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Measurement of Natural Radioactivity in Water Samples from Al Dora Thermal Power plant in Baghdad Governorate

Nada F. Tawfiq[*] *and Dhuha R. Mathloom*

Department of Physics, College of Science, AL_Nahrain University, Iraq.

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Abstract: The study aims to measure the activity concentrations of naturally occurring radioactive material (NORM) including ^{238}U, ^{232}Th, and ^{40}K in water samples collected from Al Dora thermal power plant station in Baghdad governorate – Iraq at 2017, using Na(Tl) detector gamma-ray spectrometer technique with Na(Tl) detector. The average values of activity concentrations for ^{238}U, ^{232}Th and ^{40}K in water samples were 1.529, 0.88, 43.30 Bq/L respectively. The average value of specific activity for ^{238}U was higher than the acceptable value. The average value of specific activity for ^{232}Th was lower than the acceptable value. The average values of radium equivalent (Ra_{eq}), absorbed dose rate, annual effective dose (indoor and outdoor) external hazard index (Hex), internal hazard index (Hin) and gamma index (I_γ) were 5.404 Bq/L, 2.717 nGy/h, 13.33 mSv/y, 3.33mSv/y, 0.015 Bq/L, 0.018Bq/L and 0.043Bq/L respectively, the radiological hazard index found to be safe for public and environment.

Keywords: Specific activity, NaI(Tl) Scintillation detector , water, Radium equivalent. Radiological hazard index.

1 Introduction

Traces of radionuclide are found in soil, air, water and human bodies. We inhale and ingest radionuclide every day of our lives and radioactive material has been ubiquitous on earth since its creation. The presence of natural radioactivity in soil and water resisting internal and external exposure to humans. Radioactivity elements which can be found in nature are generally categorized in two distinct families namely of arising from either “cosmic “or “terrestrial “source [1- 4].

The most commonly encountered radionuclide that irradiates the human body through external exposure is ^{235}U; ^{232}Th; and ^{40}K [5]. Surface water is more susceptible to contamination in different forms because of the events and activates of industrial agricultural and human waste, as well as pollution of soil washing, as a result of rainfall [6].

The naturally occurring of uranium in water source depending on factors such as the uranium content in the host aquifer rock, the partial pressure of CO_2 ,the presence of O_2 completion agents in the aquifer , the PH and natural of the contact between the uranium minerals and water[7].

Measurement of the levels of natural background level of the radioactivity from ^{238}U, ^{232}Th the activities from the primordial radionuclide ^{40}K and the artificially create Fission product ^{137}Cs is essential parameters with which to determine the natural radioactivity concentration level and their behavior in the environment [8].

The aim of this study was to determine the specific activity of ^{238}U, ^{232}Th and ^{40}K radionuclides in water samples and evaluate potential health hazards due to natural radiation sources in Al-Dora power plant in Baghdad.

2 Materials and Methods

2.1 Sample Collection and Preparation

AL-Dora is a city located in Al-Rashid district, southern Baghdad .The samples were collected from the thermal power plant located in the area of Al-Dora power plant, the locations of the studied samples shown in Figure 1.

Eight samples of water samples were collected from many places, in AL-Dora power plant and surrounding Tigris river area as shown in Table 1, all samples were collected in date (20/2/2017).Water sample were collected in plastic bottles with a capacity 5 litters , the water samples were heated by 100^{o}C to reduce the volume of water from (5 to1) litter using electric heater, after that one liter of each sample were sealed in a Marinelli beakers and stored for 30 days before gamma ray analysis to allow ^{226}Ra and its short-lived

[*]Corresponding author e-mail: nadafathil@yahoo.com

progenies to reach secular equilibrium [6,7]. Each sample was measured for 3 hours by using gamma-ray spectrometry with NaI(Tl) detector.

Fig. 1: Locations of the water samples in Al-Dora power.

Table 1: location of samples in (Al-Dora) power plant.

Sample	Location
W1	Italian makeup (MU) water
W2	General waste water
W3	Water from a river cliff
W4	Middle of river
W5	Waste boiler
W6	Sewage water
W7	Water outside the station 1
W8	Water outside the station 2

2.2 Energy and Efficiency Calibration

Sodium iodide NaI(Tl) scintillation detector 3"x 3" coupled to PC-MCA (4096 channel) model (Canberra, USA), based on high efficiency gamma spectrometry system used to measure the specific activity. Spectral data from the detector was analysed by using (GINE-2000) computer software. The energy (FWHM) in the peak 1.33 keV for ^{60}Co was 7%. The detector was surrounded by a lead shielding to reduce the background radiation. The efficiency calibration of the detector was carried using a multi energy stander source placed in front of the detector for a period 1080 second.

The energy calibration of the NaI(Tl) were carried using standard mixed radionuclides with energies (59.53,88.34,661.7 and 1333,1173) keV for ^{214}Am, ^{109}Cd, ^{137}Cs and ^{60}Co respectively.

Table 2: Activity Concentrations of Radionuclide in Water Samples from Al Dora power plant.

Sample	^{238}U (Bq L^{-1})	^{232}Th (Bq L^{-1})	^{40}K (Bq L^{-1})
W1	1.28	0.30	63.74
W2	0.23	1.59	3.31
W3	1.03	1.28	81.14
W4	1.19	0.43	13.23
W5	2.40	0.48	76.35
W6	0.23	0.15	36.07
W7	3.11	0.38	8.51
W8	MDA	2.39	64.02
Max.	3.11	2.39	81.14
Min.	MDA	0.15	3.31
Average	1.18	0.88	43.30

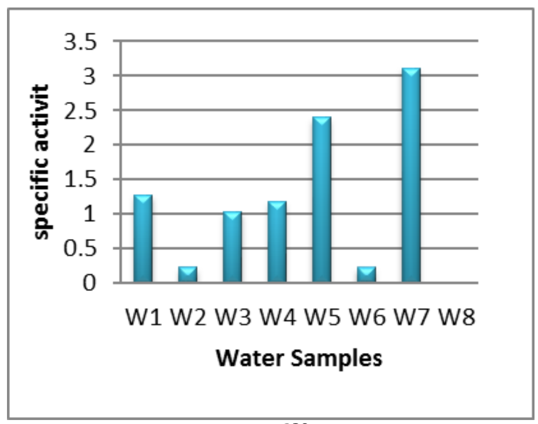

Fig. 2: Specific activity of ^{238}U in water samples .

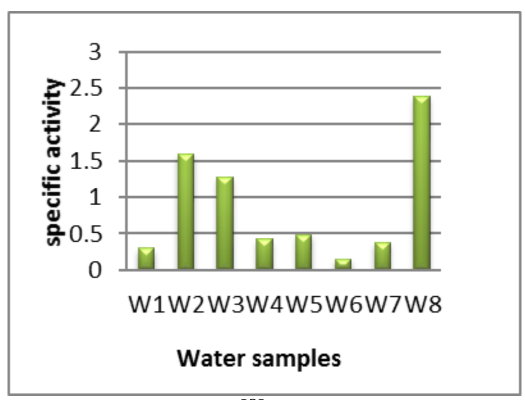

Fig. 3: Specific activity of ^{232}Th in water samples.

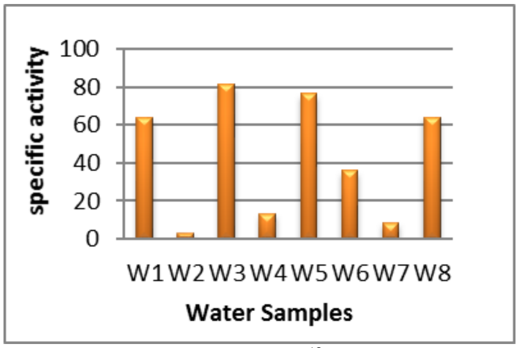

Fig. 4: Specific activity of ^{40}K in water samples.

3.2 Radiological Parameters

3.2.1 Radium Equivalent Activities (Ra_{eq})

The highest value of the radium equivalent (Ra_{eq}) in water sample was (9.113Bq/L) in (WB3) sample while the lowest value (2.766 Bq/L) in (WB2) with average (5.40 Bq/L) as shown in table 3. The Ra_{eq} values were less than the average global vale [2].

3.2.2 Absorbed Dose Rate (Dγ)

The highest value of absorbed dose rate was (4.66 nGy/h) in WB3 sample while the lowest value (1.24 nGy/h) in (WA4) with average (2.72 nGy/h)as shown in table 3. The Dγ values were less than the global average value [2].

3.2.3 Gamma Index (Iγ)

The highest value of Gamma index (Iγ) was (0.073) in WA2 sample while the lowest value (0.02) in (WB2) sample with an average (0.043) as shown in table 3. The (Iγ) values were less than the average global value [2].

3.2.4 Annual Effective Dose ($AEDE_{indoor}$ and $AEDE_{outdoor}$)

The highest value of Annual effective dose ($AEDE_{in}$) was (22.84×10^{-6}mSv/y)in WB3 sample while the lowest value (6.06×10^{-6}mSv/y) in (WB2) sample with an average (13.33×10^{-6}mSv/y), the values of ($AEDE_{indoor}$) were less than the average global value. The highest value of Annual effective dose ($AEDE_{out}$) was (5.71×10^{-6}mSv/y) in WB3 sample while the lowest value (1.51×10^{-6}mSv/y) in (WB2) sample with an average (3.33×10^{-6}mSv/y) as shown in table 4. The ($AEDE_{outdoor}$) values were less than the average global value [5].

3.2.5 Hazard index (H_{in}) and External index (H_{ex})

The highest value of hazard index (H_{in}) was (0.031) in WB5 sample while the lowest value (0.008) in (WB2) sample with an average(0.018), the (H_{in}) values were less than the average global value [2] shown in table 4.
The highest value of external index (H_{ex}) was (0.025) in WB3 sample while the lowest value (0.007) in (WB2) sample with an average (0.015) as shown in table 4. The H_{ex} values were less than the average global value [5].

Table 3: Radiological Parameters (Ra_{eq}, Dγ and Iγ) in water samples of AL-Dora power plant.

Sample	**AEDE indoor ×10^{-6} mSv/y**	**AEDE outdoor ×10^{-6} mSv/y**	**Hazard index Bq/L**	
			Hex	Hin
W1	16.86	4.21	0.018	0.021
W2	6.06	1.51	0.007	0.008
W3	22.84	5.71	0.025	0.027
W4	6.70	1.67	0.008	0.011
W5	22.54	5.63	0.024	0.031
W6	8.36	2.09	0.009	0.009
W7	9.97	2.49	0.012	0.020
W8	20.38	5.094	0.023	0.023
Max	22.84	5.71	0.025	0.031
Min	6.06	1.515	0.007	0.008
Ava.	13.33	3.33	0.015	0.018
Global limit	0.5 mSv/y	0.07 mSv/y	1	1

Table 4: Radiological Parameters (AEDE indoor, outdoor and Hex, Hin) in water samples of AL-Dora power plant.

Sample	**Ra_{eq} Bq/L**	**Dγ nGy/h**	**Iγ Bq/L**
W1	6.62	3.44	0.054
W2	2.77	1.24	0.020
W3	9.11	4.66	0.074
W4	2.82	1.37	0.021
W5	8.97	4.59	0.072
W6	3.22	1.70	0.027
W7	4.32	2.03	0.030
W8	8.35	4.15	0.067
Max	9.11	4.66	0.074
Min	2.77	1.24	0.020
Ava.	5.40	2.72	0.043
Global limit	370	48	1

4 Conclusions

The result obtained showed that the mean specific activity of ^{238}U are higher than the world average ; and the average value of specific activities of ^{232}Th and ^{40}k in water sample are lower than the acceptable value.

The average values of radium equivalent, absorbed dose rate, external hazard index, internal hazard index, annual effective dose (indoor and outdoor) and gamma index (Iγ) in water sample were lower than the average world value.

References

[1] Matiullah, Ahad, ur Rehman A., ur Rehman S., S.Faheem, M., ″Measurement of radioactivity in the soil of Bahawalpur division Pakistan″, Radiation Protection Dosimetry., **112**, 3, 443-447(2004).

[2] H. M. Mahmoud , A.G.E. Abbady , M.A. Khairy and A. El-Taher Multi-element determination of sandstone rock by instrumental neutron activation analysis J. Radioanalytical and Nuclear Chemistry., **264(3)**, 715-718(2005).

[3] A. El-Taher Elemental studies of environmental samples from upper Egypt by neutron activation analysis PhD. thesis, Al-Azhar University, Assuit, Egypt. 2003.

[4] Hashem Abbas Madkour Mohamed Anwar K Abdelhalim and A. El-Taher Assessment of heavy metals concentrations resulting natural inputs in Wadi El-Gamal surface sediments, Red Sea coat. Life Science Journal., **10 (4)**, 686-694(2013).

[5] UNSCEAR, Effects of Atomic Radiation to the Genera Assembly, in United Nations Scientific Committee on the Effect of Atomic Radiation, United Nations: New York , 2000.

[6] Chen S. B. , Zhu Y. G. , Hu Q. H., ″Soil to plant transfer of 238U, 226Ra and 232Th on a uranium mining-impacted soil from southeastern China″, Journal of Environmental Radioactivity., **82(2)** , 223-236 (2005).

[7] Jibiri N., Farai I., Alausa S., “ Estimate of annual effective dose due to natural element radio active in ingestion of foodstuffs in mining tin area of JOSPLATEAU , Nigeria″, Journal of Evironmental Radioactivity.,**94(1)**, 31-40(2007).

[8] I.H. Saleh, A.A. Abdel-Halim, "Science direct determination of depleted uranium using a high-resolution gamma-ray spectrometer and its applications in soil and sediments″, Journal of Taibah University for Science., **l(10)**, 205–211, (2016).

[9] A El-Taher and J H Al-Zahrani., Radioactivity measurements and radiation dose assessments in soil of Al-Qassim region, Saudi Arabia″, Indian J. Pure & Appl. Phys., **52**, 147(2014).

[10] A El-Taher Terrestrial gamma radioactivity levels and their corresponding extent exposure of environmental samples from Wadi El Assuity protective area, Assuit Upper Egypt Radiation protection dosimetry., **145 (4)**, 405-410(2010).

[11] A. El-Taher and M. A.K Abdel Halim Element analysis of soils from Toshki by using Instrumental Neutron Activation Analysis Techniques. Journal of Radioanalytical and Nuclear Chemistry., **300** ,431-435(2014).

[12] (ICRP), International Commission on Radiological Protection, Recommendations of the ICRP, Publication 60, Pergamum Publication, Oxford., (1990).

[13] A .El-Taher Determination of chromium and trace elements in El-Rubshi chromite from Eastern Desert, Egypt by neutron activationanalysis. Applied radiation and isotopes., **68 (9)**, 1864-1868 (2010).

[14] Report of the Ministry of Environment Iraq, Radiation Protection Center, Radiation Control Department., (2012).