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### Concentrations Radon in Water for Distribution Water Stations in Duluyiah city / Salah-Din

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#### ABSTRACT

In this research was measured radon concentration in 90 samples of water in 15 different distribution Water Stations in Duluyiah city/Salah-Din Governorate/Iraq. We used (RAD7) was average 222Rn concentration and the maximum concentration in S13 (0.336) Bq.L-1 and minimum concentration in S3 (0.124) Bq.L-1, the annual effective dose was (0.602) mSv.y-1. The mean annual dose rate in the studied models was less than the allowable rate for WHO and USEPA which is equal 1mSv.Y-1, Therefore, the studied models can be considered safe from the radiological aspect, especially radon.

#### Introduction

Radioactive contamination is defined as the presence of radioactive material in the environment, such as water and air, which adversely affect it. These substances are produced by natural phenomena or human activities such as terrorist nuclear explosions. Radiation contamination may occur as a result of exposure to radiation that can not penetrate the body of the organism, Or to expose the internal organs of the object to radioactive pollutants, and here it is called internal pollution [1-5]. Discharge of domestic and industrial effluent wastes, leakage from water tanks, marine dumping, radioactive waste and atmospheric deposition are major causes of water pollution. Heavy metals that disposed of and industrial waste can accumulate in lakes and river, proving harmful to humans and animals. Toxins in industrial waste are the major cause of immune suppression, reproductive failure and acute poisoning. Infectious diseases, like cholera, typhoid fever [6]. <sup>222</sup>Rn its elements of the periodic table and falls within the noble gases (helium-neon-xenon and others), an invisible, and odorless gas. The element created within the intermediate phase of the <sup>238</sup>U decay phase, Generate several other radioactive elements to terminate this series of anomalies with lead element [7]. Which is a chemically inert gas with an atomic mass of 86, the mass number of its most stable counterpart 222, density 9.7kg.m<sup>-3</sup>, boiling temperature(-61.8 °C) and the angulation degree (-71 °C) almost half is found in all places and at all times [8]. <sup>222</sup>Rn is a source of natural nuclear

radiation generated primarily by the natural decomposition of Uranium (<sup>238</sup>U), Thorium (<sup>232</sup>Th) and Uranium (<sup>235</sup>U), the only metal found in a gaseous state[9], Radon has three radioactive isotopes: (<sup>222</sup>Rn), (<sup>220</sup>Rn) and (<sup>219</sup>Rn) It is common in geological and environmental studies is the <sup>222</sup>Rn for its relatively long half-life of 3.82 days [10]. <sup>222</sup>Rn leads to health risks through two pathways: the inhalation of radon and the products of its decomposition after its release from water to the air of homes and direct access to radon in drinking water. The risk of lung cancer results from the inhalation of radon decay products. Radon was not associated with any other disease cancer and inhalation risk may go well beyond ingestion [11]. Because the alpha particles emitted from radon and the products of the analysis of heavy and charged particles, they occur when collisions with the atoms of the constituent cells of the tissues and organs of the body and the effects of large disturbances in them, as well as the chemical effects at the molecular level. The average length of the alpha particle pathway in the soft tissue is estimated to be limited 40 μm, its ionic energy is more than 1,000 times the capacity of beta particles and thus is more destructive to human tissue, hence the risk of exposure to the <sup>222</sup>Rn radon and its degradation products. In addition, part of the annual effective equivalent dose for people in an environment with a typical radiation back ground of 2mSv.y<sup>-1</sup> is human inhalation of the <sup>222</sup>Rn radon at 0.8 mSv. y<sup>-1</sup> [12]. Numerous studies have been conducted

in different regions of the world to determine levels of exposure to radon. A study of the radioactivity of groundwater and surface water was conducted in Duhok governorate and managed to calculate radon concentration by calculating radium concentration in measured models using a high purity germanium detector [13]. In Iran, the concentration of  $^{222}\text{Rn}$  in drinking water in Mashhad was studied by the PRASSI measurement system [14]. In Ghana, a study was conducted on selected groundwater samples to determine the concentration of radon using a gama spectrometer[15], In Iran there was also a study of radon concentration for indoor air and drinking water using RAD7[16]. In Palestine, a study was conducted on the concentration of radon in the rainwater of the roofs of houses using RAD7[17], In Hilla city in Babylon, a study was conducted on radioactivity of radon in drinking water in schools and enables the calculation of the annual dose in measured models using RAD7[18].

**The Aim of Research**

The aim of the research is to measure the concentration of irradiated radon in the water of the water distribution stations in Duluiyah city in Salah-Din because there are no previous studies in the study area,  $^{222}\text{Rn}$  is danger to due to its widespread spread in soils, building materials and groundwater as well as in water distribution stations.

**Study Area**

The study area is located in Salah-Din province (80 km) north of Baghdad, on the east bank of the Tigris river, within the sedimentary plain, It is bounded by a longitude (30 <sup>0</sup>03) north (44 <sup>0</sup>12) east, It is also a focal point between Samarra and Baghdad. It is characterized by its rich fertile soil for agriculture. It is considered a green oasis for its orchards of citrus, palms, pomegranates, peaches and vegetables, surrounded by the Tigris river on three sides.

**Material and Method**

The device used in this search is RAD7 related RADH2O production in durridge Co USA, which is designed to measure the radon in water at high accuracy and for a wide range of concentrations and to obtain readings within an hour of sampling and often the results required immediate and the most important advantage in this device its ability to determine the energy of Alpha electronically and this makes it possible to distinguish between radon isotopes and between radon and thoron. This technique known as alpha spectrometer, The RAD7 detector must be purging with fresh air for 10 minutes by connecting the closed-loop drying unit to RAD7so the outside air passes through the Desiccant and goes back inside and always notes that the air flow is the same way through the Desiccant, If the humidity is less than 6%, we start the test. The pump operates for 5 minutes. The radon is extracted from the sample and delivered to the measuring room in RAD7. then stops RAD7and waits for more than 5 minutes to reach the state of balance and then repeat for four

sessions for five minutes per session and thus the total test duration is 30 minutes and the end of each run, RAD7 will print the summary of the average radon concentration. The standard deviation, read the humidity and temperature within the machine, the date and time of the test procedure in addition to the operation number and the number of cycles and then gives the diagram of four cycles and accumulated spectrum, Where the extraction efficiency or radon removal ratio of the water in the air loop is very high in a sample size of 250 mL is 94%. Figure 1 shows that diagram RADH<sub>2</sub>O

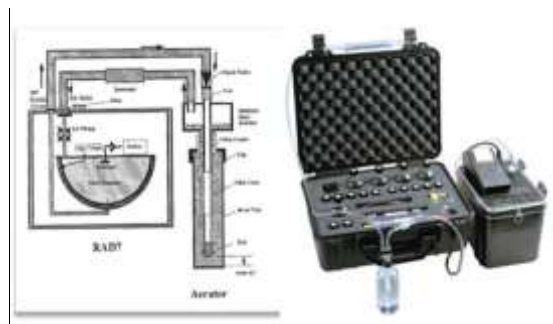


Figure 1 the diagram RADH<sub>2</sub>O [21]

The annual equivalent dose of exposure to radon was calculated using the equation [18]

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

Where:

$D_w$ , Annual equivalent dose Sv.y<sup>-1</sup>

$C_w$ , Concentration of radon in water Bq.L<sup>-1</sup>

$CR_w$ , Amount of consumption 1095 Ly<sup>-1</sup>

$D_{cw}$ , Radon conversion factor 4 Sv Bq<sup>-1</sup>

**Results and discussion**

Table (1) shows the results obtained in this study all are measured in unit Bq.L<sup>-1</sup>. The results of the examination were taken from various sources from the Duluiyah city that is a difference in the results of measurement of water models according to their location. This is due to the different geological nature of each area. The concentration of radon in the study areas between (0.124 – 0.336) Bq.L<sup>-1</sup> as shown in Table (1) which is less than the limit allowed by (EPA) which suggested that the maximum allowable concentration of radon in water is 11 Bq.L<sup>-1</sup>

**Table (1) Radon concentrations in water samples**

Sample	Mean (Bq.L <sup>-1</sup> )	Hi (Bq.L <sup>-1</sup> )	Low (Bq.L <sup>-1</sup> )
S <sub>1</sub>	0.180	0.201	0.165
S <sub>2</sub>	0.162	0.175	0.128
S <sub>3</sub>	0.124	0.151	0.112
S <sub>4</sub>	0.169	0.217	0.157
S <sub>5</sub>	0.222	0.224	0.219
S <sub>6</sub>	0.204	0.222	0.197
S <sub>7</sub>	0.172	0.217	0.121
S <sub>8</sub>	0.302	0.317	0.299
S <sub>9</sub>	0.177	0.217	0.145
S <sub>10</sub>	0.185	0.214	0.159
S <sub>11</sub>	0.199	0.245	0.187
S <sub>12</sub>	0.131	0.145	0.109
S <sub>13</sub>	0.336	0.362	0.327
S <sub>14</sub>	0.127	0.165	0.109
S <sub>15</sub>	0.139	0.184	0.125

The reason for this is due to it usually is saved water for processing then storage and distribution, the time when the radon disintegrates and the disintegrated products dissolved in water before reaching the buildings. While United Nation Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) that the value of radon concentration in water at the limits between 4-40 Bq.m<sup>-3</sup>. The European Commission has recommended to protect people from exposure to radon in drinking water that the level of public water supply 100 Bq.L<sup>-1</sup>. As for the concentration of radon in the air, the Radiation Protection Committee recommended that the concentration rate be between (200-400) Bq.m<sup>-3</sup> [19]. Comparing our results with the results of other studies of different kinds of water from different sources, a study was conducted in Babylon found that the rate of radon <sup>222</sup>Rn concentration in the drink water of the schools in the city center was about 0.094887Bq.L<sup>-1</sup>[18]. While, in Abi – Gharaq region the rate of the radon concentration was about 0.173Bq.L<sup>-1</sup>[18]. In the Kifel region, the rate reaches about 0.2997Bq.L<sup>-1</sup>[18]. The average value of the effective dose of radon concentration in the drink water of the city 0.711 mSv.y<sup>-1</sup> [18]. In Iran in villages the average of minimum radon Concentrations in water resources was 1.2 BqL<sup>-1</sup>[16]; which was related to a water tank in Baravat; and the average of its maximum amount

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was calculated as 9.88 BqL<sup>-1</sup> which was related to a private home well in Baghchamak village. The annual effective dose 3.082mSvy<sup>-1</sup> [16]. In Palestine Radon concentrations ranged from 0.037 to 0.26 BqL<sup>-1</sup> and The annual effective dose 0.5 mSvy<sup>-1</sup> [17]. In Turkey radon Concentrations in water 0.1361 BqL<sup>-1</sup> and the effective dose 0.418 mSv.y<sup>-1</sup>[20].

**Table (2) Comparison between the current study and other studies**

Country	concentrations BqL <sup>-1</sup>	effective dose mSv.y <sup>-1</sup>
Iraq [18]	0.094- 0.299	0.711
Iran[16].	1.2-9.8	3.082
Palestine [17].	0.37	0.5
Turkey[20]	0.13	0.418
Study	0.124-0.336	0.602

#### Conclusions

- 1- The concentrations of radon <sup>222</sup>Rn in the water samples in Duluiyah city (0.109 to 0.336) BqL<sup>-1</sup>.
- 2- The effective dose in water in Duluiyah city was 0.602 mSv.y<sup>-1</sup>.
- 3- That the results obtained were somewhat consistent with the results of previous studies.
- 4- The measurement of radon by using the RAD7 device needs to moderate temperature and humidity as this device depends on the semi-conductors.

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## تراكيز غاز الرادون في مياه محطات توزيع المياه في مدينة الضلوعية / صلاح الدين

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### الملخص

في هذا البحث تم قياس تركيز غاز الرادون في نماذج من المياه ، فقد تم جمع 90 عينة من 15 محطة مختلفة من مدينة الضلوعية في محافظة صلاح الدين / وسط العراق . وقد استخدم كاشف الرادون الالكتروني RAD7 وتم حساب معدل تركيز الرادون ومعدل الانحراف المعياري وكان أعلى تركيز في  $\text{S}_{13}$   $0.336 \text{ Bq.L}^{-1}$  وأقل تركيز في  $\text{S}_3$   $0.124 \text{ Bq.L}^{-1}$  وكانت الجرعة الفعالة  $0.602 \text{ mSv.y}^{-1}$  . ان معدل الجرعة السنوية المؤثرة في النماذج المدروسة كانت اقل من المعدل المسموح به لمنظمتي (USEPA و WHO) التي تساوي  $1 \text{ mSv.y}^{-1}$  و لذلك يمكن اعتبار النماذج المدروسة آمنة من الناحية الإشعاعية و خاصة الرادون