J. Myanmar Acad. Arts Sci. 2020 **Vol. XVIII.No.2C**

DETERMINATION OF RADON CONCENTRATION IN SOME WATER SAMPLES COLLECTED FROM THREE VILLAGES IN SALINGYI TOWNSHIP WITH SSNTDs

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Abstract

Water is the most abundant substance on earth, and it is the principal constituent of all living things. Radon dissolved in water can cause to significant health problems for humans through inhalation and ingestion. In the present work, a total of eleven water samples from the three villages near the Mine area in Salingyi Township were analyzed for dissolved radon by using solid state nuclear track detection technique. The principle of this technique/e is based on the production of track in the detector due to alpha particles emitted from radon and its progeny. To detect the alpha track, LR-115 plastic track detectors were used for an exposure time of 100 days. After exposure, the tracks are made visible by chemical etching and counted manually under the binocular microscope. The measurement track density is converted into radon concentration. The concentration of radon has been found to be varying from 0.36±0.02 $pCil^{-1}$ to 0.61±0.04 $pCil^{-1}$. The present results show that the radon concentrations in all water samples are below the allowed limit from International Commission on Radiological Protection agency which is 27 $pCil^{-1}$(ICRP 2009). In addition to the radon concentrations, the annual effective dose has been calculated.

Keywords: Track density, Radon concentration, Annual effective dose.

Introduction

Radon is a colorless, odorless, tasteless radioactive gas. It forms naturally from the decay of radioactive elements, such as uranium, which are found at different levels in soil and rock throughout the world. Radon gas in the soil and rock can move into the air and into ground water and surface water. Radon is present outdoors and indoors. It is normally found at very low levels in outdoor air and in drinking water from rivers and lakes. It can be found at higher levels in the air in houses and other buildings, as well as in water from underground sources, such as well water.

Radon breaks down into solid radioactive elements called radon progeny such as polonium- 218, polonium-214 and lead-214. Radon progeny can attach to dust and other particles and can be breathed into the lungs. As radon and radon progeny in the air break down, they give off alpha particles, a form of high energy radiation that can damage the DNA inside the body's cells.

In this research work, the LR-115 SSNTD film is used to measure the alpha track detection. Track detectors are successfully performed in ^{222}Rn (radon) concentration measurement. Solid state nuclear track detection technique was simple, easy and useful technique to measure the alpha detection because it was low cost and not concerned with the electronic detector assembly. This research is carried out in order to know whether it is dangerous or not for people who live near the Mine area, as a result of radon output in water samples from three villages near the Mine area in Salingyi Township, Sagaing Region.

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Method and Materials

Sample Collection

To measure the radon concentration, eleven kinds of water samples (eight water samples from wells, one water sample from tube-well, one water sample from Yama stream and one water sample from waste water) were collected from Kan Gon village, Done Daw village and Ywa Tha village, near the Mine area, in Salingyi Township, Sagaing Region. The list of collected places and locations are shown in the Table (1). The location map of three villages is also shown in Fig. (1).

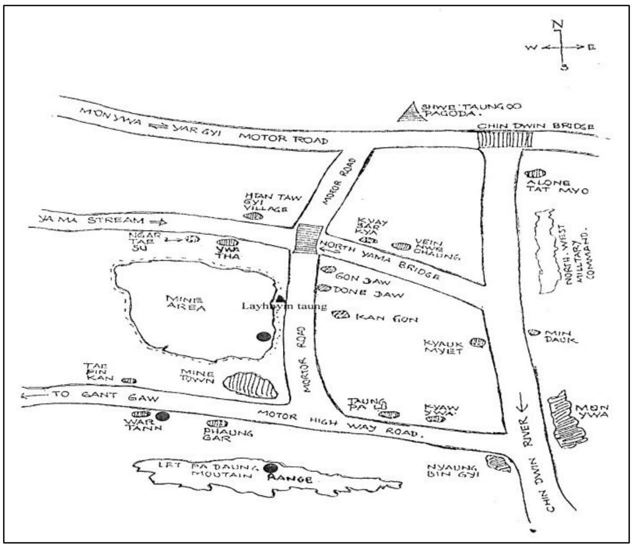

Figure 1 The location map of three villages

Table 1 List of collected places and location of water samples

Sr No	Name of Sample	Collected places	Kind of water	Depth of well (m)	North latitude	East Longitude	Elevation (m)
1	W1	Done Daw Village	well water	~ 12	22˚ 8.19′	95˚ 3.79′	71
2	W2	Kan Gon Village	well water	~ 15	22˚ 7.67′	95˚ 3.78′	81
3	W3	Kan Gon Village	well water	~ 14	22˚ 7.66′	95˚ 3.78′	81
4	W4	Kan Gon Village	well water	~ 15	22˚ 7.49′	95˚ 3.34′	103
5	W5	Kan Gon Village	tube-well water	~ 61	22˚ 7.50′	95˚ 3.35′	103
6	W6	Done Daw Village	well water	~ 14	22˚ 7.69′	95˚ 3.42′	75
7	W7	Ywa Tha Village	well water	~ 16	22˚ 8.83′	95˚ 2.55′	68
8	W8	Ywa Tha Village	well water	~ 14	22˚ 8.79′	95˚ 2.33′	82
9	W9	Ywa Tha Village	stream water	-	22˚ 8.78′	95˚ 2.32′	82
10	W10	Ywa Tha Village	waste water	-	22˚ 8.77′	95˚ 2.31′	82
11	W11	Done Daw Village	well water	~ 12	22˚ 7.96′	95˚ 3.24′	73

Experimental Details

In our research work, the LR-115 (cellulose nitrate) films, solid state nuclear track detector, are used. 100 mL of water sample was placed in a cylindrical plastic can of diameter 7 cm and height 5.5 cm. 1cm×1cm LR-115 film was fixed on the top of inner surface of the Can, in such a way, that its sensitive surface is facing the water sample. The Can is sealed air tight with adhesive tape and kept for exposure of about 100 days. The geometrical parameters of plastic can as illustrate in Fig. (2). During exposure period, the sensitive side of the detector faced the sample is exposed freely to the emergent radon form the sample in the Can, so that it can record alpha particle resulting from the decay of radon in the remaining volume of the Can. At the end of exposure time, these detectors were removed from the Cans and etched in 2.5N NaOH 100 mL at 60°C for 60 minutes.

To be 2.5N NaOH 100mL, 10g of NaOH was put into measuring cylinder and poured the distilled water 100 mL. Then the distilled water was stirred with glass rod to dissolve all NaOH. During etching, the temperature was kept constant with accuracy of ±1°C and without stirring. After etching these detectors, the solution in the beaker was poured into another beaker through small plastic sieve with handle. Then, the detectors were washed with water until the surfaces of the detectors become cleaned. Finally, the detectors were taken out and dried on the filter paper and tracks produced by alpha particles were observed under binocular microscope.

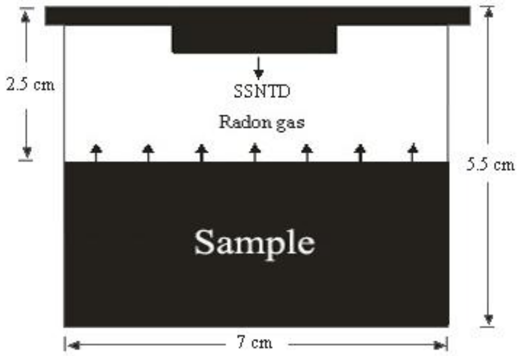

Figure 2 Experimental set-up for the measurement of radon concentration

Track Counting and Track Density Calculation

Track counting was performed by using binocular microscope (100X magnification). Only tracks that have completely perforated the sensitive layer had been counted. The number of tracks viewed on the camera was counted for different fifty views by changing the vertical and horizontal position of detector under the microscope.

The track density of each sample was calculated by using track density equation:

$$\text{Track Density (Track cm}^{-2}\text{ day}^{-1}) = \frac{\text{Number of Net Track}}{\text{Microscopic View Area}} \times \frac{\text{Magnification}}{\text{Exposure Time}} \quad (1)$$

Radon concentration was also calculated by following equation:

In the present work, because of some difficulties encountered in here, the calibration factor could not be found out ourselves. Thus, the calibration factor obtained from the others' work was used. The calibration factor used for radon concentration was,

0.05016 track $cm^{-2}day^{-1}$ = 1 Bqm^{-3} for LR-115 Type II (Muramatsu, 2002)

$$\text{Radon Concentration (Bqm}^{-3}) = \frac{\text{Track Density (track cm}^{-2}\text{day}^{-1})}{0.05016 \text{ track cm}^{-2}\text{day}^{-1}/\text{ Bqm}^{-3}} \quad (2)$$

To convert becquerel per cubic meter to picocuries per liter; 37Bqm^{-3} = 1 pCil^{-1} was used. Then the annual effective dose was also calculated by following equation:

$$1 \text{ pCil}^{-1} = 1.62 \text{ mSv yr}^{-1}$$

$$\text{Annual Effective Dose (mSv yr}^{-1}) = \text{Radon Concentration (pCil}^{-1}) \times 1.62 \text{ (mSv yr}^{-1}/\text{pCil}^{-1}) \quad (3)$$

In this research, the background of detector has been measured and its value was 0.12±0.03 track cm^{-2} day^{-1}.

Results

In this research, a total of eleven water samples from three villages in Salingyi Township were analyzed. The results of the alpha track densities, radon concentrations and annual effective doses in water are summarized in Table (2). The comparison graph of alpha track densities, radon concentrations and annual effective doses for these samples are presented from Fig. (3) to Fig. (5). Table (2) Alpha track density, radon concentration and annual effective dose for water samples

Sr No	Water Samples	Alpha track density (track cm^{-2} day^{-1})	Radon Concentration (pCi l^{-1})	Annual effective dose (mSv yr^{-1})
1	W1	0.73 ± 0.05	0.39 ± 0.03	0.64 ± 0.04
2	W2	0.86 ± 0.04	0.46 ± 0.02	0.75 ± 0.04
3	W3	0.81 ± 0.05	0.43 ± 0.02	0.69 ± 0.04
4	W4	0.94 ± 0.06	0.50 ± 0.03	0.82 ± 0.05
5	W5	1.13 ± 0.07	0.61 ± 0.04	0.99 ± 0.06
6	W6	0.77 ± 0.05	0.41 ± 0.03	0.67 ± 0.04
7	W7	0.96 ± 0.06	0.52 ± 0.03	0.84 ± 0.05
8	W8	0.78 ± 0.05	0.42 ± 0.03	0.68 ± 0.04
9	W9	0.67 ± 0.04	0.36 ± 0.02	0.59 ± 0.03
10	W10	0.75 ± 0.05	0.40 ± 0.03	0.66 ± 0.04
11	W11	0.67 ± 0.04	0.36 ± 0.02	0.59 ± 0.03

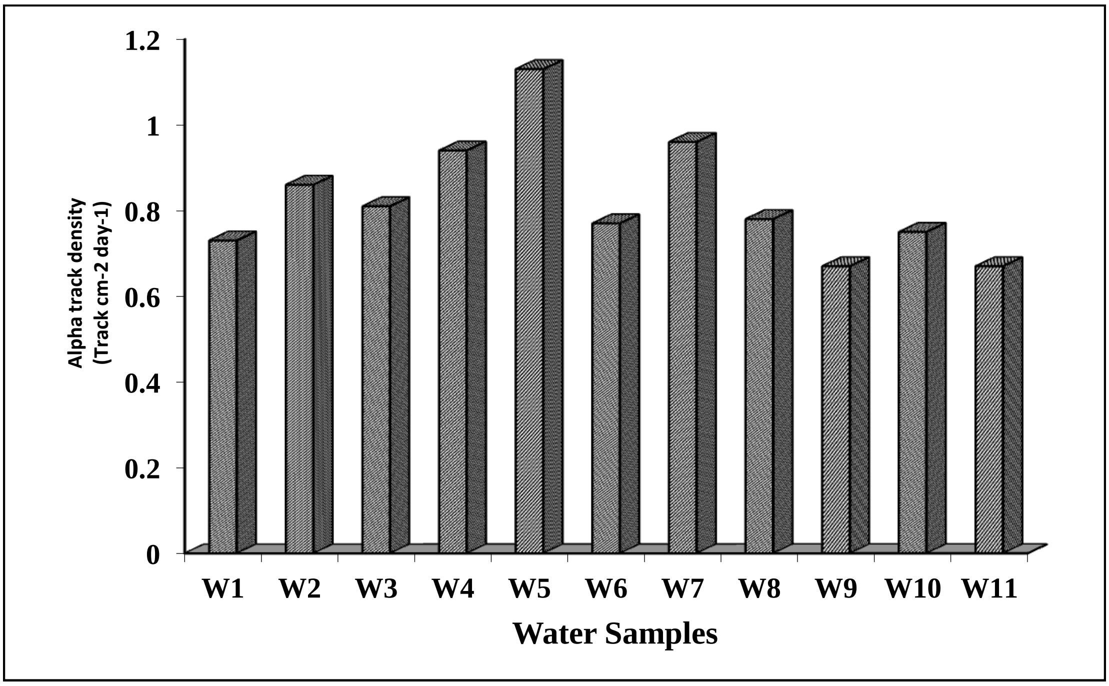

Figure 3 Comparison graph of the alpha track density for water samples

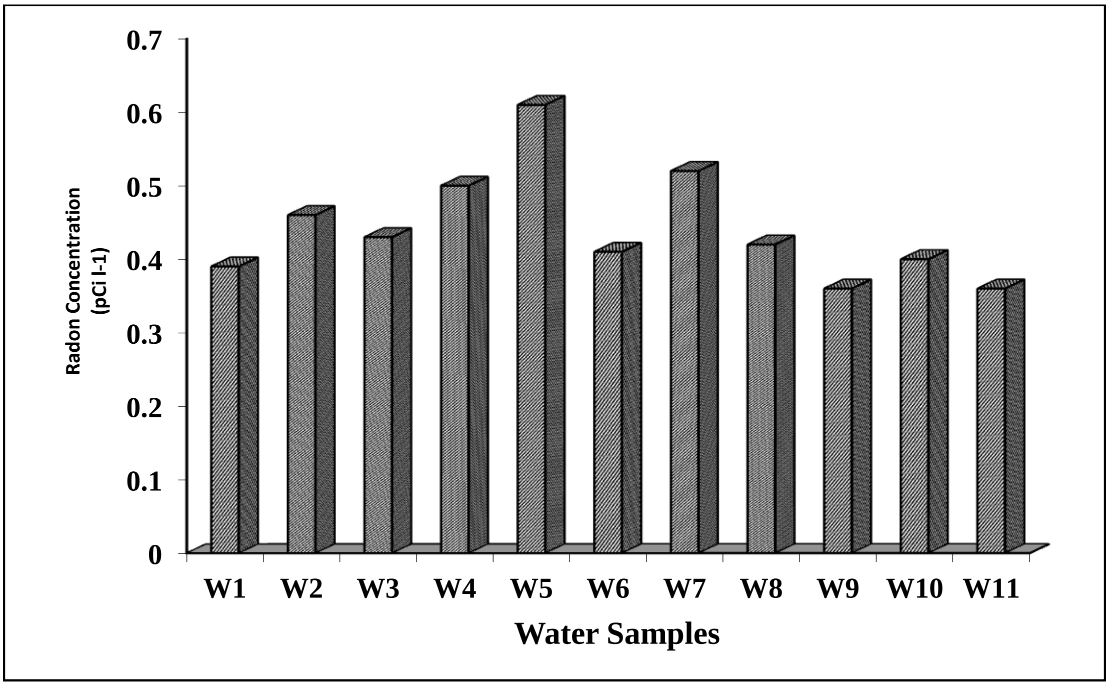

Figure 4 Comparison graph of the radon concentration for water samples

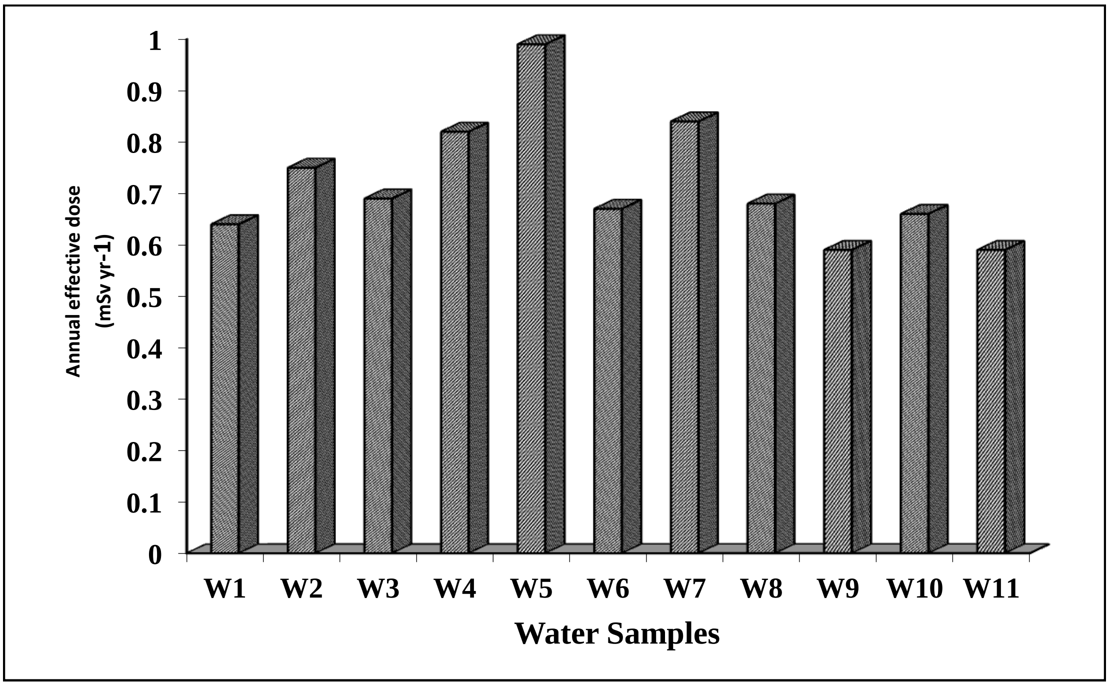

Figure 5 Comparison graph of the annual effective dose for water samples

Discussion

The concentration of radon in water samples varies from a minimum value of 0.36±0.02 pCil-1 to a maximum value of 0.61±0.04 pCil-1. The minimum value of annual effective dose is 0.59±0.03 mSvyr-1 and the maximum value is 0.99±0.06 mSvyr-1.

Radon concentration of sample W5 is the highest among eleven samples. This sample is collected from 61m depth tube-well in Kan Gon village. There is a lot of waste soil from Mine, copper purifying and near the acid factory at the Mine area.

The radon concentration of sample W7 and W4 are lower than the sample W5 and higher than the other samples. Sample W4 and W5 are the same in village but their depth of well are different. So, the values of radon concentrations are also different.

Sample W9 and W11 are the lowest radon concentrations in all samples. Sample W9 is collected from Yama stream near Ywa Tha village and sample W11 is collected from 12m depth well in Done Daw village. Sample W11 is the drinking water for Done Daw village and the other villages which are near the Done Daw .

Sample W1 and W10 are slightly different in their radon concentrations. Sample W1 is collected from 12m depth well in Done Daw village and W10 is collected from waste water of Mine area which flows into the Yama stream.

Sample W3, W6 and W8 are collected from the same depth of 14m well and different in villages, which are Kan Gon village, Done Daw village and Ywa Tha village respectively. Among in three water samples, sample W3 has the highest radon concentration. This is due to that the Kan Gon village have waste soil and copper purifying.

The present results show that the radon concentration in water is below the allowed limit from International Commission on Radiological Protection (ICRP) agency which is 27 $pCil^{-1}$ (2009). In addition to the radon concentrations, the annual effective dose in water is also below the permissible limit from ICRP agency which is 3 - 10 $mSvyr^{-1}$ (2009).

Conclusion

The result of this research was found that the radon concentration and the annual effective dose measured by sample W5 (collected from 61m depth tube well) is the largest and that of the sample W9 (collected from Yama stream) and W11 (collected from 12m depth well) are the smallest among the other samples. This is due to the samples are taken from different places; the materials contain radioactive elements in different proportions depending upon local geology and depth of the water source. And then, the radon is not concerned in water that comes from lakes, rivers and reservoirs (called surface water) because the radon will be released into the air before reaching water supplier or home. The result for all water samples are well within the prescribed safe limit. It can be concluded that the samples of water in this research are safe for radiation hazards to the villagers and visitors by using these water.

Acknowledgements

I would like to express my sincere thanks to Dr Khin Khin Win, Professor and Head, Department of Physics, University of Yangon for her kind encouragement and permission to carry out this research,

I would like to thank Dr Myo Lwin, Professor, Dr Ye Chan, Professor and Head, Universities' Research Center, Dr Aye Aye Thant, Professor, Department of Physics, Dr Yin Maung Maung, Professor, Department of Physics and Dr Than Zaw Oo, Professor, Universities' Research Center, University of Yangon, for their suggestion and comments for this research.

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