Radon Concentration in Buildings in the South Region of Kingdom of Saudi Arabia

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Abstract: The radioactive radon gas is generated as a daughter of radium-226 in uranium-238 series which has half life time of about 1600 year, this mean that the radon gas is continually generation. The main source of the radon gas is the upper layer of earth surface, rocks, Deep water and some kind of granite. There for the radon gas is present in all building materials and building specially the closed building. The uptake of radon gas is represent about 50% of the equivalent dose for the major number of peoples the uptake of radon continually with high or low dose will case many specially cancers. In these work solid state nuclear track detectors (CR-39) in the form of squares of dimension 2 cm will placed in plastic cups and sets in some selected areas at Al- Qunfudhah University College for a long period. For the first stage including summer and autumn, the concentrations of radon and Exhalation rates in different places was changed from 121 to 265 Bq\cdot m^{-3} and 2.88 \times 10^{-4} to 6.31 \times 10^{-4} respectively. While the second stage through the summer only it was 88 to 219 Bq\cdot m^{-3} and 4.34 \times 10^{-4} to 10.8 \times 10^{-4} respectively.

Keywords: CR-39, Radon Concentration, Saudi Arabia, Can Technique

I. INTRODUCTION

Exposure to the radon gas which is present naturally in the environment as a daughter of radium-226 can cause a significant health hazard. The poorly ventilated in the dwelling areas like houses, universities, schools and other building in the Saudi Arabia\(^{(1-4)}\) can increase the radon concentration in these areas, therefore the annihilation rate will increase to the level higher than the international levels which we can see in the NCRP reports\(^{(5-11)}\) . Because of the windows in the King Saudi Arabia are continuously closed (90%) and it was absent in a wide range of rooms, Bad ventilation arise. Because of the high sensitivity of the solid state nuclear track detector CR-39 to alpha energy up to 40 MeV it was used in several investigations which were done in different regions in Saudi Arabia and other Arabic and foreign country\(^{(12-27)}\) for a long period through different seasons of the year. In the present work the radon concentration and exhalation rates were measured for different placed inside the Al- Qunfudhah University college which including conference rooms, meeting rooms libraries, and laboratories' and other places.

II. EXPERIMENTAL TECHNIQUE

In this study the indoor radon concentrations were investigated using Solid State Nuclear Track Detector PolyAllyl Diglycol Carbonate called (CR-39). A checking water bath with variable temperatures with capacity 18 liters used for etching process. An optical microscope model TU-
19642C-230 with different eye pieces connected to personal computer through video camera with resolution of 10 mega pixel. Ken-4 program were used to analyze the pictures. The detector matrix were divided into squares with area of 2cm$^2$ then it were cleaned with alcohol and mounted in a plastic cans covered with filter papers as we can see in Fig. 1. About 100 samples were distribute in different places in the Al-Qunfudah University college in the south region of the King Saudi Arabia. Several stages were done for six and three months covering spring and summer together (31 March to 30 Sep.) and the summer season only (31 May to 30 August.) respectively. After the end of the measuring periods the sample were collected from different places. The chemical etching solution was peppered using high purity sodium hydroxide NaOH (99.5%) with concentrations of 6.25 mol.l$^{-1}$. The samples were placed in the glass beaker filled with etching solution then the beaker were covered with a tight lid to prevent the change of the concentration of the etching solution. The beaker were placed in a checking water bath at a temperature of about 70±0.1°C for 6 hours(16).

III. RESULTS AND DISCUSSIONS

After the end of the etching process the detectors were cleaned and dried, then the track density was determined by scanning the detectors using optical microscope with suitable amplifications. Fig.2 show that one example of the alpha particle tracks as we can show in the optical microscope.

The track density must be transfer to the unit of the activity of the radon concentration by using the calibration factor and equilibrium factor between the radon and radon progeny which was 0.4 as recommended ICRP(1993)(10). The radon concentration (27) is given by:

$$C = \frac{N - N_B}{K S t M} \quad (Bq.m^{-3})$$

where $N$, $N_B$, $t$, $M$, $S$ and $K$ are the number of tracks, background, expouger time in hour, number of fields, area of view and calibration factor $K$=0.18 $\alpha$-tracks cm$^{-2}$d$^{-1}$ per Bq cm$^{-3}$ of radon respectively. The annihilation rates(16) were calculated by:
\[ E' = \frac{CV\lambda}{A\left[T + \frac{1}{\lambda(e^{-\lambda T} + 1)}\right]} \]

Where \( A, V, \lambda, \) and \( T \) are the area of the can in \( \text{m}^2 \), effective volume of the can in \( \text{cm}^3 \) decay constant of radon in \( \text{h}^{-1}(0.00756 \text{ h}^{-1}) \) and espouser time in hours respectively.

The annual effective dose equivalent was computed from the integrated radon using the following equation:

\[ D = \frac{R \times 0.4 \times 3.88 \text{mSvWLM}^{-1} \times 7000\text{h}}{3700\text{Bqm}^{-3} \times 170\text{h}} \]

Where \( D \) and \( R \) are the annual effective dose equivalent in \( \text{mSvY}^{-1} \) and the integrated radon concentration in \( \text{Bq.m}^3 \) respectively. The samples were divided into seven groups according to the ventilation of places, where group one have the good ventilation condition while the ventilation condition go to the worst until rich to the very bad ventilation condition in group seven.

As we can see in Fig.3a the radon concentration in the first changed from 121 to 265 \( \text{Bq.m}^3 \), while it was changed from 88 to 219 \( \text{Bq.m}^3 \) for the second stage as we can see in Fig.3b. On the other hand Fig.4(a, b) show that the exhalation rate, which were changed from \( 2.88 \times 10^{-3} \) to \( 6.31 \times 10^{-3} \) \( \text{mBq.m}^{-3} \) and \( 4.34 \times 10^{-3} \) to \( 10.82 \times 10^{-3} \) \( \text{mBq.m}^{-3} \) for the first and second stage respectively. Fig.5 shows the mean value of Radon concentration in different groups.

![Graph showing radon concentration in different groups](image_url)
IV. CONCLUSION

In this work we found that the radon concentration and exhalation rate are vary from one place to another according to the ventilation of this place. However we divided the results into seven groups each of them contain the rooms which approximately have the same ventilations condition. Beside the bad ventilation the other factors likes building materials played a very important role and it will increase the radon concentration in the buildings under investigation.
At the end of this word the authors recommend that:
1. Ventilate all rooms, libraries, laboratories and other places under investigation at least one time per week
2. Make sure all rooms have at least one or more windows according to the area of place

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