-in-air monitor, using RAD H₂O technique with closed loop aeration concept. Subber A. R. et al. in(2011) (Subber A. R. et al. 2011) studied the methods to measure radon in in surface, underground water and oil-produced water separated from oil in Basra Governorate in Iraq using fast electronic techniques RAD-7 and the passive method by using the solid state nuclear track detectors CR-39 and L115-II. And Al Zabadi H. et al. in (2012) (Al Zabadi H. et al. 2012) used RAD-7 detector for measuring the concentration of radon for drinking water supplies in Palestine. The aim of this study was determined the important radioactive element radon in healthy drinking water, because several factors such as increases used it and availability in markets different types. The aim of the present work is to measure the concentration of radon in drinking water in Al-Kufa city using new technical called RAD-7 detector

2.Study area

In this study 13 regions was taken as fair distribution in Kufa city .The locations were determined using (GIS) program(Fig.(1)) through which we got the map of the Kufa sites which was drawn by using GPS technical .Table (1) showed the sites of measurement in Kufa city for taking samples. .

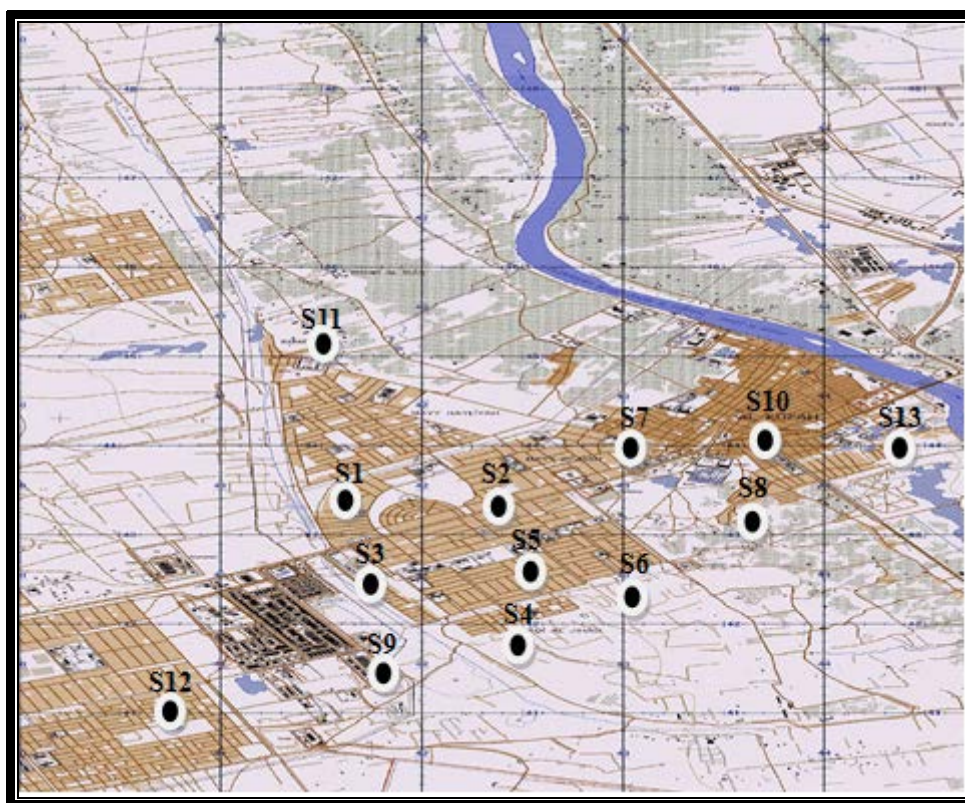


Figure (1) Map of sites of Kufa area

Table (1) Sites of measurements in Kufa area for taking samples

No.	Name	Coordinates
1	Al. Mutanabi	44 ^o 22' 53.662" E , 32 ^o 1' 48.533" N
2	Al.Askary	44 ^o 22' 52.701" E , 32 ^o 2' 7.472" N
3	Al.Shorta	44 ^o 23' 21.377" E , 32 ^o 1' 40.2" N
4	Tamoz	44 ^o 23' 19.438" E , 32 ^o 1' 2.182" N
5	Al.Jameah	44 ^o 23' 21.377" E , 32 ^o 1' 40.2" N
6	Kinda	44 ^o 23' 21.377" E , 32 ^o 1' 40.2" N
7	Al.Jamhoriaa	44 ^o 23' 57.168" E , 32 ^o 1' 59.881" N
8	Al.Moallemeen	44 ^o 23' 37.175" E , 32 ^o 1' 47.986" N
9	Methamaltammar	44 ^o 23' 38.578" E , 32 ^o 1' 18.738" N
10	Al.Rashadiah	44 ^o 24' 12.41" E , 32 ^o 1' 57.693" N
11	Messan	44 ^o 21' 32.478" E , 32 ^o 3' 16.807" N
12	Al.Forat	44 ^o 24' 38.225" E , 32 ^o 2' 150.766" N
13	Al.Jedada	44 ^o 24' 21.563" E , 32 ^o 2' 25.565" N

3.Sampling and assays

Water samples were taken from Kufa city. Radon concentrations in these samples were measured with RAD-7 an electric radon detector connected to RAD-H₂O accessory (Durridge Co,USA, 2010) for a period of one month. Figure (2) shows the schematic diagram of RAD-H₂O .In the setup of RAD-7 detector was used for measuring radon in water by connecting it with a bubbling kit which enables to degas radon from a water sample into the air in a closed loop. A sample of water was taken in a radon – tight reagent bottle of 250 mL capacity connected in a close circuit with a zinc sulphide coated detection chamber which act as scintillator to detect alpha activity and a glass bulb containing calcium to absorb the moisture , Air was then circulated in a close

circuit for a period of 5-10 min until the radon was uniformly mixed with the air and the resulting alpha activity was recorded and it directly gives the radon concentration .

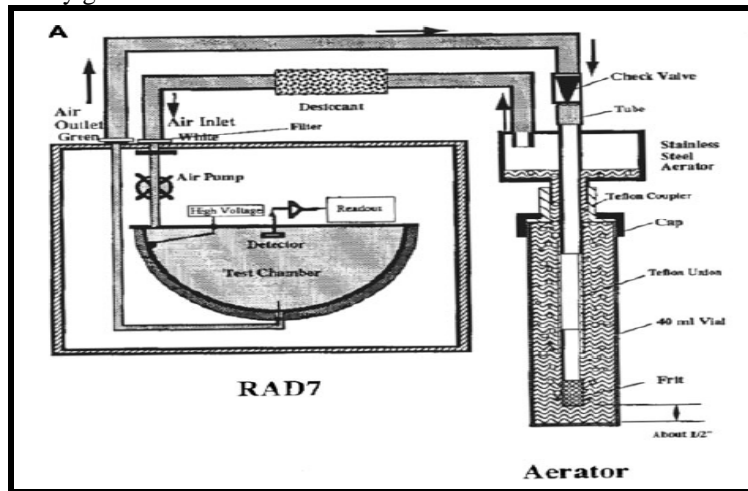


Fig. 2. Schematic representation of the RAD 7 instrument for measuring radon in water (Durrige Company Inc., 2010)

4. Result and discussion

Table (2) and Fig.(3) showed the results of radon (^{222}Rn) concentration for unit (Bq.m^{-3}), while Table (3) showed annual effective dose (for unit mS.y^{-1}) of drinking water in kufa city .

From Table (2) the location sample (Kinda) had highest radon concentration, while location sample (Al.Jameah) had lowest radon concentration of each location samples in Kufa city for drinking water which had mean value (73.577 Bq.m^{-3}).

From the spectra that shown in Figures (4) and (5) for higher and lower of location in of Kufa city can be noted the relation between the count rate and the energy which consist of Radon daughters in $\text{A}(^{218}\text{po})$, $\text{B}(^{214}\text{po})$ and Thoron daughters $\text{D}(^{216}\text{po})$, $\text{E}(^{212}\text{po})$.

The annual effective dose, D_w , due to the inhalation of radon, resulting from the radon concentration in domestic water, was calculated according to the following expression UNSCEAR (B), 2000 (UNSCEAR B, 2000) :

$$D_w = C_w C_{Rw} D_{cw} \dots\dots\dots (1)$$

where : D_w is the annual effective dose (Svy^{-1}) due to ingestion of radionuclide from the consumption of water. C_w is the concentration of ^{222}Rn in the ingested drinking water (Bq L^{-1}). C_{Rw} is the annual intake of drinking water (Ly^{-1}). D_{cw} is the ingested dose conversion factor for ^{222}Rn (SvBq^{-1}).

Also Table (3) , showed the highest value of the annual effective dose in sample (Kinda) was $0.8588 \mu\text{Sv.y}^{-1}$,but the less value of the annual effective dose in sample (Messan) was $0.14174 \mu\text{Sv.y}^{-1}$. All results of the annual dose effective for ^{222}Rn of ground water in Al-Kufa city were smaller than the normal limits of world (1 msv.y^{-1} (UNSCEAR, 2000).

Results of the average radon of concentration in drinking water in Al-Kufa city were smaller than the accordable limit as reported in WHO (WHO. 2004). The allowed maximum concentrations level for ^{222}Rn in water is 500 Bq.m^{-3} . The reason for vibration in radon concentration could be a function of geological structure of the area, depth of the water source and also differences in the climate . Others have reported that the geological structure of an area is a predominant factor for high radon concentration and climate is also an important factor (Vaupotic J. et al. 1998).

All the results summarized in Fig.(3) as well. In the lack of radon map for Iraq, one may compare these data with the surrounding area. The work of Misconi and Navi summarized the average radon concentration in different Middle East countries (Vaupotic J. et al. 1998) ; in Iran (Hamadan) 364 Bq m^{-3} , Syria (Damascus) 45 Bq m^{-3} , Jordan (north) 144 Bq m^{-3} , Israeil (national) 47 Bq m^{-3} , Saudia Arabia (Al- Jauf) 30 Bq m^{-3} and Yemen (Hodeidah) 42 Bq m^{-3} . However those are mainly for doweling, which is affected by the water used.

Table(2) The activity concentration of (^{222}Rn) in (Bq.m^{-3}) of drinking water sample in kufa city

No.	Name of Location	Mean of Concentration Radon (Bq.m^{-3})
1	Al. Mutanabi	37.3±2.770
2	Al.Askary	151±9.129
3	Al.Shorta	113±7.654
4	Tamoz	43.7±2.671
5	Al.Jameah	3.9±0.0432
6	Kinda	226±8.876
7	Al.Jamhoriaa	94.35±10.651
8	Al.Moallemeen	149±7.437
9	Methamaltammar	39.7±3.652
10	Al.Rashadiah	47.7±4.388
11	Messan	37.3±2.541
12	Al.Forat	5.9±0.124
13	Al.Jedada	75.1±7.654

Table(3) The annual effective dose of (^{222}Rn) in ($\mu\text{sv.y}^{-1}$) of drinking water sample in kufa city

No.	Name of Location	The Annual Effective Dose ($\mu\text{sv.y}^{-1}$)
1	Al. Mutanabi	5.24438
2	Al.Askary	21.2306
3	Al.Shorta	15.8878
4	Tamoz	6.14422
5	Al.Jameah	0.54834
6	Kinda	31.7756
7	Al.Jamhoriaa	13.26561
8	Al.Moallemeen	20.9494
9	Methamaltammar	5.58182
10	Al.Rashadiah	6.70662
11	Messan	5.24438
12	Al.Forat	0.82954
13	Al.Jedada	1.076152

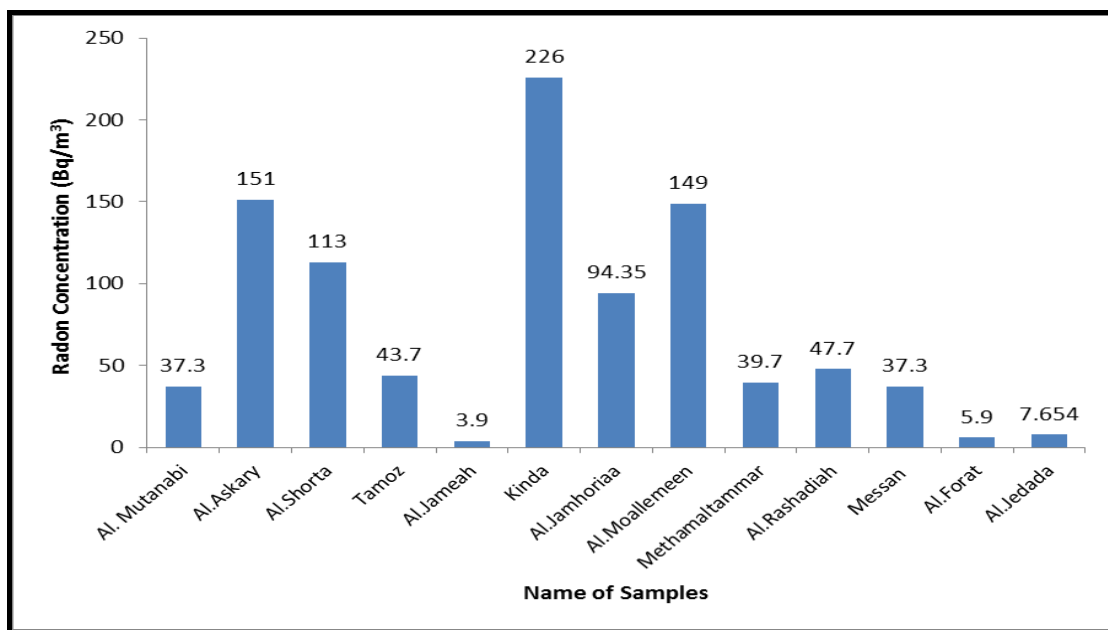


Fig.(3) Radon Concentration of drinking Water in Kufa city

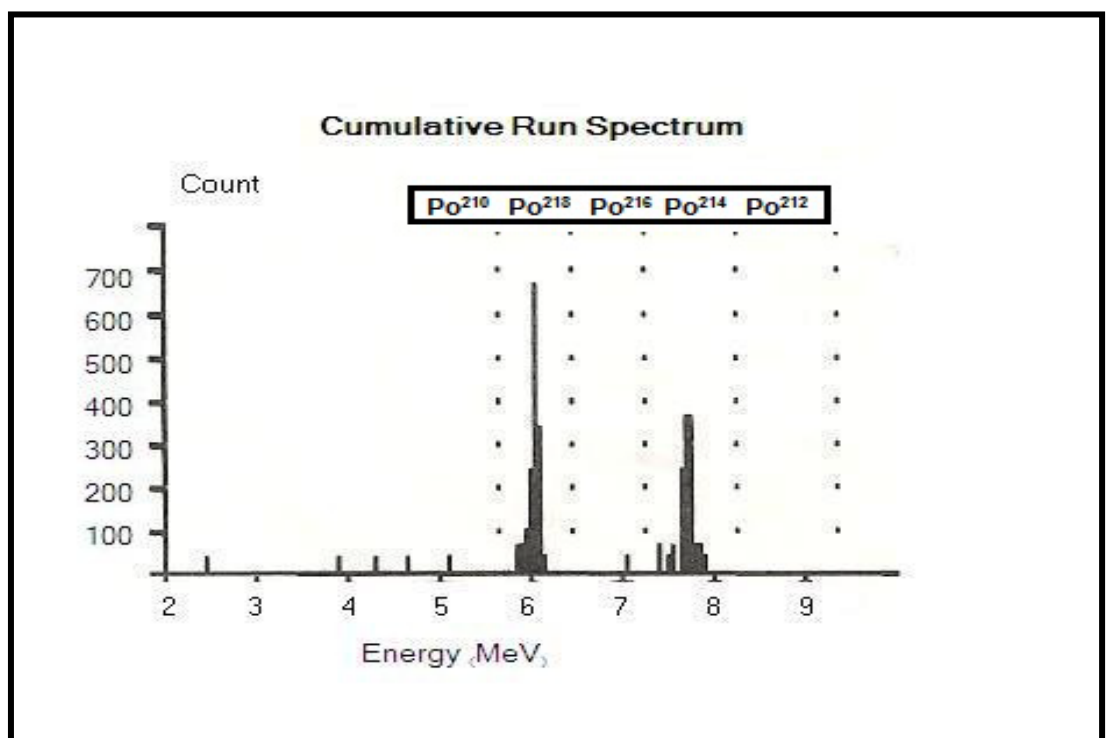


Fig.(4) alpha energy spectrum of location Sample(Kinda)

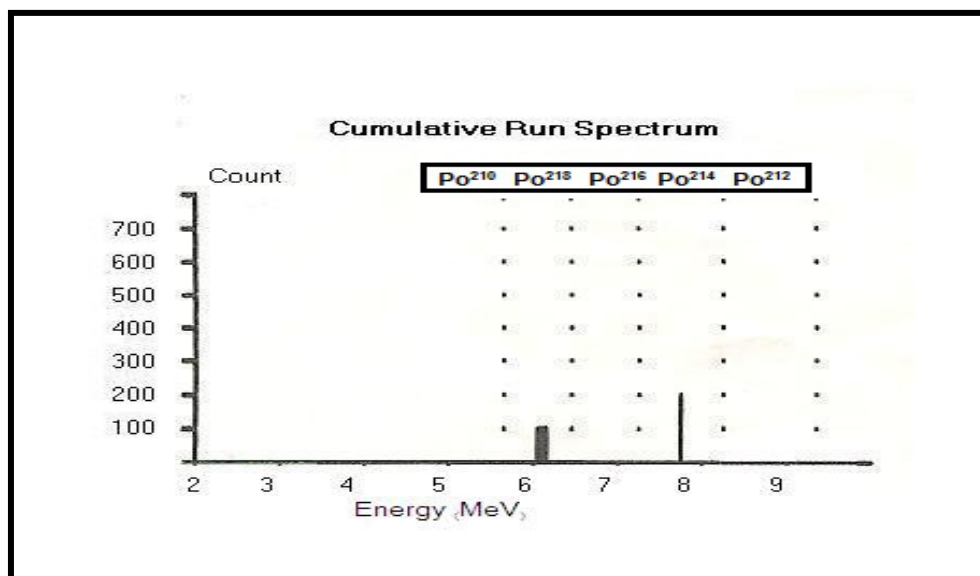


Fig. (5) alpha energy spectrum of location Sample(Messan).

5. Conclusion

In the paper the results of the ^{222}Rn measurements in 13 region in Kufa city drinking waters are presented. The measurements were performed by RAD-7 radon detector manufactured by DURRIDGE company Inc. From the results for all samples drinking water, it can be concluded that the majority of drinking water in this paper is safe to use from the standpoint of concentration of radon in them.

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