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INDOOR RADON CONCENTRATION MEASUREMENTS OF THE NARANI HALL (SOUTH) IN MEIKTILA UNIVERSITY BY USING SOLID STATE NUCLEAR TRACK DETECTORS

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Abstract

A study of indoor radon concentration has been carried out in the three rooms of Narani Hall (south) in Meiktila University Campus, Meiktila Township, Mandalay Region in Myanmar, using LR-115 Type II Solid State Nuclear Track Detectors (SSNTDs). Three small pieces of LR-115 ($1cm \times 1cm$) detectors each was attached on the ceiling 9 ft from the floor of the room.According to the present measurements, it was found that, the value of concentration of radon ranges from 25.12 ± 3.39 Bq m^{-3} to 53.63 ± 11.76 Bq m^{-3} with an average value of 35.75 ± 6.98 Bq m^{-3}. The annual effective dose ranges from 0.43 ± 0.044 m Sv yr^{-1} to 0.92 ± 0.074 m Sv yr^{-1} with an average value of 0.61 ± 0.045 m Sv yr^{-1}.

Keywords: Indoor radon concentration, radon concentration ranges, annual effective dose ranges

Introduction

Radon is a natural radioactive gas, released from the normal decay of the elements uranium, thorium, and radium in rocks and soil, without odour, colour or taste and is an α emitter that decays with a half-life of 3.82 days**.** Radon is an unstable radionuclide that disintegrates through short lived decay products called radon daughters and radon progenies. The short lived progeny, which decay emitting heavily ionizing radiation called alpha particles. Indoor radon concentrations are almost always higher than outdoor concentrations. Radon levels are generally highest in cellars and basements because these areas are nearest to the source and are usually poorly ventilated**.** The detection and radon concentration measurements are one of the most important procedures in environmental protection. In the present study indoor radon concentration in Narani Hall (south) at Meiktila University were measured. Figure (1) shows Radioactive decay scheme of radon ^{222}Rn. In this radon

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concentration measurements, one type of solid state nuclear track detectors (SSNTDs), LR-115 type II was used. The principle of this technique is based on the production of track in the detector due to alpha particles emitted from radon and its progeny.

After exposure, the tracks are made visible by chemical etching and counted manually under the optical microscope. From the alpha track detection, we carried out alpha track densities, the radon concentrations and annual effective doses. The plastic track detector LR-115 Type II used in this work is a cellulose nitrate red dyed film, manufactured by Kodak Pathe France, LR-115 is a solid state nuclear track detector (SSNTD) based on cellulose nitrate and has been commonly used for measurement of concentration of radon gas and / or radon progeny. The sensitive surface for alpha particle, red dyed, is of 10μm thickness of cellulose nitrate (CN) layer on a colorless inert backing material and the base is 100μm polyester. The composition of LR-115 Type II ($C_6H_8O_9N_2$) is shown in fig (2). Its advantage is that after suitable etching, the tracks appear as colorless holes against a red background. Obviously, only one side of this film is sensitive, and this must determined before used. Etched tracks show up as bright holes in a dark red background, and are very clearly visible under a low power microscope of magnification.

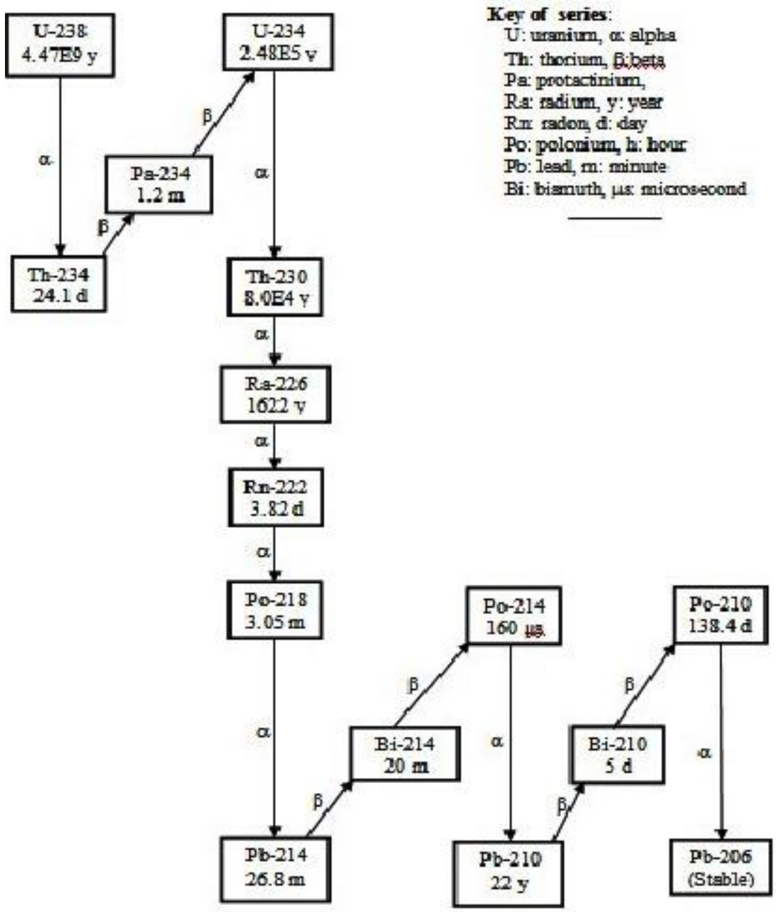

Figure 1: Radioactive decay scheme of uranium ^{238}U

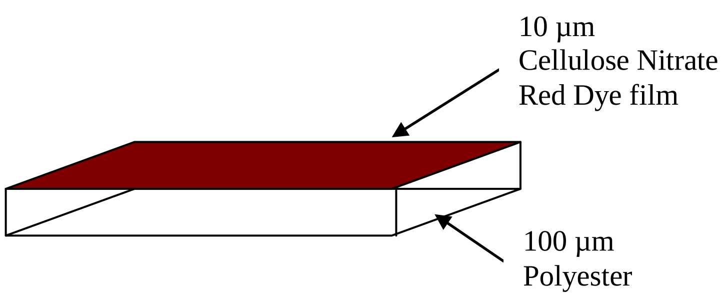

Figure 2: The Structure of the Solid State Nuclear Track Detector LR -115 Type II Cellulose Nitrate film

Experimental Details

In this work, large sheets of LR-115 having 24 cm^2 was cut into small pieces of size 1 cm × 1 cm. There small pieces of LR-115 detectors were attached on the ceiling at 9 ft height from the floor. One of the detector sample (S1) was attached at the ground floor, another one sample (S2) was attached at the first floor and the last one sample (S3) was attached at the second floor of Narani Hall (South) in Meiktila Uniuersity Campus. The photograph of Narani Hall at Meiktila University is shown in Fig (3). The installed places of sample (1) (Ground floor of Narani Hall at Meiktila University) is shown in Fig (4). The install places of sample (2) (First floor of Nartani Hall at Meiktila University) is shown in Fig (5). The installed places of sample (3) (second floor of Narani Hall at Meiktila University) is shown in fig (6). These samples were exposed to radon in air to collect α - tracks on 100 days. At the end of exposure time, these samples were etched with 2.5N NaOH solution. Chemical etching was carried out in a thermostatically controlled bath at temperature 60$\pm$1℃ for 90 minutes as etching duration. The etching process of detector is shown in figure(7).After etching process, the samples were removed and washed under running tap water to remove the etching residue from the etch pits. And then the samples were dried on the filter paper. After drying, the number of tracks was determined using optical microscope and the track densities, radon concentration and annual effective doses were calculated.

Figure 3: The photograph of Narani Hall at Meiktila University

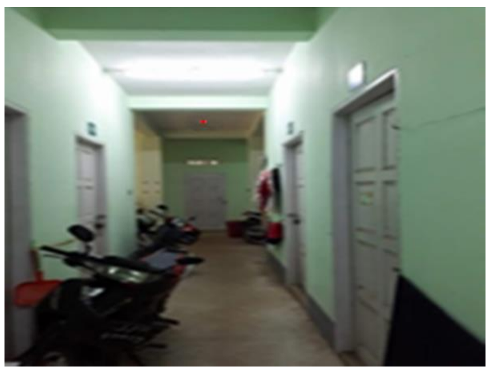

Figure 4: The installed places of sample (1) Ground floor of Narani Hall at Meiktila University

Figure 5: The installed places of sample(2) First floor of Narani Hall at Meiktila University

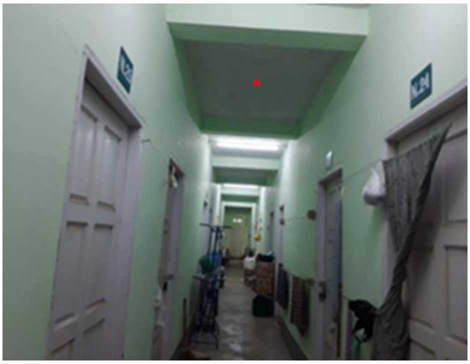

Figure 6: The installed places of sample(3) Second floor of Narani Hall at Meiktila University

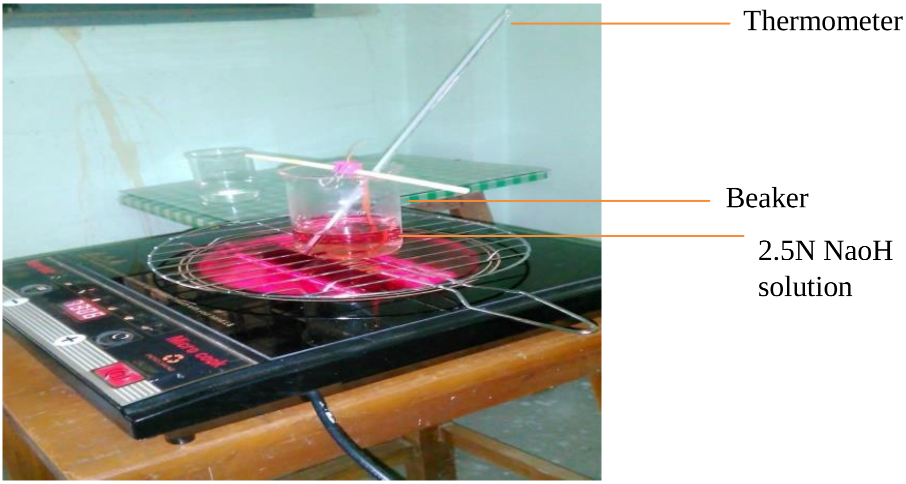

Figure 7: Etching Process of Detectors

After chemical etching, the etched tracks produced by alpha particles were observed and counted using biological microscope model Optima G-205 at Botany Department in Meiktila University. The mostly used method of track counting employs an optical microscope is as shown in Figure (8). According to the observation views of the screen of microscope, alpha tracks were counted to reduce the statistical errors. The photographs of alpha tracks in LR-115 detectors are shown in figure (9) to figure (11).

In this work, alpha tracks were counted for different fifty views and the track densities were calculated by using equation:

$$\text{Track Density(track cm}^{-2}\text{)day}^{-1}\text{)} = \frac{\textit{Number of Net Tracks}}{\text{Area of counted view} \times \text{Exposure time}} \quad (1)$$

$$\text{Radon(Bqm}^{-3}\text{)} = \frac{\text{Track Density}}{\text{Calibration Factor}} \quad (2)$$

$$\text{Annual Effective Dose} = \text{Radon Concentration} \times 0.0172 \text{ mSvyr}^{-1} \quad (3)$$

Figure 8: OPTIMA G-205 Biological Microscope

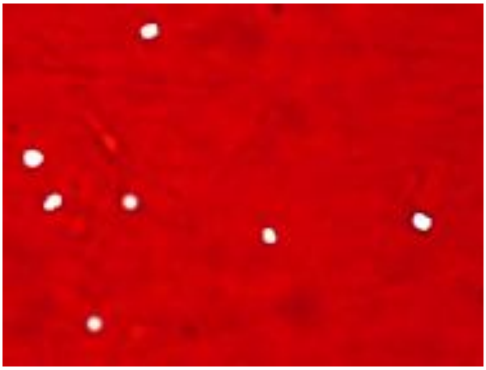

Figure 9: Photograph of Alpha tracks in LR - 115 Detector for Sample(S1)

Figure 10: Photograph of Alpha tracks in LR -115 Detector for Sample (S2)

Figure 11: Photograph of Alpha tracks in LR-115 Detector for Sample (S3)

Results and Discussion

From the experimental work, the estimate of radon concentrations and the annual effective doses were carried out. Average number of alpha tracks and track densities of each sample were calculated by using equation(1). By using calibration factor 0.05016 track cm^{-2} day^{-1} = 1 Bqm^{-3}, radon concentrations can be calculated from equation (2). And then the annual effective doses were calculated by using equation(3).The average number of tracks and track densities were mentioned in Table (1). The radon concentrations and annual effective doses were mentioned in Table (2) and Table (3).The graphs of alpha track densities, radon concentrations and annual effective doses from three different places are shown in Fig (12) to Fig(14). The comparison graph of ICRP Level and Samples in annual effective doses are shown in Fig (15).

Table 1: The Alpha Track Densities (track cm^{-2} day^{-1}) for three different floors

Sr. No.	Name of Samples	Average number of Alpha Tracks	Alpha Track Densities (track cm^{-2} day^{-1})
1	S1	0.76 ± 0.19	2.69 ± 0.22
2	S2	0.46 ± 0.12	1.43 ± 0.15
3	S3	0.42 ± 0.09	1.26 ± 0.13

Table 2: The radon concentrations (Bq m^{-3}) for three different floors

Sr. No.	Name of Samples	Radon concentrations (Bq m^{-3})
1	S1	53.63 ± 11.76
2	S2	28.51 ± 5.78
3	S3	25.12 ± 3.39

Table 3: The Annual Effective Doses (m Sv yr^{-1}) for three different floors

Sr. No.	Name of Samples	Annual Effective Doses (m Sv yr^{-1})
1	S1	0.92 ± 0.07
2	S2	0.49 ± 0.05
3	S3	0.43 ±0.04

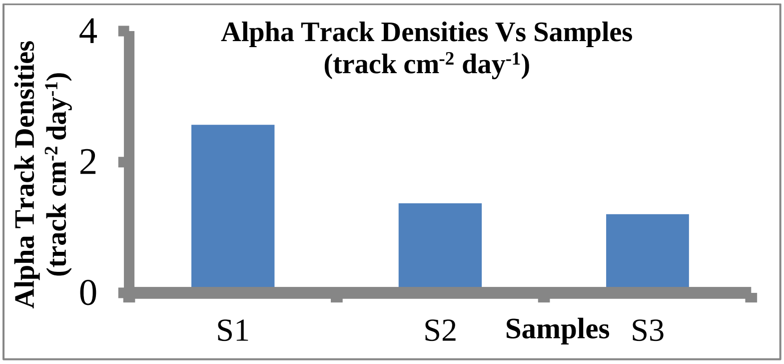

Figure 12: Comparison graph of alpha track densities for three different floors

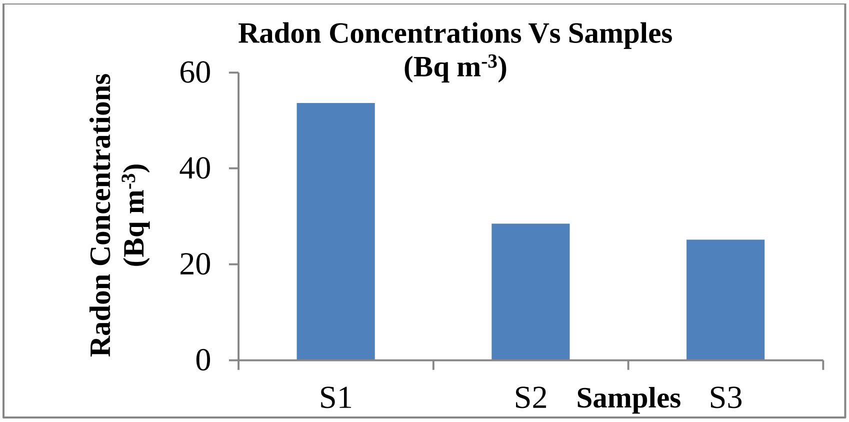

Figure 13: Comparison graph of radon concentrations for three different floors

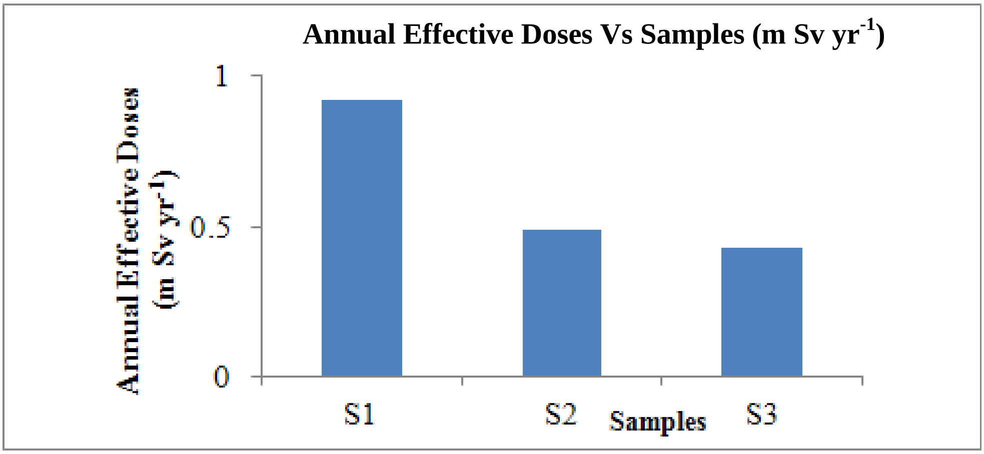

Figure 14: Comparison graph of annual effective doses for three different floors

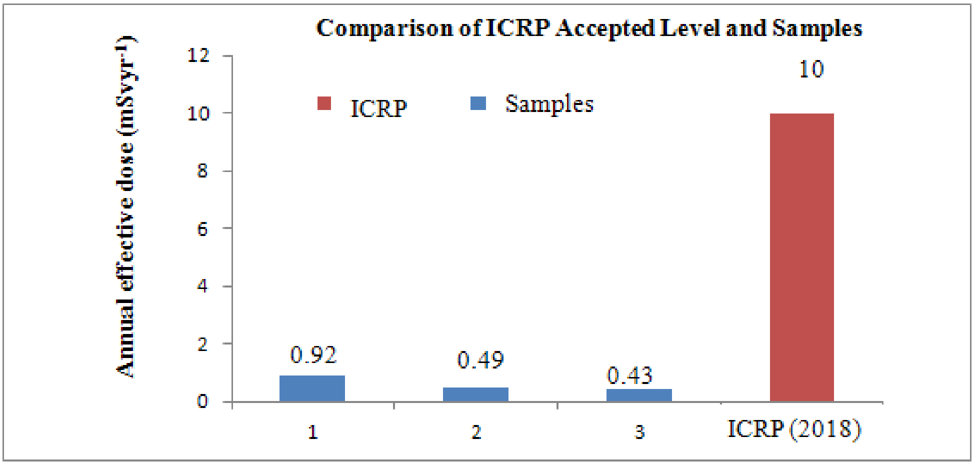

Figure 15: Radioactive decay scheme of radon ^{222}Rn

Conclusion

Radon is the biggest contributor to natural radiation in the environment and causes long term health concern. Therefore, the measurement of radon concentration is needed for environmental purpose. The results of indoor radon concentration measured with LR-115 type II were presented in this work. The results have been found lower than that of ICRP limited level. From this observation, radon will not accumulate in this building due to rich ventilation. Because, a ventilation rate is inversely proportional to the radon level. Finally, it is proved that concentration of radon crowded areas are generally safe in terms of health risks.

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