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MEASUREMENTS OF RADON CONCENTRATIONS OF SHWEKU TANKE PAGODA AT PAKOKKU TOWNSHIP IN MAGWAY REGION, MYANMAR

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Abstract

In this research paper, radon concentrations from two places of Shweku Tanke Pagoda at Pakokku township in Magway region have been estimated by using alpha sensitive two CR-39 detectors (SSNTDs). Radon track densities, radon concentrations and annual effective doses were carried out from these two detectors at 18th March from 15th July, 2022. The radon concentrations were observed 15.78 $\pm$8.63 Bqm^{-3} and 16.41 $\pm$ 10.615 Bqm^{-3} from two locations in these Pagoda. The radon concentrations from two places were found that lower than the recommended WHO (2009) reference level of 100Bqm^{-3}. The annual effective dose from two locations were observed 0.27$\pm$0.148 mSvyr^{-1} and 0.28$\pm$0.18 mSvyr^{-1} which were lower than the International Commission on Radiological Protection (ICRP) recommendation of 5mSvyr^{-1}. The radon concentrations from the two places of Shweku Tanke Pagoda were found within the safe limit.

Keywords: radon concentrations, CR-39, SSNTDs, annual effective dose

Introduction

Shweku Tanke Pagoda is one of the historical pagodas in Myanmar. It is situated at Pakokku city in Pakokku township, Magway Region. It was built by King Alaungsithu at 454 eras. Tanke or Tangee (ornamental backdrop of throne) of standing Buddha image from Shweku Tanke Pagoda is world famous wood carvings sculpture. It was carved prominent sculptor by U Kan Gyi in 1908. The height of the Tanke is twelve feet and ten inches, length five feet and ten inches, cubic thickness is eight inches. It was carved with the best wood yamanaythar (Khin Nu Swe, 2016). In this research work, the investigations of radon concentrations of Shweku Tanke Pagoda were measured in Pakokku city at Pakokku Township in Magway division.

Radiation is the energy that transport either in the form of electromagnetic waves or particles. Basically, radiation can be classified into two types. The first type is ionizing radiation such as (X-ray, gamma ray, alpha and beta particles) that contains high energy to transport electrons from atoms and molecules in the cell. The harmful result of ionizing radiation is biological damage to Deoxyribose Nucleic Acid (DNA) or other parts of the body. Even low doses of radiation, there is a higher risk of cancer. The second type is non-ionizing radiation such as (radio waves, micro waves, Ultra violet Ray (UV), Infrared Ray (IR) and visible light).

Radiation includes an important sector of our daily life as the world is naturally radioactive. Radioactive materials are present in earth crust, the floors and walls of the building and in the food. Radioactive elements are being occurred naturally from the radon gases in the air we breathe, in the muscles, the bones and the tissue of the human bodies.

The atoms are unstable and changes in the atoms of another element through ionizing radiation process. This process is known as radioactivity which means the spontaneous decay and transformation of unstable atomic nuclei accompanied with the emission of nuclear particles or photons. Exposure to natural radiation occurs in two ways. For the first time by gamma ray and radon exhalation. Gamma radiation rises from ^{40}K,^{238}U and ^{232}T, thus exposing the entire body to that radiation while radon leads to internal dose exposure. Half of the total annual effective dose received by the population stems from radon and its decaying products There are many factors that contribute to indoor radon. These factors are the construction of terrestrial, internal or external building materials, soil characteristics, water supply, ambient air, environmental

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standards (temperature, atmospheric pressure, precipitation). There are four radioactive decay series, Uranium, Actinium, Thorium and Neptunium. Radon (^{222}Rn) gas is obtained from these decay chain of ^{238}U, ^{235}U,^{232}Th and ^{237} Np (Irving Kaplan et al, (1954). Radon is colourless, odourless and is an alpha emitter that decays with a half-life of 3.82 days into a series of radon progeny.

In order to measure the radon concentration, Solid State Nuclear Track Detectors (SSNTDs) CR-39 was used. Solid State Nuclear Track Detectors are dielectric materials or solid insulator such as mica, glass synthetic plastics etc., which record and permanently store the trajectory of fast-moving charged particles in the form of submicroscopic trials of continuous damage called "latent tracks". These nuclear tracks formed are identified by using optical microscope.

This research is to measure the radon concentrations of Shweku Tanke Pagoda by using CR-39 SSNTDs detector. In this research, two detectors S1 and S2 were placed in Shweku Tanke Pagoda at 20th March to 17th July in 2022 as shown in the figure (1).

This research will support the data of the radon concentrations of the selected places of Shweku Tanke Pagoda at Pakokku city in Magway region. The information of this research will be benefit for the people from this region.

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Figure 1. Shweku Tanke Pagoda in Pakokku Township

Figure 2. Location map of Shweku Tanke Pagoda in Pakokku Township

Figure 3(a). CR-39 detector S1 under the Buddha Image

Figure 3(b). CR-39 detector S2 infront of the main buliding

Figure 4(a). The etching photograph of CR-39 detector

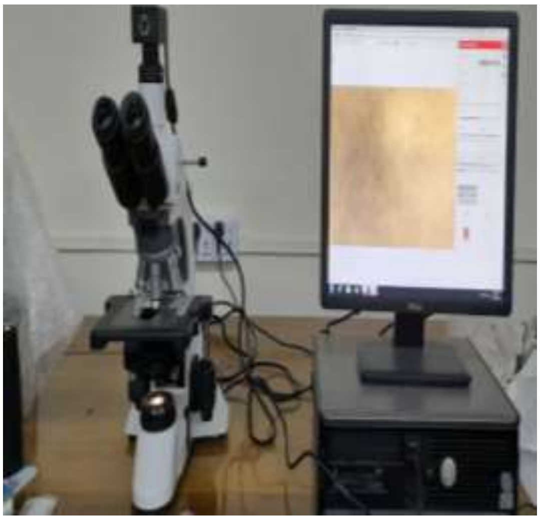

Figure 4(b). Photograph of optical microscope

Materials and Methods

Study Area

The two detectors were placed in the main building of Shweku Tanke Pagoda in 9th quarter of Pakokku city which is situated between 21° 20' 21.89" North latitude and 95° 04′ 13" East longitude. Location of the places of Shweku Tanke Pagoda were shown in figure 2.

Study Period

The study period is18th March from 17th July, 2022. The exposure time of the detectors is 120 days.

Sample Preparation

The two detectors were cut into small pieces of size 1cm x 1cm each. The first detector S1 were placed under the throne of the Buddha image and the second detector S2 were placed on the wall in front of the main building of the Shweku Tanke Pagoda as shown in the figure 3(a) and figure 3(b). After 120 days, the two detectors were removed from the two places. 6N NaOH solution will be needed to prepare. Firstly, 24g of NaOH was weighted in the balance and put in 100mL of empty beaker. Distilled water were poured into this beaker with NaOH to reach the 100mL scale point and stirred with a glass rod to dissolve NaOH. The NaOH solution were poured into another empty glass beaker. The beaker with NaOH solution was heated on a stove with temperature controller. When the temperature reached at 70°C, one of the radon exposed CR 39 detector was put into the beaker for 6 hours and 30 minutes. During etching period, the temperature was kept constant with accuracy 70$\pm$1°C for 6 hours and 30 minutes as shown in figure 4(a). After it was etched, the detector was washed with distilled water thoroughly until the surface of the detector became cleaning from etchant. Finally, the detector was dried in open air to avoid scratching from the detector After drying the detector, it was placed under optical microscope (Olympus B202 BX51) as shown in figure 4(b) from Universities' Research Center with digital camera and a display system to count the tracks produced by alpha particle of the detector. The tracks of the detector were viewed 20 times to reduce the statistical error. Another detector was also made like this procedure.

Materials and Methods

The two detectors CR-39 were used to investigate the radon concentrations of Shweku Tanke Pagoda from Pakokku township.

Solid State Nuclear Track Detectors Technique

The selected CR-39 detector is made of polyally diglycol carbonated with a thickness of 1.5mm. Solid State Nuclear Track Detectors (SSNTDs) technique is the technique of measuring the number of particles by observing their tracks in certain organic and in organic materials has been used for the study of nuclear physics. SSNTDs techniques is based on the damage created in a solid along the path of a heavily ionizing particle such as an alpha particle are a fission fragment. The damage along the path called a track can been seen an ordinary optical microscope after etching with suitable chemicals. The visible tracks are counted either by direct observation with the help of automated instruments. (Durrani et al., (1997)

CR-39 Track Detector

CR-39 is Allyl Diglycol Carbonate (ADC) is a plastic polymer commonly used in the manufacture of eyeglass lenses. CR-39 is made by polymerization of diethylenegylcol bis allylcarbonate(ADC) in presence of diisopropyl peroxydicarbonate initiator. CR-39 plastic has an index of refraction of 1.498. An alternative use includes a purified version that is used to measure neutron radiation, type of ionizing radiation in neutron dosimetry. In the radiation detection application, CR-39 is used as a solid state nuclear track detector to detect the presence of ionizing radiation. Energetic particles colliding with the polymer structure leave a trail of broken chemical bonds within the CR-39. Before etching, photographs are taken of the biological sample with the affixed CR-39 detector, with care taken to ensure the prescribed location marks on the detector are noted. After etching process, automated or manual scanning of the CR-39 is used to physically locate the ionizing radiation recorded, which can be mapped to the position of the radionuclide within the biological sample.

Track Detection Technique

Solid state nuclear track detectors technique is fundamentally similar to cloud chamber and ionization chamber techniques. The passage of heavily ionization nuclear particles through most insulating solids creates narrow paths of intense damage trails on an atomic scale. The size of the latent tracks is very small about 50 $\dot{A}$ and therefore track etching technique has to be used to enlarge the size of the tracks. The etched tracks in the detector are permanent and these tracks can easily be seen visually by using the optical microscope. (Price P B et al., 1975)

Microscopic Observation

The nuclear track formed are identified by using Olympus Bx51 optical microscope. The optical microscope with Bx51 digital camera attached was used in this research work. The tracks formed were viewed under different magnifications as the display monitor. The visible area containing tracks in an SSNTD will vary depending upon the magnification. Also, in a given SSNTD, the size of tracks formed depend upon the energy of irradiating particles and etch conditions.

Nature of the Damage

Most tracks are ionization produced defects by the results of the interaction of charge particle with the electrons attached to atoms in the detector. The magnitude of the damage from ionization and excitation processes along a particle trajectory can be determined. (Harald Enge et al., (1987).

Alpha Track Density

The technique of SSNTD is based on the damage created in an insulating solid along the path of a heavily ionizing particle such as alpha particle. The damage along the path called a track can be seen with optical microscope. The visible tracks were counted either by direct observation by a human or with the help of automated instruments. Within viewing optical image analysis with 20 times, the average value of the track density with statistical error were calculated by counting number of tracks using Arithmetic mean and standard error method with the help of Microsoft Excel. The alpha track density in solid state nuclear track detector is the number of net alpha track per unit area in equation 1 (Fareed M et al., IJSR (2018).

$$Track\ density = \frac{Number\ of\ Net\ Tracks}{Area\ of\ Counting} \qquad (1)$$

Chemical Etching

Chemical etching was carried out in a thermostatically controlled bath at temperature ranging from 70±1°C. The etching time was one and half hours. The etchants which have been most commonly used for plastic detectors are aqueaous alkaline solutions of 6N NaOH solution. 240 g of NaOH was added into 1 L of distilled water. Size of the track depends upon the concentration of etching solution, etching time and temperature. Each detector was placed in the beaker with NaOH solution and heated 70 ± 1°C with temperature-controlled stove as shown in the figure 4(a). After heating in one and half hours, the detector was removed and washed with distilled water to remove the etching residue from each pit. After being washed with distilled water, the detector was dried in air for twelve hours. Then the detector was counted under an optical microscope. The etched track diameter was typically a few micrometers in size and larger in size after prolonged etching.

Calibration Factor of Radon Concentration

According to number the alpha tracks as shown in the figure 5(a) and figure 5(b), the radon concentrations were calculated by using the number of tracks. The calibration factor was obtained from the inter-laboratory comparison exercises carried out at the national level by the Environmental Assessment Division of BARC, Mumbai. Calibration factor 0.065Bqm^{-3} were used to estimate the radon concentrations of the detectors. The annual effective doses 0.072 mSv y^{-1} were carried out using publication (ICRP1993). (Moe Win et al., 2014)

Result and Discussion

The track densities in different places of detectors were shown in table (1), the radon concentrations of the two different places were shown in table (2), the annual effective dose in different places were shown in table (3). Comparison of the track densities for different places were shown in figure (6), Comparison of radon concentrations of two places were shown in figure (7). Comparison of the annual effective dose in two places were shown in figure (8). The track densities, radon concentrations and annual effective dose of detector S1 was lower than the detector S2 in the main building of the Shweku Tanke Pagoda.

In this research work, the radon concentrations were observed 15.78 $\pm$8.63 Bqm^{-3} and 16.41 $\pm$ 10.615 Bqm^{-3} from two locations in these Pagoda. The radon concentrations from two places were found that lower than the recommended WHO (2009) reference level of $100Bqm^{-3}$. The annual effective dose from two locations were observed 0.27$\pm$0.148 $mSvyr^{-1}$ and 0.28$\pm$0.18$mSvyr^{-1}$ which were lower than the International Commission on Radiological Protection (ICRP) recommendation of $5mSvyr^{-1}$.

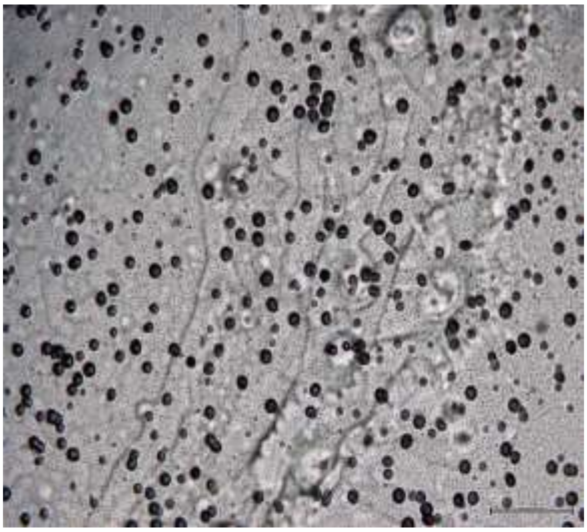

Figure 5(a). Photomicrograph of detector S1

Figure 5(b). Photomicrograph of detector S2

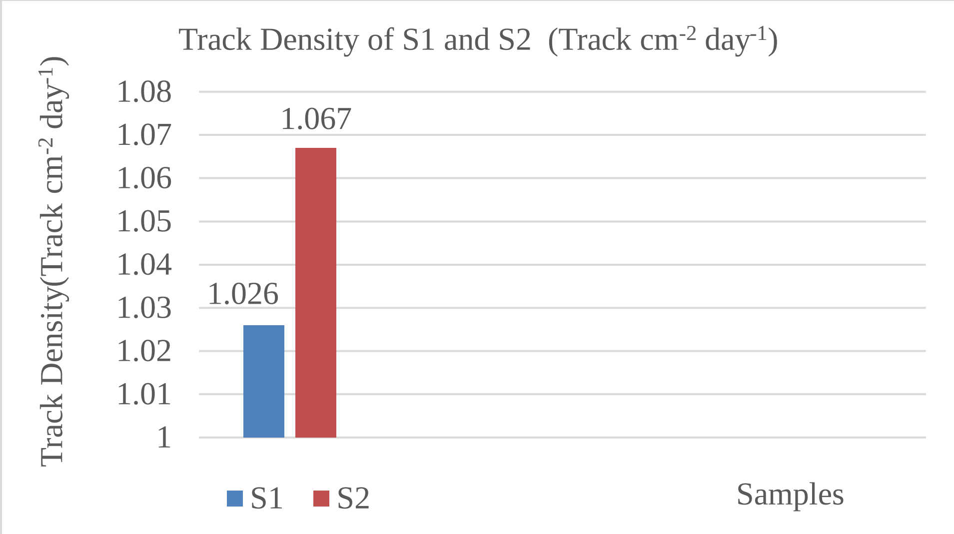

Figure (6). Comparison of the track densities for two places

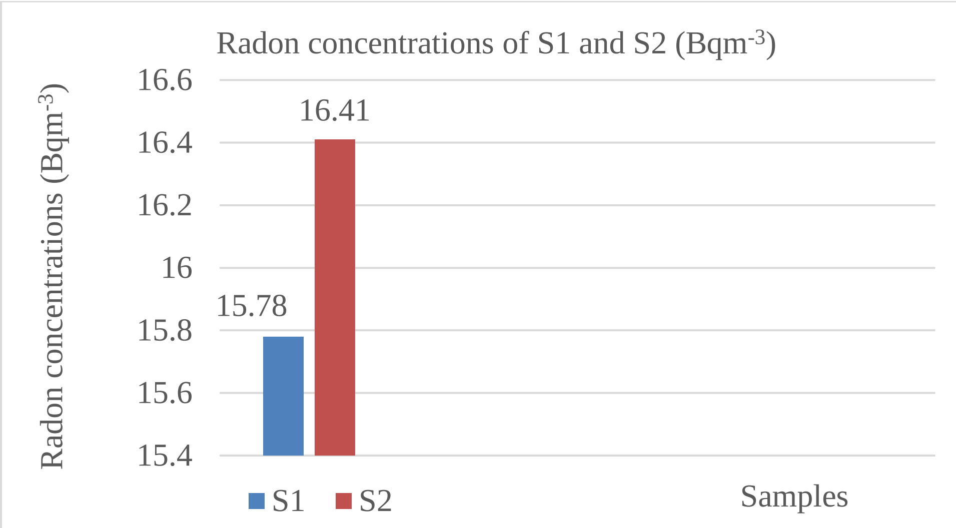

Figure (7). Comparison of radon concentrations for two places

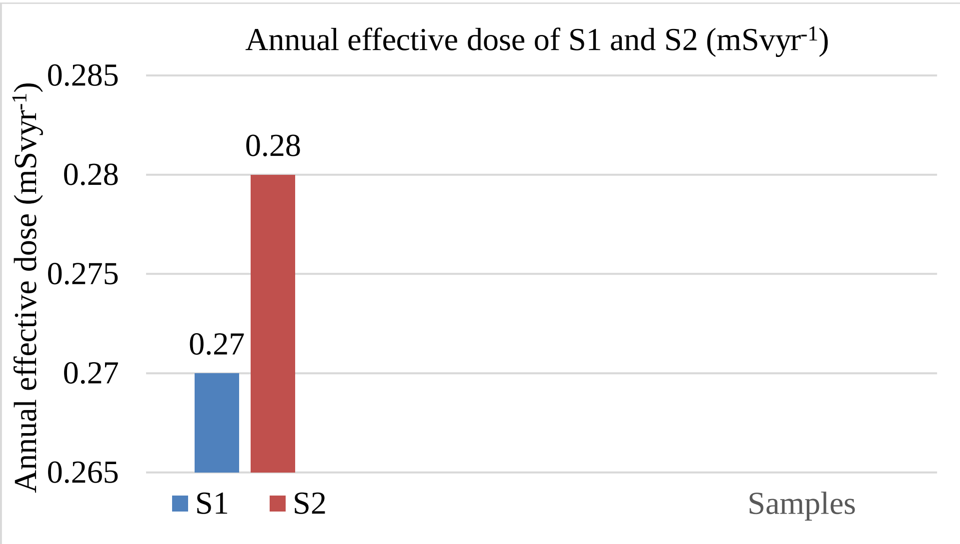

Figure (8). Comparison of the annual effective dose for two places

Table (1). Track Density of the detectors

No	CR-39 Detector	Average Track Density (Track cm^{-2} day^{-1})
1	S1	1.026±0.561
2	S2	1.067±0.69

Table (2). Radon Concentrations of the detectors

No	CR-39 Detector	Radon Concentrations (Bqm^{-3})
1	S1	15.78±8.63
2	S2	16.41±10.615

Table (3). Annual Effective dose of the detectors

No	CR-39 Detector	Annual Effective Dose ($mSvyr^{-1}$)
1	S1	0.27±0.148
2	S2	0.28±0.18

Conclusion

The radon concentrations of sample S1 from the wall under the throne of Buddha image were seen that lower than the radon concentration of sample S2 from the wall in front of the main building. The air ventilation of the place from sample S1 is better than the place from the sample S2. The radon concentrations from the two places of Shweku Tanke Pagoda were found within the safe limit. Although the radon concentrations were within the acceptable limit, radon concentration measurements will be needed to measure seasonally. The data of my research work will be useful data for the people from this region.

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