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Health impact of Radon in water to Schools for City of Hilla - Iraq

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Abstract : In this research the concentration of radon ^{222}Rn in the drink water was measured in different schools in Hilla city. The study included 7 schools in the city center and 7 schools in Abi – Gharaq and 7 schools in Kifel. The samples of water were collected from reservoirs of the drink water in those schools.
The concentration of radon ^{222}Rn was measured by the RAD7 detector with annex RAD H_2O. The importance of this study comes from the large numbers of the pupils who attend the schools. The locations of the samples have been identified on a map using the GIS system.
The study found that the rate of radon ^{222}Rn concentration in the drink water of the schools in the city center was about 0.094887Bq.L^{-1} . While, inAbi –Gharaq region the rate of the radon concentration was about 0.173Bq.$L^{-1.}$ In the Kifel region, the rate reaches about 0.2997Bq.$L^{-1.}$
The average valueof the effective dose of radon concentration in the drink water of the city center schools was about 0.40437 mSv.y^{-1} while Abi – Gharaq region was about 0.586 mSv.y^{-1} and the Kifelwas 0.711 mSv.y^{-1}.
Key-word : Radioactive, Drinking water, RAD7, Radon,Schools, Human life, effective dose.

Introduction

Radon is a unique natural element being found as a gas, noble,and radioactive in all of its isotopes. As gases, the isotopes are mobile and carry messages over significant distances, within the earth and inthe atmosphere, but on the other side of the coin, inhalation can bea problem to one's health. The fact that radon is noble ensures that it is not immobilized by chemically reacting.The ground and fresh water usually contain a variety of radionuclides. One of the most frequently studied natural radionuclides is 222Rn since it delivers the highest doses to humans after its intake via ingestion of drinking water[1].

Radon (^{222}Rn), formed during radium disintegration, is a naturally occurring radioactive element, an odorless, colorless and tasteless noble gas that provides the largest contribution to the effective dose absorbed by the population. It has a half-life of 3.82 days, decays by emitting 5.49MeV α particles, and generates radioactive progeny[2].

Two of the ^{222}Rn decay products, ^{214}Po and ^{218}Po, are α emitters, and they contribute over 90% to the total radiation dose received due to radon exposure[3]. Exposure to radon occurs primarily through inhalation, resulting in radiation to the lung and to a lesser degree other organs through radon gas dissolved in blood. Yet, in conditions with very high concentrations in drinking water, ingestion can be the primary source of exposure to organs other than the lung. In terms of ingested radon, the radiation exposure is primarily due to radon gas itself, and the contribution of its progeny is less than in the case of indoor radon[4].

The ^{222}Rn concentration in water is due to the decay of ^{226}Ra associated with the rock and soil.

Apparently, the radon gas percolates through the soil and rock, and dissolves in the water.Therefore, the concentration of radon in water is higher than one would expect if the activity were due only to supporting dissolved ^{226}Ra in the water[5].

The radon concentration levels in surface water are generally very low, whereas the highest concentrations of dissolved radon are usually found in many groundwater systems flowing through granite or granitic sand and gravel formations, in aquifer and sedimentary rocks, in very deep wells and in crystalline rocks[6].The occurrence of high levels of radon in drinking water represents a potential health risk due to human exposure through inhalation on account of exhalation of radon and its decay products from water into household air and through ingestion of radon from direct ingestionconsumption of radon in drinking water. However, the exposure of the ingested radon with intake of the water is less than the inhaled radon from the radon exhalation from the same water. Radon exposure may cause health risks in terms of cancer of human organs, mainly the stomach and lungs. Therefore in recent years, a great interest arose towards the natural radioactivity in water.Many researchers have measured radon in various water types in many regions worldwide[7].

2. Location of the study area

In this study 21 regions were taken as fair distribution in Hilla city in Iraq, south of the capital Baghdad,The locations were determined using (GIS) program. Fig.1 illustrates the map of Al-Hilla city and shows the distribution of studied locations, where it was drawn by GPS technical, which has an area of (878 Km^2), with location of latitude (32 ˚ 36) N, and longitude(44 ˚ 15) E[8] .

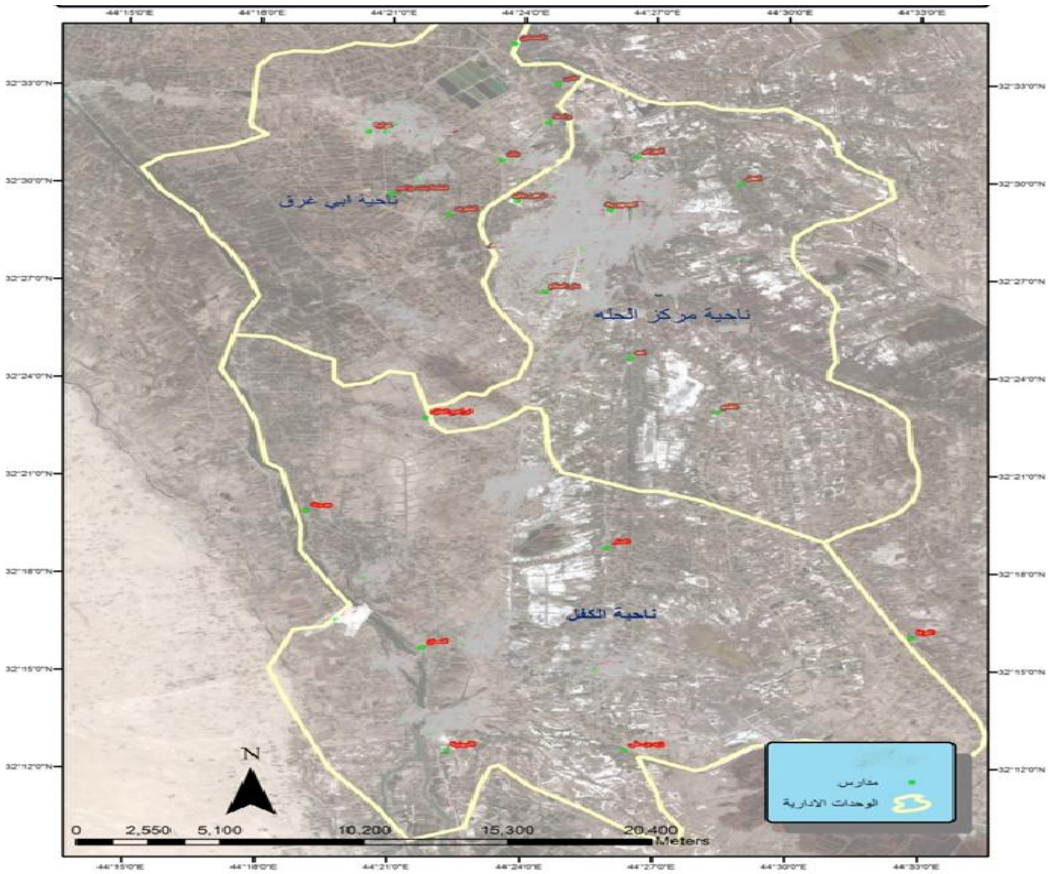


Fig. 1. Sketch map shows locations of study samples in the schools of Hilla city.

3. Experimental Part

The calibrated alpha spectrometer DURRIDGE RAD7 USA, with special accessories for radon measurement in water was used for measurements of Radon concentration in drinking water. The detector converts alpha radiation directly to an electric signal and has the possibility of determining electronically the

energy of each particle, which allows the identification of the isotopes (218Po, 214Po) produced by radiation, so it is possible to instantaneously distinguish between old and new radon, radon from Thoron, and signal from noise[9].

The radon 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 250ml capacity. Air was then circulated in a closed 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[10].

RAD7 is used in the measurements of radon concentration in the surface and ground water. in which time 95% of equilibrium would have been reached .Finally, each set of readings includes four 5- min cycles that at last takes 30 min[10].

RadH2O is designed for the analysis of small water samples (250 ml) with high activities. The air is circulated in a closedcycle through a radon-tight water bottle, containing the sample to extract the radon. Sample water is pumped through a gas exchange cylinder, which is connected to the air cycle. Radon outgasses from the water until solubility equilibrium is reached. In both cases the air cycle is connected to the radon alpha detector via a drying unit to remove water vapor[11]. Detailed descriptions of the RAD7detector as well as the two water extraction procedures are available. The Rad H2O procedure is suitable for groundwater analyses, but its detection limit is in most cases too high to analyze surface water, typical detection limits achieved for the two standard techniques compared to improvements discussed[11]. Figure (1) shows RAD7 and schematic diagram of RADH2O.and, Figure (2) shows the device RAD-H2O

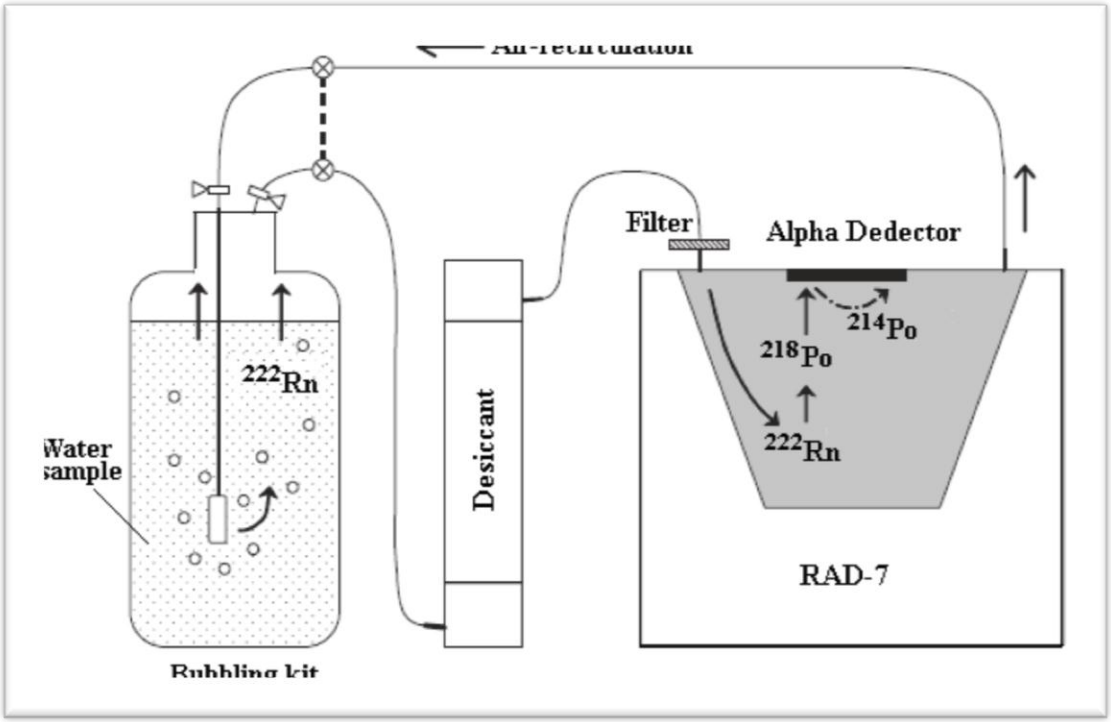


Fig.(2) Schematic of RAD H2O assembly[12].

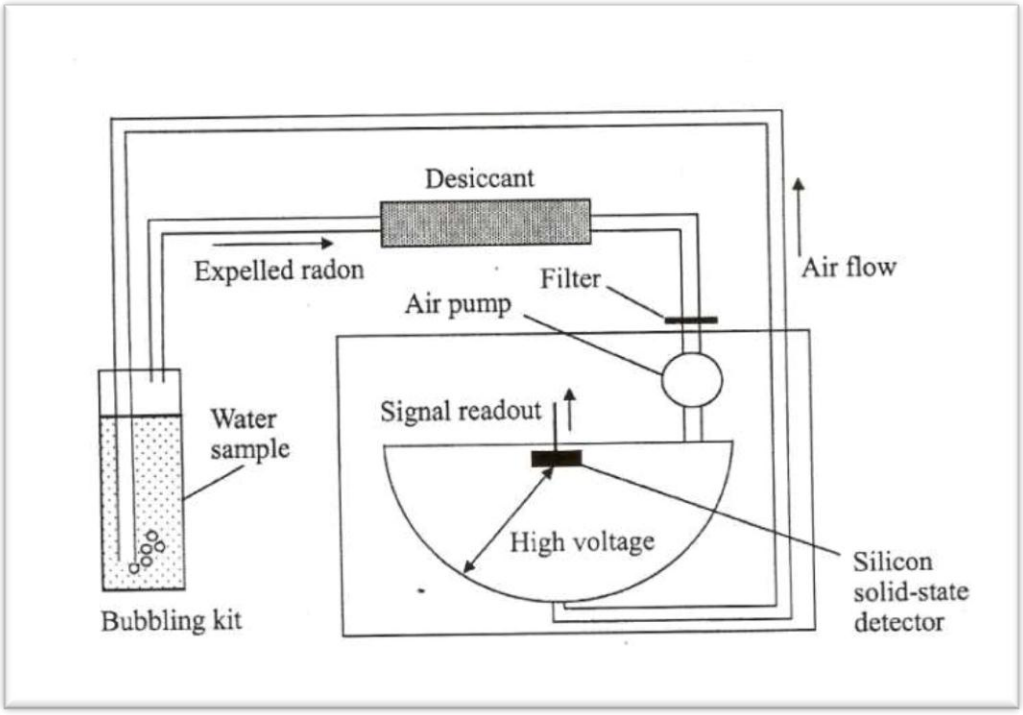
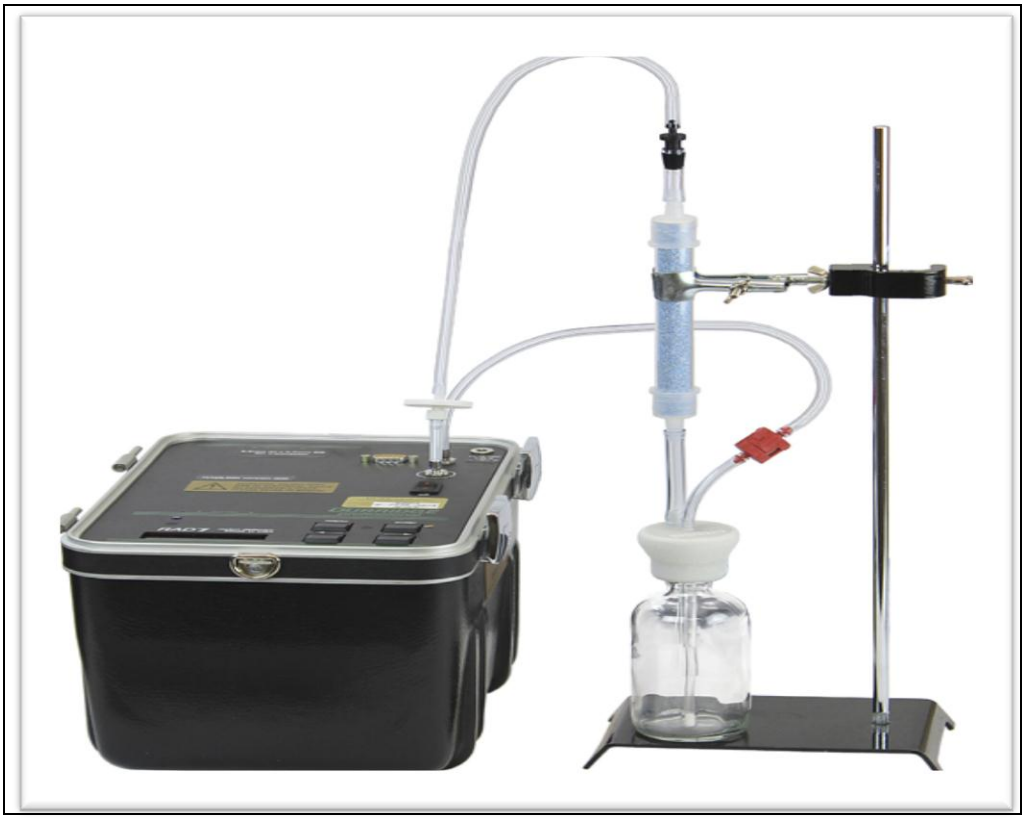


Fig.(2)B: Schematic of RAD H2O assembly



Figure(3). RAD7H2O [8].

The annual effective dose to an individual consumer due to intake of radon from drinking water is evaluated using the Eq. (1), as shown in the table (1).

Dw = CwCRwDcw..... (1)

where Dw is the annual effective dose (Sv y^{-1}) , Cw concentration of ^{222}Rn(Bq. L^{-1}) CRw annual intake of drinking water (1095 L y^{-1}),Dcw is the ingested dose conversion factor for ^{222}Rn (4 Sv Bq^{-1})[9].

4. Results and discussion

Table (1) Measurement results for water samples from the schools.

Schools	Sample	Mean ($Bq.L^{-1}$)	High ($Bq.L^{-1}$)	Low ($Bq.L^{-1}$)	Effective dose($mSv.y^{-1}$)	Samples location
Al-Jezaair	S1	0.325	0.145	0.00	1.4235	N 32°,30′, 47. 87″ E 44°,26′,33.21″
Al-Jomohoria	S2	0.036	0.144	0.00	0.15768	N32°,29′, 10. 10′″ E 44°,25′,53.78″
Zohor Babylon	S3	0.217	0.435	0.00	0.95046	N32°,29′, 27. 33′″ E 44°,23′,51.76″
Al-Adil	S4	.1440	0.288	0.00	0.63072	N 32°,29′, 58. 91″ E 44°,28′,55.21″
Daar Al-Salaam	S5	0.036	0.144	0.00	0.15768	N 32°,26′, 34. 19″ E 44°,24′,34.26″
Uhod	S6	0.109	0.154	0.00	0.47742	N 32°,24′, 36. 56″ E 44°,26′,25.72″
Al-kaim	S7	0.0722	0.145	0.00	0.316236	N32°,22′, 57. 26″ E 44°,28′,24.89″
Al-Tathamon	S8	0.144	0.432	0.00	0.63072	N 32°,34′, 15. 35″ E 44°,23′,45.08″
Fass	S9	0.217	0.579	0.00	0.95046	N 32°,33′, 1.7 7″ E 44°,24′,45.34″
Wasit	S10	0.072	0.290	0.00	0.31536	N 32°,31′, 50. 96″ E 44°,24′,30.96″
Babylon	S11	0.072	0.145	0.00	0.31536	N 32°,30′, 41. 23″ E 44°,23′,27.33″
Kawkaba	S12	0.253	0.435	0.00	1.10814	N 32°, 29′, 26. 0″ E 44°, 20′, 40.98″
FatimaBint Huzam	S13	0.144	0.288	0.00	0.63072	N 32°,29′, 37. 6″ E 44°,20′,58.45″
Al-Toofof	S14	0.688	1.160	0.288	3.01344	N 32°,29′, 0. 146″ E 44°,23′,43.96″
Ibrahim AL-Khalil	S15	0.109	0.145	0.00	0.47742	N32°,22′, 53. 75′″ E 44°,21′,52.30″
Beirut	S16	0.108	0.145	0.00	0.47304	N 32°,19′, 53. 89″ E 44°,19′,4.84″
Al-Menar	S17	0.0362	0.145	0.00	0.15855	N 32°,18′, 45. 53″ E 44°,25′,56.83″
Al-Naaman	S18	0.108	0.432	0.00	0.47304	N 32°,15′, 43. 23″ E 44°,21′,44.78″
Al-Kufa	S19	0.0722	0.145	0.00	0.13623	N 32°,16′, 1. 04″ E 44°,23′,49.86″
Al-Shihabia	S20	0.036	0.145	000	0.15855	N 32°,12′, 32. 64″ E 44°,22′17.92″
Zaidibn Ali	S21	0.398	0.724	0.145	1.7432	N 32°,12′, 35. 85″ E 44°,26′,19.97″

Samples were collected from 21 schools from drinking water, Short term measurements using the RAD7, Table (1) shows the results were obtained in this study. The last column represents a sample Location using GPS**.**

By looking at the details of the results, one can recognize that there are differences in the results between the RAD7,were found to vary from low value (0.036) $Bq.L^{-1}$at S5and (0.072)at S7 to high value (0.688) $Bq.L^{-1}$ at S14 and (0.398) at S21, shown in table (1) that there is a difference in measurement results for water according to locations samples,All the results summarized inFig. (4) the reason is attributed to the difference in the geological nature of each region of the earth and environmental conditions and seasons of the year,present results show that the radon gas concentration in tap water is below the allowed limit from (International Commission of Radiation Protection) which is 11 BqL^{-1}, proposed by the US Environmental Protection Agency[13], it can be seen that present value is well below this recommended value .

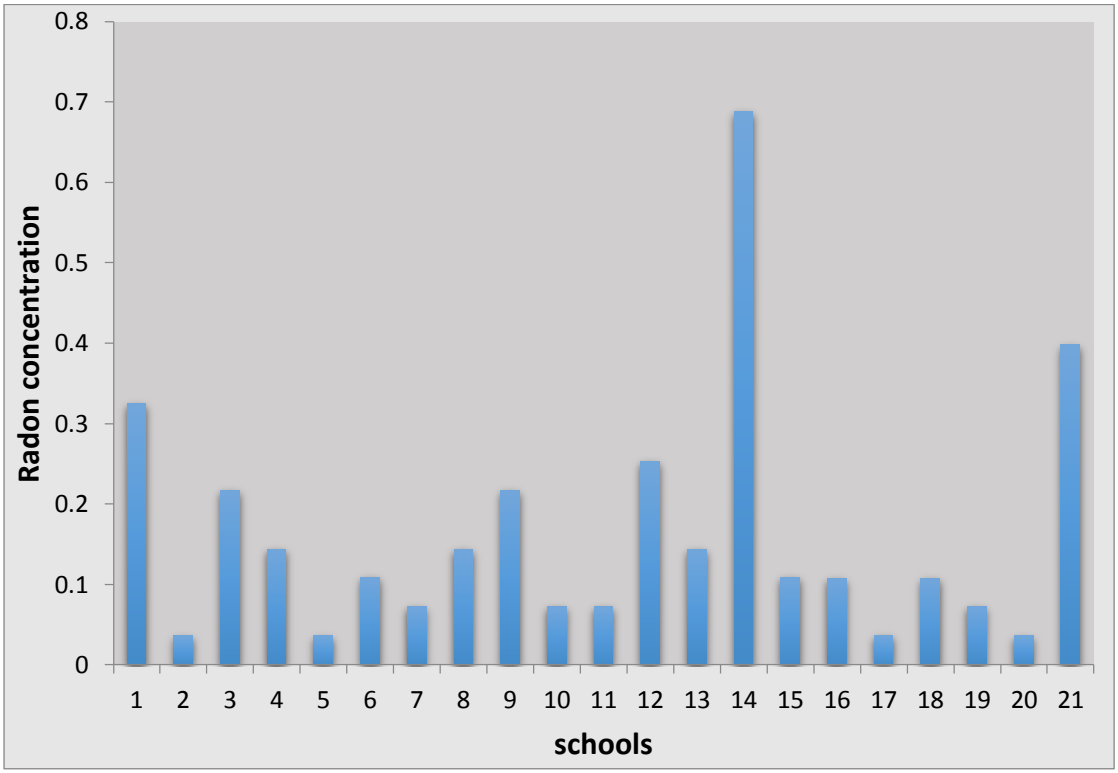


Fig.(4) A histogram illustrating the change in radon gas concentration (Bq/L) in water samples in all regions studied.

5. Conclusion

From the present work, it can be concluded that the radon concentrations in the drink water of the schools by using the detector RAD7, These results have shown variations of radon concentration in water due to different locations of the samples was taken, Where the radon concentrations varied due to difference in procedures of measurement, geology of the study areas, .This research was done in order to determine the effect of this gas , also natural waters.

Contamination is a worldwide problem which deserves large attention notonly due to its environmental hazards butalso for the risks to the human health as wellas the economic damages.

Finally, this study showed that the concentration of radon in drink water is within normal limits which set by the relevant organizations as the maximum allowable concentration of radon in water, which is given by[13] 11 $Bq.y^{-1}$.

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