Radon Concentration Measurement in Water from Lashio University, Using Solid State Nuclear Track Detectors

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Abstract

In this paper, the radon emanated from water at Lashio University, Myanmar has been measured. For the measurements, sensitive CR-39 plastic track detectors as Solid State Nuclear Track Detectors (SSNTDs) were used. Based upon the available data, radon concentration has been calculated.

Key words: Radon, solid state nuclear track detector, etchant, Lashio.

Introduction

Radium is a naturally occurring radioactive element present in trace amounts throughout the earth's crust. The decay of radium leads to radon in the environment (indoor and outdoor). The increased interest in measurement of radium and radon concentration in water near thermal power plants is due to associated health hazards and environmental pollution. There are three isotopes of radon: ^{219}Rn (action), ^{220}Rn (thoron), ^{222}Rn (radon) which belong to the decay chain of ^{235}U, ^{232}Th and ^{238}U respectively. Radon (^{222}Rn) is a colourless, odourless and is an α -emitter that decays with a half-life of 3.82 days into a series of radon progeny. A large body of human epidemiological data on occupational exposures to radon and its progeny yielded quite consistent risk factors down to dose encountered in some dwelling.

Only about 1 to 2% of radon in the air comes from drinking water. However, breathing radon released air from tap water increases the risk of lung cancer over the course of lifetime. Some radon stays in the water; drinking water containing radon also presents a risk of developing internal organ cancers, primarily stomach cancer. However, this risk is smaller than the risk of developing lung cancer from radon released air from tap water.

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Most often, the radon in home's indoor air can come from two sources; the soil or water supply. Compared to radon entering home through water, radon entering home through soil is usually a much larger risk. By testing for radon in both air and water, the results could enable more completely assess the radon mitigation options best suited to situation. The radon in water supply poses an inhalation risk and a small ingestion risk. Research has shown that risk of lung cancer from breathing radon in air is much larger than risk of stomach cancer from swallowing water with radon in it. But most of risk from radon in water comes from radon released into the air when water is used for showering and other household purposes. In the present investigation, the radon emanated from water at different sources in Lashio University campus has been measured.

In order to find out 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.

Material and Methods

Solid state nuclear track detectors technique is fundamentally similar to cloud chamber and ionization chamber techniques. However, they are different in track detection method. In general, 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 50Å) and therefore track etching technique has to be used to enlarge the size of the track. The etched tracks in the detector are permanent and these tracks can easily be seen visually by using the optical microscope. To find out the radon concentration, Solid State Nuclear Track Detectors (SSNTDs) CR-39 was used. SSNTDs are based on the damage created in a solid along the path of heavily ionizing particles such as alpha particles and other ions. A known amount (100cc) of the water samples of different places from Lashio University were collected and these samples were placed in plastic cans. CR-39 plastic detectors (1 cm x 1 cm) were fixed on the bottom of the lid of each can with tape such that, sensitive side of the detector faced the specimen. The cans were tightly closed at the top and sealed as shown in figure (1).

After exposure time of 100 days, the detectors were removed and subjected to a chemical etching process in 6 N NaOH solution at 70°C for 5 hours as shown in figure (2). After it was etched, the detector was washed and dried and tracks produced by alpha particle were observed and counted under a Biological Microscope, Mode MT 4300H attached with CK 3900, CV-S 3200, Color Video Camera. And the measurement conditions are expressed as follows,

Measurement Conditions

Detector	:	CR-39
Samples	:	4 different places at Lashio University
Sample 1 (S1)	:	Front of Rector's House
Sample 2 (S2)	:	Lashio(1), Hall
Sample 3 (S3)	:	Front of Engineering Building
Sample 4 (S4)	:	Stadium Building
Sample 5 (S5)	:	Background
Irradiation Time	:	100 days
Etchant	:	6 N NaOH at 70 ºC, without stirring
Etching Time	:	5 hours
Microscope	:	Biological Microscope, Mode MT 4300H attached with CK 3900, CV-S 3200, Color Video Camera
Microscopic Diameter	:	0.65 mm

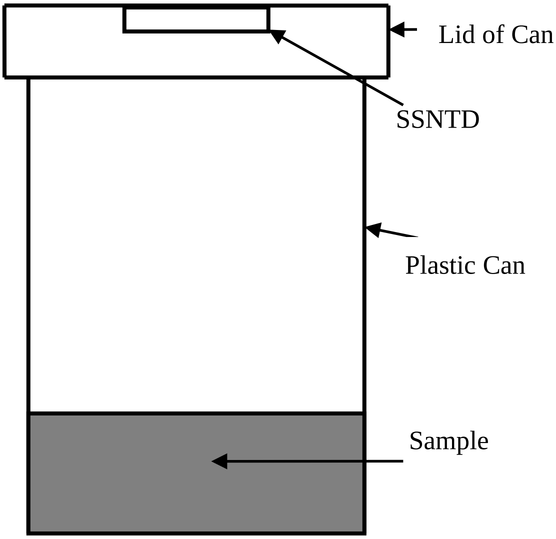


Fig. (1) The schematic diagram of the Can Technique

Fig. (2) The etching photograph of CR-39 detectors

The technique of SSNTD is based on the damage created in an insulating solid along the path of a heavily ionizing particle such as an alpha particle or a fission fragment. The damage along the path, called a track. The alpha track density in solid state nuclear track detector is the number of net alpha track per unit area, from the following equation,

$$\text{Track Density} = \frac{\text{Number of Net Tracks}}{\text{Area of Counting}} \quad .$$

To estimate the radon concentration, the calibration factor obtained after inter-laboratory comparison exercises carried out at the national level by the Environmental Assessment Division of Bhabha Atomic Research Center (BARC), Mumbi. Calibration factor was used, 0.065 track $cm^{-2}day^{-1}$ = 1 Bqm^{-3}. Then, annual effective doses from radon were carried out using publication International Commission on Radiological Protection (ICRP, 1993), where 1 Bq m^{-3} = 0.0172 m Sv yr^{-1}.

Results and Discussion

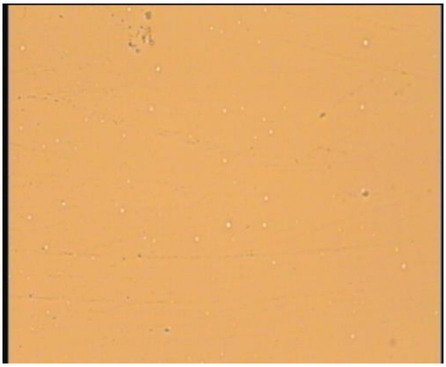
From SSNTD results in figure (3), the estimate of radon concentrations, and the annual effective dose were carried out. The average indoor radon levels in different water in Lashio University are tabulated in table (1). We noted that SSNTD are increasingly being used to obtain the time integrated concentration levels of radon and its daughters.

The graph of average track density for various samples is shown in figure (4) and the radon concentrations and annual effective dose of the samples are shown in figure (5) and (6). In case of the calculated values of radon concentration were 1.6502×10^{2} Bqm^{-3}, 4.0605×10^{2} Bqm^{-3}, 0.0927×10^{2} Bqm^{-3} and 2.3733×10^{2} Bqm^{-3}. The maximum alpha track density was 26.3935 track cm^{-2} day^{-1} and maximum radon concentration was 4.0605×10^{2} Bqm^{-3}, were found in sample S2(Lashio (1) Hall).The minimum alpha track density was 0.6026 track cm^{-2} day^{-1} and minimum radon concentration 0.0927×10^{2} Bqm^{-3}, were found in sample S3(Front of Engineering Building).

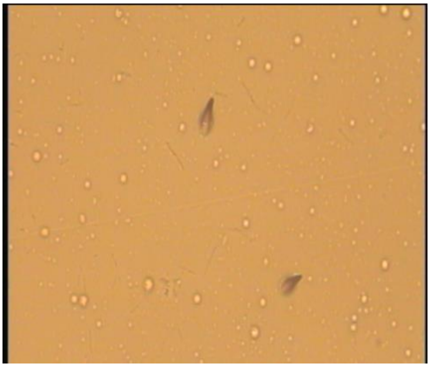
Samples from different rooms have been collected and are analyzed for the estimation of mean effective dose through radon concentrations by using CR-39, a solid state alpha-detector. The variations of radon concentration in different samples were 1.6502×10^{2} Bqm^{-3}, 4.0605×10^{2} Bqm^{-3}, 0.0927×10^{2} Bqm^{-3} and 2.3733×10^{2} Bqm^{-3}, because uranium concentrations of radon emanation are varied from one place to another. From the results, the maximum annual effective dose is 6.9841×10^{-5}m Svy^{-1} (For S2) and the minimum annual effective dose is 0.1594 m Svy^{-1} (For S3). It can be seen that the radon concentrations vary from sample to sample. It may be due to that samples collected from different places may have different uranium and radium contents.

Conclusion

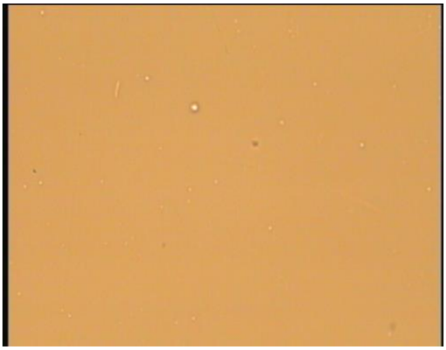
It may be seen from the data of annual effective dose received by the occupants of different places that radon varies from 0.1594 m Svy^{-1} to 6.9841 m Svy^{-1} which is therefore on the lower limit side (3-10 m Svy^{-1}) as recommended by (ICRP, 1993). In the light of these findings, the effective doses from external irradiation and the inhalation of radon decay products are significant from the point of view of health.



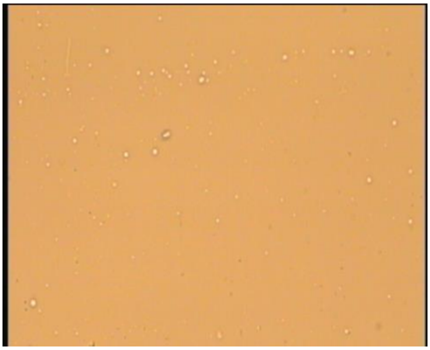
(a) Sample 1



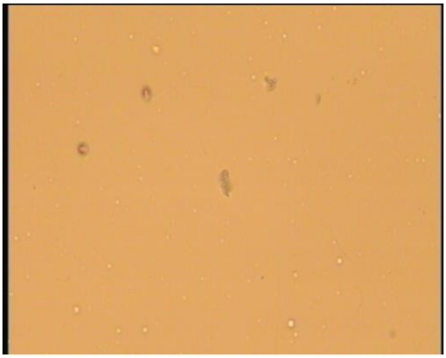
(b) Sample 2



(c) Sample 3



(d)sample 4



(e) Sample 5

Fig. (3) Photomicrograph of samples in detector CR 39

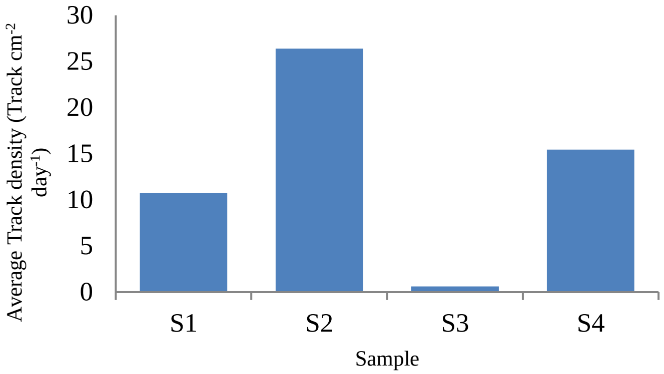


Fig. (4) The graph of average track density

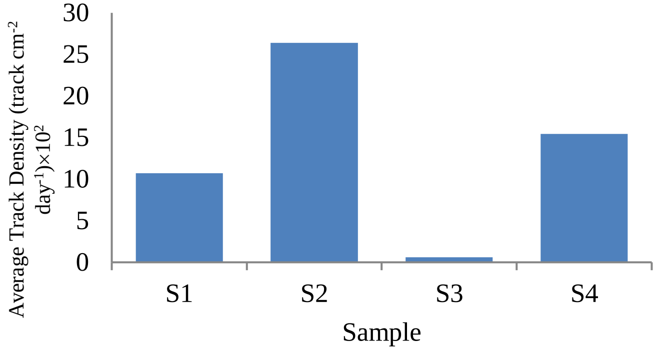


Fig. (5) The graph of average radon concentration

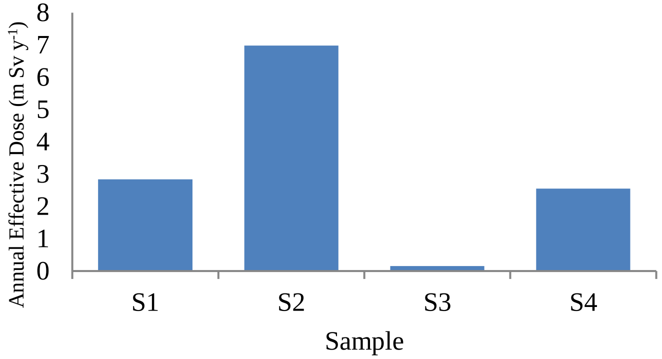


Fig. (6) The graph of annual effective dose

Table (1) The average indoor radon levels in different water in Lashio University

No.	Sample Code	Track Density (Track cm^{-2} day^{-1})	Average Radon Concentration (Bq m^{-3})	Annual Effective Dose (m Svy^{-1})
1	S1	10.7261	$1.6502x10^2$	2.8383
2	S2	26.3935	$4.0605x10^2$	6.9841
3	S3	0.6026	$0.0927x10^2$	0.1594
4	S4	15.4263	$2.3733x10^2$	4.0821

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