RADON DETERMINATION FOR BASEMENT OF BUILDING BY USING SOLID STATE NUCLEAR TRACK DETECTOR

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Abstract

Determination of radon in basement of building was carried out by using LR 115 Type II solid state nuclear track detector with exposure period of 100 days during rainy season, winter and summer. The detectors were placed about 2.4 m from the floor at the five concrete tiles in the basement of selected building. After exposure, the detectors were etched in a NaOH solution of 2.5 N at temperature of 60°C for 90 min. Optical microscope NIKON ECLIPSE 50i was used to count the number of tracks on the detector. It was observed that track density of samples ranged from 7.80 ± 0.49 to 16.51 ± 0.91 C/cm^2 day^{-1} in rainy reason, 5.48 ± 0.33 to 8.79 ± 0.54 C/cm^2 day^{-1} in winter and 6.88 ± 0.41 to 14.73 ± 0.74 C/cm^2 day^{-1} in summer. Radon concentration values were found to vary from 155 ± 9.73 to 329 ± 18.14 Bqm^{-3} with a mean value of 239.4 ± 12.35 Bqm^{-3} in rainy season, 109 ± 6.51 to 175 ± 10.71 Bqm^{-3} with a mean value of 139.6 ± 8.79 Bqm^{-3} in winter and 137 ± 8.25 to 294 ± 14.72 Bqm^{-3} with a mean value of 181.80 ± 10.60 Bqm^{-3} in summer. The overall radon concentration varied from 109 ± 6.51 to 329 ± 18.14 Bqm^{-3} with an average of 186.80 ± 10.58 Bqm^{-3} and the annual effective dose varied from 1.88 ± 0.11 to 5.66 ± 0.31 mSv/yr with the average value of 3.22 ± 0.18 mSv/yr in basement of selected tower for rainy season, winter and summer. The value of radon concentration and the annual effective dose in basement of selected building for rainy season, winter and summer were within the reference levels (200–600 Bqm^{-3} and 3–10 mSv/y) of International Commission of Radiological Protection (ICRP).

Keywords: Radon concentration, Annual effective dose, LR-115 type II SSNTDs

Introduction

Radon is a chemical element with symbol Rn and atomic number 86. It is a radioactive, colorless, odorless, tasteless, noble gas, occurring naturally as a decay product of radium-226, which is found in uranium ores, phosphate rock, shale, igneous and metamorphic rocks such as granite, gneiss, and schist, and in common rocks such as limestone. Its most stable isotope, ^{222}Rn, has a

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half-life of 3.8 days. Radon gas produced by natural sources can be accumulated in buildings, especially in confined areas such as basements or lowest levels of homes. The concentration of radon in buildings depends on house construction type, soil characteristics, ventilation rate, wind direction, atmospheric pressure, humidity, temperature and even the life style of people. Radon concentration inside the buildings varies from season to season, and from month to month and from day to day until between day and night.

Experimental Procedure

Data Collection

LR 115 Type II solid state nuclear track detector, SSNTD (1.5cm ×1.5cm) was hang with the string at the five concrete tiles in the basement of selected building for summer, rainy season and winter through 100 days illustrated in Figure 1. The height of detectors was kept about 2.4 m from the floor.

Figure 1: Sample at concrete tiles inside the basement of selected building near Kamayut Township

Etching of Detectors

The etching process of radon exposed detectors was performed at Nuclear Laboratory, Department of Physics, University of Yangon. 10 g of NaOH granular was firstly weighed with filter paper using weight balance and 100 ml of measuring cylinder was filled 100ml of distilled water. Both of them were put into the 250 ml glass beaker and stirred with glass rod until NaOH granular were completely dissolved in distilled water. The beaker with 2.5 N NaOH solution was heated on a stove with temperature controller. When the temperature reached at 60°C, the radon exposed LR- 115 detector

was put into the beaker for 90 minutes. During etching, the temperature was kept constant with accuracy of ± 1°C and without stirring. After etching, the detector was washed under the running water until the surface of the detector became cleaned from etchant. Finally, the detectors were taken out and dried with filter paper.

Track Counting and Track Density

The track counting of radon exposure detectors were performed by using Optical microscope (10X magnification).The number of tracks were counted view by view changing vertical and horizontal position of detector under the microscope. Then average track density was calculated from the equation:

$$\text{Alpha Average Track Density} = \frac{\text{Average alpha Tracts}}{\text{Microscopic View Area} \times \text{Exposure Time}}$$

Calculation of Radon Concentration and Annual Effective Dose

The radon concentration and annual effective dose can be calculated from the data of average alpha track counts. The calculations are based on the following conversion factor:

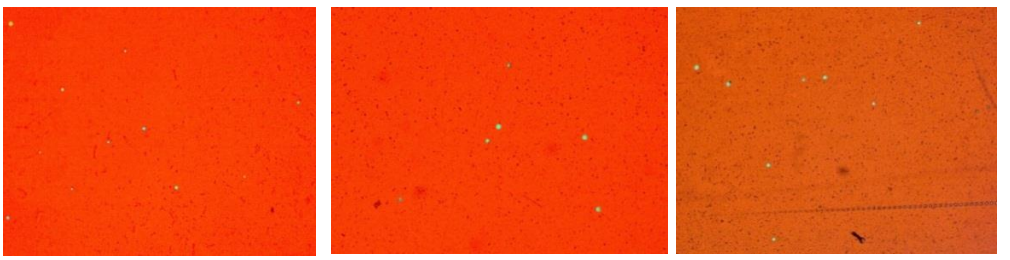
$$1\text{Bq/m}^3 = 0.05016 \text{ track/cm}^2\text{/day}$$

$$1\text{Bq/m}^3 = 0.0172 \text{ mSv/yr} \qquad \text{(ICRP, 2007)}$$

Results and Discussion

The alpha tracks photograph of LR 115 type II detector which were placed in the basement of selected building for rainy season, winter and summer were shown in Figure 2 (a), (b) and (c).Table 1 illustrated the average alpha tracks, track density, radon concentration and annual effective dose in the basement of tower for rainy season, winter and summer. The average track density produced by radon, average radon concentration and average annual effective dose in basement were plotted in Figure 3 to Figure 6. It was found that the average alpha track varied from 6.12 ± 0.38 to 12.96 ± 0.71 in rainy season, 4.3 ± 0.26 to 6.9 ± 0.42 in winter and 5.4 ± 0.33 to 11.56 ± 0.58 in

summer. Track density of samples ranged from 7.80 ±0.49 to 16.51 ± 0.91 C/cm^2 day in rainy season, 5.48 ± 0.33 to 8.79 ± 0.54 C/cm^2 day in winter and 6.88 ± 0.41to 14.73 ± 0.74 C/cm^2 day in summer. Radon concentration values were found to vary from 155 ± 9.73 to 329 ± 18.14 Bqm^{-3} with a mean value of 239.4 ± 12.35 Bqm^{-3} in rainy season, 109 ± 6.51 to 175 ± 10.71 Bqm^{-3} with a mean value of 139.6 ± 8.79 Bqm^{-3} in winter and 137 ± 8.25 to 294 ± 14.72 Bqm^{-3} with a mean value of 181.8 ± 10.60 Bqm^{-3} in summer. The radon concentration of samples in rainy season were greater than that in other two seasons except sample 2 because there was humidity in basement environment of selected building. The radon concentration in winter was lower than that in summer because of ventilation rate in basement. It was clearly seen that the value of average alpha track, track density due to radon, radon concentration and annual effective dose were changed with season because of daily temperature, humidity, poor ventilation, darkness, and pressure values during the measurements in basements of building.



(a) (b) (c)

Figure 2: The photograph of alpha tracks in Samples for the basement of building for (a) rainy season (b) winter and (c) summer

Table 1: Average alpha tracks, track density, radon concentration and annual effective dose of LR 115 from the basement of building for rainy season, winter and summer

		Sample 1	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**	**Average**
Average Alpha Tracks	rainy season	12.96 ± 0.17	6.58 ±0.30	11.64 ± 0.56	6.12 ±0.38	9.84 ±0.47	9.43 ±0.38
	winter	4.30 ± 0.26	6.90 ± 0.42	5.20 ± 0.40	5.58 ±0.36	5.52 ± 0.29	5.50 ±0.35
	summer	11.56 ± 0.58	6.96 ± 0.41	5.40 ± 0.33	5.72 ±0.27	6.14 ± 0.40	7.16 ±0.40
Track Density (C/cm^2 day)	rainy season	16.51 ± 0.91	8.38 ± 0.38	14.83 ±0.71	7.80 ±0.49	12.54 ±0.60	12.01 ±0.62
	winter	5.48 ±0.33	8.79 ±0.54	6.62 ±0.51	7.11 ±0.46	7.03 ±0.36	7.01 ±0.44
	summer	14.73 ±0.74	8.87 ±0.52	6.88 ±0.41	7.29 ±0.48	7.82 ±0.50	9.12 ±0.53
Radon Concentration (Bqm^{-3})	rainy season	329 ±18.14	167 ±7.61	296 ±14.22	155 ±9.73	250 ±12.05	239 ±12.35
	winter	109 ±6.51	175 ±10.71	132 ±10.26	142 ±9.26	140 ±7.30	139.6 ±8.81
	summer	294 ±14.72	177 ±10.33	137 ±8.25	145 ±9.61	156 ±10.11	181.80 ±10.60
Annual Effective Dose (mSv/yr)	rainy season	5.66 ±0.31	2.87 ±0.13	5.08 ±0.25	2.67 ±0.17	4.30 ±0.21	4.12 ±0.21
	winter	1.88 ±0.11	3.01 ±0.18	2.27 ±0.18	2.44 ±0.16	2.41 ±0.12	2.40 ±0.15
	summer	5.05 ±0.25	3.04 ±0.18	2.36 ±0.14	2.50 ±0.17	2.68 ±0.17	3.13 ±0.18

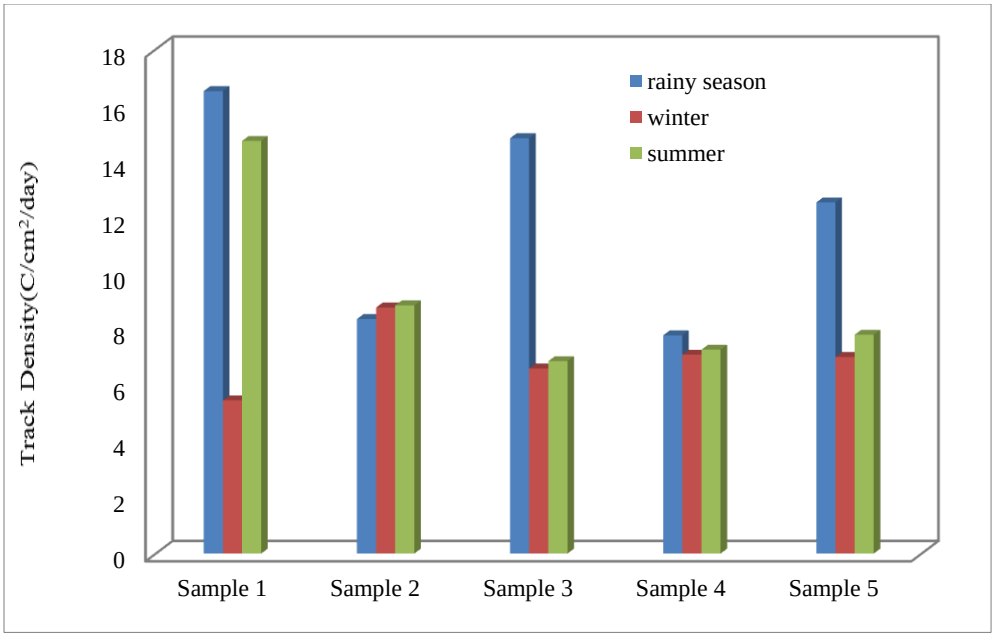


Figure 3: Track density in basement of building with three seasons

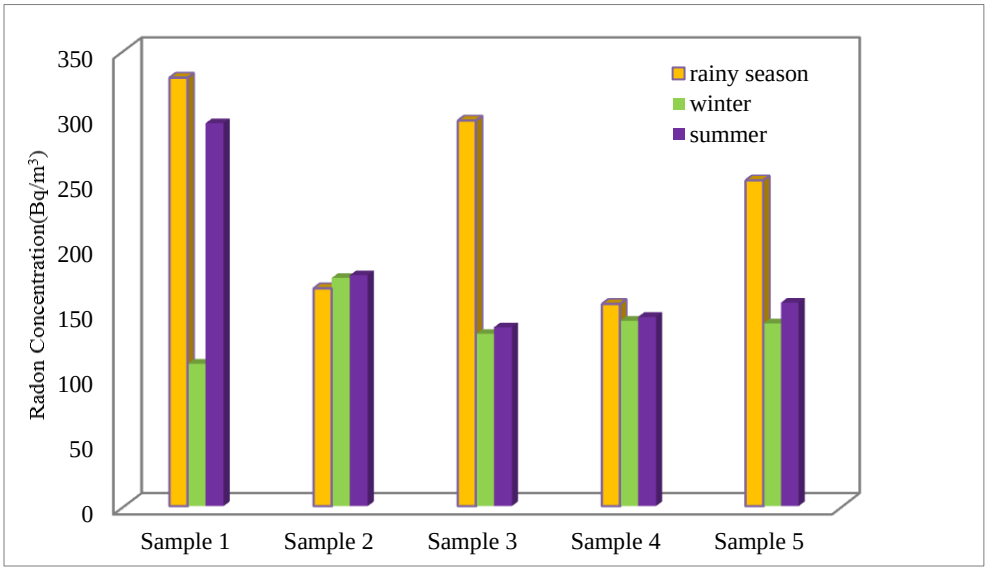


Figure 4: Radon concentration in basement of building with three seasons

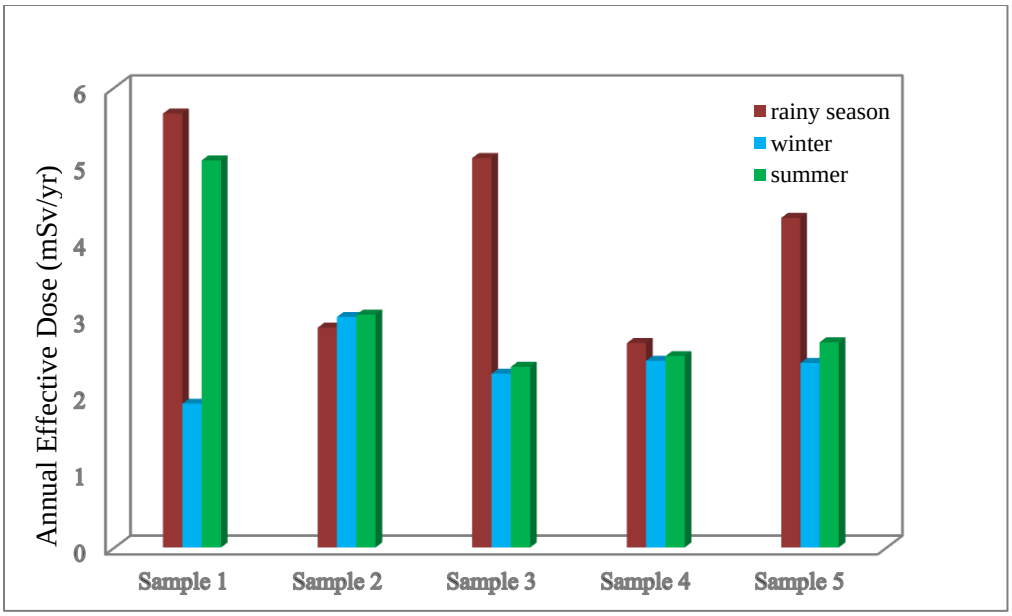


Figure 5: Annual effective dose in basement of building with three seasons

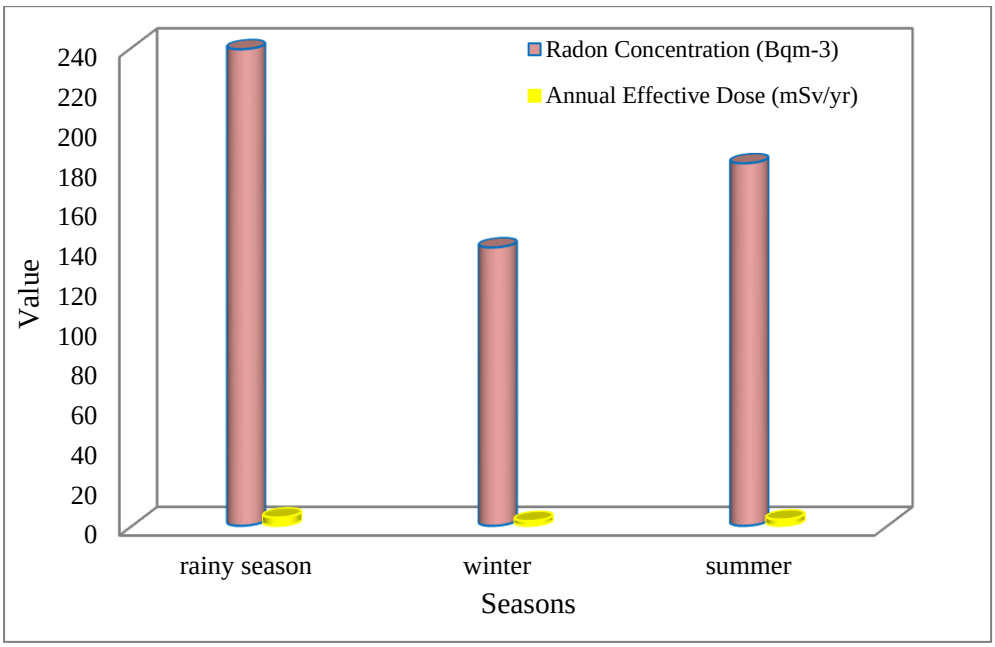


Figure 6: Average radon concentration and Average annual effective dose in basement of building with three seasons

Conclusion

Radon (^{222}Rn) concentrations was measured in basement of building by using solid state nuclear track detectors with exposure period of 100 days in rainy season, winter and summer. The overall radon concentration varied from 109 ± 6.51 to 329 ± 18.14 Bqm^{-3} with an average of 186.80 ± 10.58 Bqm^{-3} and the annual effective dose varied from 1.88 ± 0.11 to 5.66 ± 0.31 mSv/yr with the average value of 3.22 ± 0.18 mSv/yr in basement of selected tower for rainy, winter and summer. Radon levels were found to be seasonal dependent. The average values of concentration of radon and average annual effective dose of radon in basement of tower were within the reference levels (200–600 Bq/m^3 and 3 – 10 mSv/y) of International Commission of Radiological Protection (ICRP). The average value of overall radon concentration and the annual effective dose were lower than the reference levels (200 – 600 Bq/m^3 and 3 – 10 mSv/y) of International Commission of Radiological Protection (ICRP). Thus, seasonal variation was affected radon level in basement of the building but there was no radiological hazards for human beings.

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