International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.04, April 2018
www.ijarse.com

IJARSE
ISSN: 2319-8354

"Radium/Radon Content and Radon Exhalation Rates from Some Soil Samples by Using SSNTD"

Dr. Hiranya Kumar Sarma

Principal, Suren Das College, Hajo, Kamrup, Assam, Pin-781102, (India)

ABSTRACT

Radon (^{222}Rn) is a radioactive inert gas originating from the decay of radium (^{226}Ra).

Radon exhalation rate from soil is one of the most important factors for evaluation of the environmental radon level. Solid State Nuclear Track Detectors (SSNTD) has been widely used for the study of different aspects of radon emission from soil and others.

Can Technique has been used for the estimation of radium content and radon exhalation rates. In this paper, we are presenting the results of radon concentration, its exhalation rates and radium content in soil samples collected from Township area of Duliajan, Assam (India). The radon concentration varies from 108.39 to 244.89 Bq/ m^3. The radon exhalation rates in terms of area and in terms of mass varies from 57.06 to 128.66 mBqm^{-2}hr^{-1} and 1.61 to 3.64 mBqkg^{-1}hr^{-1}. The radium content varies from 2.59 to 5.85 Bq/ Kg. A good correlation is observed between radium content and radon exhalation rates in soil samples.

***Keywords*: Radon, Radium, Soil, SSNTD**

I.INTRODUCTION

Radium (^{226}Ra) is a decay product of Uranium (^{238}U). Radium decays to produce radon (^{222}Rn) which decays to Polonium by alpha emission.

Over the past few decades, there has been a large scientific interest in the study of environmental radon. One of the main reasons is its associated health hazard; another is its widespread use as an environmental tracer [1]. Uranium is present in rocks and soil. The most abundant isotope is ^{238}U that decaying generates ^{222}Rn Radon is a noble gas and thus does not undergo chemical reactions which could preclude its free movement within the soil. Soil is a source of radon. The infiltration of radon gas (222 $_{Rn}$) from soil has been identified as one of the main mechanisms influencing indoor radon levels in many buildings [2]. It was reported that a world wide average of 60.4% of indoor radon comes from the ground and surrounding soil of buildings [3]. Information on the spatial variability of radon exhalation rate would be useful for identifying areas with a risk of high radon exposure. On the other hand, the well understood chemical behavior (inert gas) of radon ^{222}Rn and its convenient half life (3.825 days) make radon to be a useful tracer in studies of air mass transportation. For example, it is often used in validating global atmospheric transport models [4, 5]. Once radon is free to move, when it has left its original matrix through the emanation process; it can give rise to different mechanisms of migration, until it arrives at the soil surface and exhalates to the atmosphere. The first mechanism of migration is diffusion. The second one is convection, which can occur when a sufficient thermal gradient is available within the soil depending on many local parameters such as viscosity, porosity, permeability. The third one is transport by means of gas carrier [6].

Henshaw et al, 1990, [7] claimed that the radon exposure is associated with the risk of leukemia and certain other cancers, such as melanoma and cancer of kidney and prostate.

II. AREA UNDER INVESTIGATION:

In the present investigation, estimation of radium (^{226}Ra) and radon (^{222}Rn) has been carried out in the environment of Township area Duliajan, Assam, India. The area occupied by rocks of Tikak Parbat and Tipam formation of Tertiary age. Tikak Parbat formation is composed of sand stone, shale and coal. The composition of Tipam formation is dominated by sand stone. Geographical location of the area is 27°22′N latitude and 95°19′E longitude. The height of the ground level is 140 meter from the mean sea level.

III. EXPERIMENTAL METHOD

The "Can technique' [8, 9, 10, 11, 12] is used for the measurement of radium and radon exhalation rate in some soil samples collected from different locations of the area. The dried samples collected from different locations are finely powdered and sieved through a 200 mesh sieve. The fine powder (250gm) of samples from the site is placed in different glass bottles and sealed with thin polyethylene sheets for 30 days so as to attain the equilibrium. After one month, LR-115 (type II) plastic detectors are fixed on the lower side of cork lids, which are then gently pressed against the polyethylene sheets on the glass bottles (acting as emanation chambers, as shown in Fig. 1), so that the equilibrium is not disturbed or there is minimum possible disturbance, if any. The bottles are then sealed and left as such for 90 days so that the detectors can record α-particles produced by the decay of radon. The exposed detectors are etched in 2.5N, NaOH solution at $(60\pm1)^0C$ for 90 minutes using a constant temperature bath. The tracks are counted using an (OLYMPUS) optical microscope at 400X magnification.

The "Can technique" (Fig.1), is used to calculate the radium concentration in soil samples and is calculated using the following relation [13]:

$$C_{RA} = \rho hA / KT_eM$$

Where C_{RA} is the effective radium content of the given sample (Bq kg^{-1}), ρ is the track density (track cm^{-2}). M is the mass of the sample (250gm), A is the area of cross section of the bottle ($7.085\times10^{-3}m^2$), h is the distance between the detector and the top of the sample (0.135 m), K is the sensitivity factor, which is equal to 0.0245 tracks $cm^{-2}d^{-1}$ per Bqm^{-3} [13] in the present case and T_e is the effective exposure time (in days). T_e is related to the actual exposure time T and decay constant λ for ^{222}Rn by the relation:

$$T_e = T - 1/\lambda(1-e^{-\lambda T})$$

The radon exhalation rate in terms of area is calculated from the equation below [9, 11]:

$$E_A = CV\lambda / A\,[T + 1/\lambda(e^{-\lambda T}-1)]$$

Where E_A is the radon exhalation rate in terms of area ($Bq.m^{-2}h^{-1}$); C is the integrated radon exposure as measured by LR-115 plastic detector ($Bq.m^{-3}h$); V is the effective volume of the can (m^3); λ ($=7.5\times10^{-3}h^{-1}$) is the decay constant for radon; A is the area of the can (m^2). This formula is also modified to calculate the radon exhalation rate in terms of mass ($Bq.Kg^{-1}h^{-1}$).

The radon exhalation rate in terms of mass is calculated from the expression:

$E_M = CV\lambda / M[T+1/(e^{-\lambda T}-1)]$

Where E_M is the radon exhalation rate in terms of mass and M is the mass of the sample (250 gm).

The value of λ can be calculated with the help of the formula:

$$T = 0.693 / \lambda$$

Where T = half life of radon = 3.82 days

The integrated Radon concentration can be calculated with the help of the formula:

$$C_R = T_R / d\,K$$

Where T_R is the number of tracks cm^{-2}, d is the time of exposure, K is the calibration factor (sensitivity factor) = 0.0245 Tracks $cm^{-2}\,d^{-1}/Bq.m^{-3}$.

IV. RESULTS AND DISCUSSIONS

We have collected the soil samples from Township of Duliajan area, Assam, India. It is located in the north-eastern corner of Brahmaputra valley of Assam, India, in the Dibrugarh district, having petroleum mines, (Oil India Ltd.), fertilizer factory. The values of radon exhalation rates from soil samples and radium content in soil samples collected from these locations are given in Table. It is evident from the Table that the radon exhalation rate in terms of area varies from 57.06 to 128.66 $mBqm^{-2}h^{-1}$ with an average of 97.27 $mBqm^{-2}h^{-1}$ in soil samples collected from Township. For Township area, radon exhalation rate in terms of mass varies from 1.61 to 3.64 $mBqKg^{-1}h^{-1}$ with an average of 2.69 $mBqKg^{-1}h^{-1}$.

The variation of the radium content in soil samples collected from Township are also shown in Table. The radium content in soil varies from 2.59 to 5.85$BqKg^{-1}$ with an average of 4.24 $BqKg^{-1}$.

It can be seen from the Table that the radon exhalation rate varies appreciably from one place to another. This variation may be due to the differences in radium content [14] and porosity of the soil [15, 16]. In the present study we observed that the radium content in soil samples also varies appreciably from one place to another.

The variation of radon exhalation rates in terms of area with radium content is shown in Fig. 2 and the variation of radon exhalation rates in terms of mass with radium content is shown in Fig: 3.

The maximum acceptable value of radium activity in soil and rocks (building materials) must be less than 370 $Bq.Kg^{-1}$ for safe use [17].

V .CONCLUSION

1) The observed values of radium activity in soil samples in the present study are less than the maximum permissible value and much lower than the global value 30 $BqKg^{-1}$ [18].

2) We have observed a positive co-relation between radium content in soil and radon exhalation rates from soil as expected.

3) The results reveal that the area is safe as for as the health hazard effects of radium is concerned.

ACKNOWLEDGEMENT:

The author (Dr.H.K. Sarma) is thankful to University Grants Commission (UGC), for providing financial assistance to carry out this work in a Minor Research Project.

REFERENCES

[1.] Escobar V.G, Tome, F.V., Lozano, J.C., "Procedures for the determination of ^{222}Rn exhalation and effective ^{226}Ra activity in soil samples", Appl. Radiant. Isot, (1999).

[2.] Deka P.C., Sarkar S., Sarma B.K., Goswami T.D., Ramachandran T.V. and Nambi K.S.V., Indoor radon / thoron levels in dwellings of the hilly regions surrounding Guwahati, Assam, Indoor Built Environ, 12,343-349, (2003).

[3.] Ren. T., "Source, level and control of indoor radon," Radiat. Prot., 21[5], 291 (2001).

[4.] Dorr, H., Kromer, B., Levin, I. et al., "CO_2 and radon -222 as tracers for atmospheric transport," J. Geophys.Res., 88 [C2], 1309,(1993).

[5.] Moriizumi, J., Nagamine, K., Iida, T., Ikebe, Y., "Estimation of areal flux of atmospheric methane in an urban area of Nagoya Japan, inferred from atmospheric radon -222 data," Atmos. Environ., 30[10-11], 1534 (1996}.

[6.] Yang et al. "Exhalation of radon and its carrier gases in SW Taiwan," 36, [1-6], 425-429, (2003).

[7.] Henshaw, D.L., Eotough, J.B. Richarbson, J. B.., "Radon as a causative factor in induction of myeloid leukaemia other cancer," Lancet, 355, 1008-1015, (1972).

[8.] Alter M. W., Price P.B.,"Radon detection using track registration material", Terradex Corporation U. S. Patent 3, 665, 194, (1972}.

[9.] Abu-Jarad F "Application of nuclear track detectors for radon related measurements". Nuclear Tracks and Radiation Measurements 15 [1-4], 525, (1998).

[10.] Somogyi, G., "The environmental behavior of radium", Technical reports series no.310, 1, IAEA, Vienna, 229-256, (1990).

[11.] Khan, A. J. Prasad, R. & Tyagi, R. K., "Measurement of radon exhalation rate from some building materials", Nuclear Tracks and Radiation Measurements, 20,609-10, (1992).

[12.] Sarma, H.K."Study of radium content and Radon exhalation rates from some soil samples by using ssntd", IRJNAS, Vol.3, no,3,(2016).

[13.] Singh, Surinder, Sharma Dinesh Kumar, Dhar Sunil, Kumar Aravind, Kumar Ajay, "Uranium, Radium and radon Measurements in the Environs of Nupur Area, Himachal- Himalayas, India"., Environ Monit Assess ,128: 301-309, (2007).

[14.] Azam, A. Naqvi, A.H. & Srivastava D.S. "Radium Concentration and Radon Exhalation Measurement Using LR-115 Plastic Track Detectors". Nuclear Geophysics, 9(6), 653-657, (1995).

[15.] Ramachandran, T. V. & Subha Ramu M.C. "Estimation of indoor radiation exposure from the natural radioactivity content of building materials", Oncology, 3, 20,-25 (1989).

[16.] Folkerts, K.H., Keller, G. & Muth, R., "An experimental study of diffusion and exhalation of ^{222}Rn and ^{220}Rn from building materials", Radiation Protection Dosimetry, 9, 27-34, (1984).

[17.] OECD, Exposure to radiation from the natural radioactivity in building materials. Report by a group of the OECD Nuclear Energy Agency, Paris, (1979).

[18.] UNSCEAR United Nations Scientific Committee on the Effects of Atomic Radiations United Nations, New York. (1993).

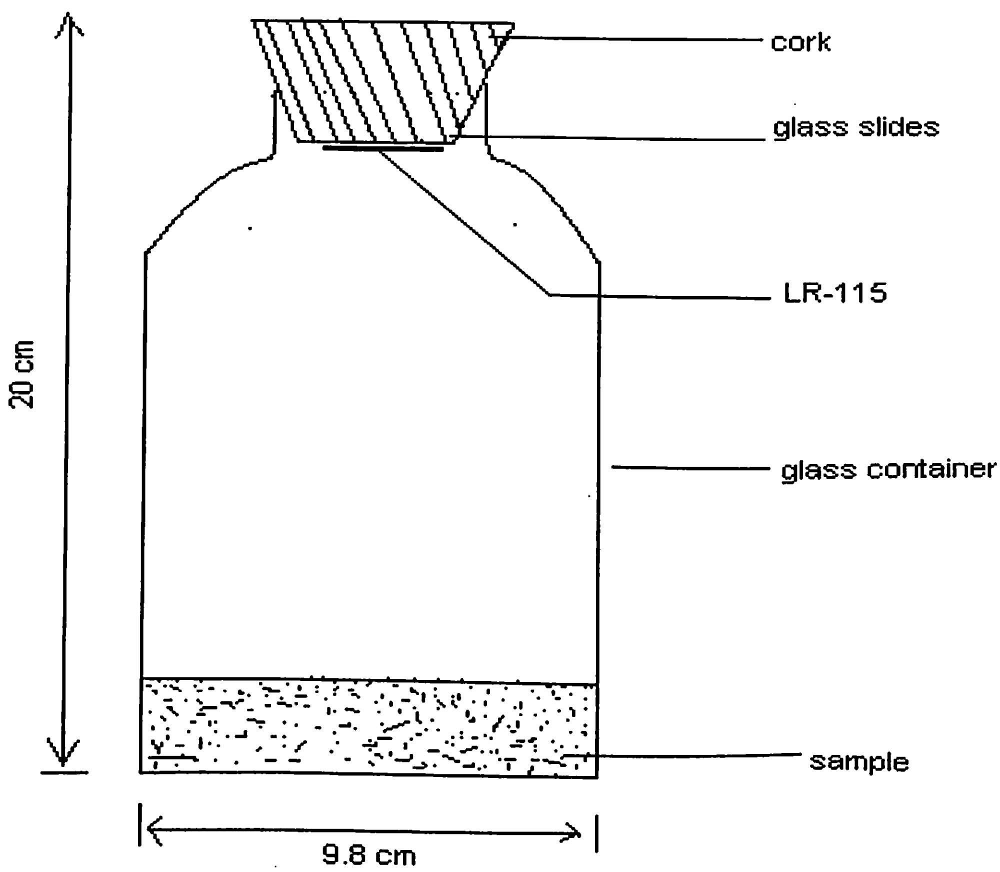

Fig. 1: Can Technique

International Journal of Advance Research in Science and Engineering
Volume No.07, Issue No.04, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Table: Values of Radon Exhalation Rates and Radium Content in Soil Samples collected from Township of Duliajan

Location	House No.	Track density (Tracks cm^{-2})	Radon Concentration ($Bq.m^{-3}$)	Radium Content in Bq./Kg	Mean Radium Content in $Bq.Kg^{-1}$	Radon Exhalation Rates in terms of Area(E_A) in $mBqm^{-2}h^{-1}$	Mean Radon Exhalation Rates in terms of Area(E_A) in $mBqm^{-2}h^{-1}$	Radon Exhalation Rates in terms of Mass(E_M) in $mBqKg^{-1}h^{-1}$	Mean Radon Exhalation Rates in terms of Mass(E_M) in $mBqKg^{-1}h^{-1}$
Township	1	239	108.39	2.59		57.06		1.61	
	2	258	117.10	2.79		61.53		1.74	
	3	303	137.00	3.28		72.16		2.04	
	4	317	143.76	3.43		75.52		2.14	
	5	357	161.90	3.67		97.34		2.32	
	6	368	166.89	3.86		85.03		2.41	
	7	371	168.25	3.92		101.11		2.45	
	8	392	177.71	4.12		108.21		2.64	
	9	394	178.68	4.24		93.42		2.72	
	10	404	183.21	4.35		110.12		2.75	
	11	408	185.03	4.41		115.23		2.80	
	12	415	188.21	4.42		97.34		2.88	
	13	425	192.74	4.5		99.01		3.04	
	14	427	193.65	4.62		101.81		3.12	
	15	451	204.53	4.88		107.41		3.18	
	16	472	214.05	5.11		112.87		3.32	
	17	493	223.58	5.34		117.48		3.32	
	18	519	235.37	5.62		123.63	97.27±9.7	3.51	2.69±0.09
	19	528	239.45	5.72		125.87		3.56	
	20	540	244.89	5.85	4.24±0.09	128.66		3.64	

IJARSE
ISSN: 2319-8354

Fig. 5.9: Variation of Radon Exhalation Rates interms of Area With Radium Content

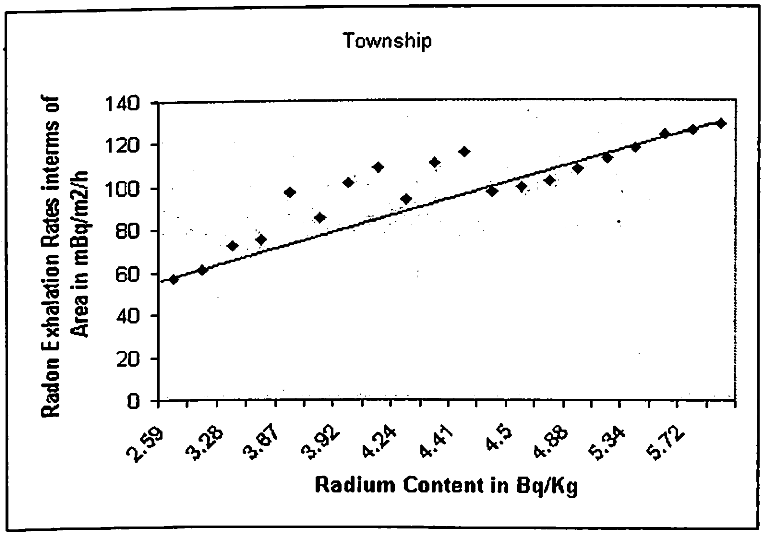

Fig. 5.10: Variation of Radon Exhalation Rates interms of Mass With Radium Content