Measurement of the Radon Concentration in Dust for Some Small side areas of Diwaniyah City by using Nuclear Impact detector CR-39

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Abstract
In this research , the radon concentrations were measured in the rising dust samples as a result of the movement of trucks and vehicles to some small side areas of the city of Diwaniyah - Qadisiyah Governorate in the advanced nuclear laboratory in the Department of Physics / College of Education for Pure Sciences - Ibn Al-Haytham / University of Baghdad with the technique of nuclear impact detector CR-39, whereas the reagents were exposed for period of 30 - day dust samples, results were recorded for radon concentration of dust samples have values ranging from (287.42 ±38.5 – 743.21± 83.6 ) Bq / m$^3$ where the results were higher than the internationally accepted limit recorded by (ICRP) which was (200-300) Bq / m$^3$, also it has been calculated the radiation indicators which represented by the annual effective dose (AED) and potential Alpha Energy Concentration (PAEC) whereas the rate of radiation indicators was higher than the internationally accepted limit .

Key word : Radon , Dust , nuclear impact detector CR-39 .

1. Introduction.
The radiation is a natural part of the environment in which we live and everyone is exposed to this radiation through soil, water, air and food. Humans are always exposed to radiation rushes from sources existing in their surroundings like radioactive metals such as uranium and thorium and other elements that are present in the rocks of the earth's crust where the rate of radiation dose is estimated at an altitude of one meter above the limestone rock, which is in the range of 20 millimeters per year, for granite rocks it rises to 150 millimeters per year [1].

The radioactive elements can be found in the human body by inhaling radioactive gases or enter the radioactive elements into the body with food or drink which leads to their participation in the composition of the body and become a permanent source of radiation to the body, the most important of these elements is the element potassium, which causes a dose of 20 millimeters per year in the human gonads [2]. Humans are also exposed to radiation coming of the outer space in the form of cosmic rays is related to the amount the dose of cosmic rays to which a person is exposed on the Earth's surface and the amount of height from the surface of the earth where the dose increases as the height increases [3].
On the other hand, the industrial sources of radiation created by man have grown after the Second World War, where the number of nuclear reactors has increased very significantly as well as the fission residues of radioactive elements used in nuclear tests, as well as the use of radiation in the treatment and diagnosis of many diseases, development of production of petroleum industries and the accompanying NORM the dust accompanying nuclear tests due to the widespread spread of radiation in the universe and the increase in the amount of radiation dose received by the human being, attention has been given to its prevention because it poses a serious threat to human life [4].

So that, it was necessary to take the necessary measures to protect man and the environment from the dangers of radioactive contamination, it was the first effort in this area by the Runken Society of 1916 ICRU followed and was founded in 1928 as well as the International Agency for Prevention of Radiation (ICRP) and then the International Atomic Energy Agency (IAEA). It is a United Nations agency with interests in the peaceful use of atomic energy and prevention of radiation contamination, in addition to National Societies in all countries of the world to protect their citizens [2], so several studies have emerged and research to estimate the level radioactivity in soil, water, air and plants and their impact on living things.

2. Experimental.

The study was conducted by selecting (15) samples from different locations of Diwaniyah city - Qadisiyah governorate, rising dust patterns were collected as a result of vehicle movement by using a suitable device to draw air (vacuum cleaner) at a distance of 150 cm, Its surface is used for measurement as the duration for a single sample collection, it did not exceed 30 minutes for all models where the weight of each sample was (10g). The nuclear trace detector CR-39 was of British origin with an approximate area (1 × 1cm²) and a thickness (250 µm) that these reagents are pieces of plastic materials, in this study were exposed to the reagent for the studied models for 30 days through place the sample in small plastic containers and place the reagent inside a cylindrical container size information the sample was covered with a container to expose the reagent to the chemical reagents of the plastic reagents were carried out with NaOH (6.25 N) at (60 ° C) for (6) hours. the radon concentration was calculated from the following relationship [5]:

\[ C_{RH} = \frac{E_R}{\rho_x} \left( \frac{\rho}{T} \right) \] ...

\[ C_{RH} : \text{Radon concentration in units (Bq/m}^3) \]

\[ E_R : \text{Radon exposure from standard source in units (Bq day/m}^3) \]

\[ \rho : \text{Effects intensity from exposure to standard radium source in mm}^2 \text{ units.} \]

\[ t : \text{exposure time in units of day.} \]

Or by the following relationship after calibration of the system [5]:

\[ C_{RH} (\text{Bq m}^{-3}) = \frac{1}{k} \left( \frac{\rho}{t} \right) \] ...

Whereas k is the calibration factor, the slope of the straight line in Fig. 2, calculated from the linear relationship between radon exposure and the density of traces, is equal to (0.2568Track m³/Bq day mm²). The calibration element used the radium Ra²²⁶ half-life (1600 year) effectively (5µCi) of the radon emitter Ra²²² by exposing it directly to reagent CR-39 inside a cylindrical container of known size and for different periods of time.
Fig. 1 Map of the districts of (Diwaniyah province).
3. Results and discussion.

After exposing CR-39 solid state nuclear trace detectors for mounting dust samples due to the movement of wheels and cars for most small side areas of the city of Diwaniyah - Qadisiyah province for 30 days were collected reagents to obtain the density of effects per unit area and then calculate the concentrations of radon gas by comparing with the standard models (calibration) using the relationship between effects intensity the radon was exposed to the standard source where the relationship was linear as in Figure (2). From the slope of the graph, the concentrations of radon for unknown samples were calculated using the two relationships (1) and (2), Radiation indicators were calculated as annual effective dose (AED) and potential Alpha Energy Concentration (PAEC) calculated by the two following relationships [6][7]:

\[
\text{AED} = C_{\text{RN}} \times F \times H \times T \times D \quad \ldots \ldots \quad (3)
\]

\[
\text{AED} = C_{\text{RN}} \times 0.4 \times 0.8 \times 8760 \times 0.9 \times 10^{-6}
\]

\[
\text{PAEC} = \frac{F \times C_{\text{RN}}}{3700} \quad \ldots \ldots \quad (4)
\]

Whereas the results of radon concentrations and the intensity of effects and radiation indicators of the dust samples are listed in Table (1), the lowest value of the radon concentration in the air was recorded with the effects and radiation indicators of the dust samples in the sample (S3) and were within the limits (287.42 ±38.5 Bq/m³) It is within the universally accepted and amounting (200 – 300 Bq/m³) [8], The highest value of radon concentration in the air with the intensity of the effects and radiation indicators of the studied samples was recorded in the sample (S5) and was (743.21 ±83.6 Bq / m³), which is higher than the internationally accepted limit. Figure (3) shows the radon concentration levels for dust samples using a CR-39 reagent and Figure 4 shows the annual effective dose for the studied samples.
Table (1) Radon concentration, intensity of effects and radiation indicators using CR-39 detector for dust samples of some small side areas of Diwaniyah city - Qadisiyah governorate.

| Sample | Location | Track number (track/mm²) | CRn (Bq/m³) | AED (msv/y) | PAEC (WL) |
|--------|----------|----------------------------|-------------|-------------|------------|
| S1     | University Site / first Location | 2422.85 | 314.49± 46.4 | 7.93 | 0.0339 |
| S2     | University Site / Second Location | 2464.28 | 319.87± 36.6 | 8.06 | 0.0345 |
| S3     | Professors Site / first Location | 2214.28 | 287.42± 38.5 | 7.25 | 0.0310 |
| S4     | Towards Shami Site / first Location | 3967.14 | 514.94± 91.1 | 12.99 | 0.0556 |
| S5     | Towards Shami Site / Second Location | 5725.71 | 743.21± 83.6 | 18.75 | 0.0803 |
| S6     | Karar Site / first Location | 4847.14 | 629.17± 105.1 | 15.87 | 0.0680 |
| S7     | Karar Site / Second Location | 4865.71 | 631.58± 91.5 | 15.93 | 0.0682 |
| S8     | Green Site / first Location | 4065.71 | 527.74± 32.2 | 13.31 | 0.0570 |
| S9     | Green Site / Second Location | 2860.00 | 371.23± 28.1 | 9.36 | 0.0401 |
| S10    | Industrial Site / first Location | 5158.57 | 669.59± 82.9 | 16.89 | 0.0723 |
| S11    | Industrial Site / Second Location | 3628.57 | 470.99± 47.3 | 11.88 | 0.0509 |
| S12    | Ramadan Site / first Location | 4217.14 | 547.39± 37.5 | 13.81 | 0.0591 |
| S13    | Teachers Site / first location | 3968.57 | 515.13± 40.3 | 12.99 | 0.0556 |
| S14    | Teachers Site / Second Location | 4102.85 | 532.56± 56.3 | 13.43 | 0.0575 |
| S15    | Virginity Site / first Location | 4414.28 | 572.98± 59.3 | 14.45 | 0.0619 |
|        | the average |                       | 509.88 ±40.0 | 12.86 | 0.0550 |
|        | World average |                 | 200-300 | 3-10 [8] | 0.0533 [8] |

Fig. 3 concentration of radon for dust samples of some small side areas of Diwaniyah city - Qadisiyah governorate.
Fig. 4 The annual effective dose (AED) of dust samples

Through the results obtained for radon concentrations recorded by using CR-39 solid state nuclear detector we conclude that these results were higher than the internationally accepted limit (ICRP 2010) which is equal to (200 - 300 Bq / m³) except the values of sample (S3) It is within the universally accepted limit, but in high concentrations due to the fact that some of these sites were a military base in 2003 and some of them have military sites so far and some of them represent the industrial places to repair cars and weapons, as well as that most of these areas are close to the main street of the city of Najaf, and the dust can be transferred as the cause and as indicated by the study of the reference[9] Therefore we suggest conducting the process of cladding the streets or at least spraying them with water to minimize their environmental damage while conducting periodic monitoring of the aerosol pollutants of the area.

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