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Radon Exhalation rate of soil and indoor radon concentration of various places of Karbi Anglong District of Assam.

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Abstract: *In this paper we report our results on radon exhalation rate of soil as well as indoor radon concentration of a few places of Karbi Anglong District of Assam. The technique of passive method has been adopted using LR-115 (type-II) plastic detector. Significant variations in radon exhalation rate and indoor radon concentration have been observed for the studied locations. The minimum and maximum values of radon exhalation rate as found for the present investigation are 348.37±17.4 mBqm^{-2}h^{-1} (10.52±0.52 mBqkg^{-1}h^{-1}) and1864.2±92.7 mBqm^{-2}h^{-1}(56.29±2.8 mBqkg^{-1}h^{-1}).For indoor radon concentration the minimum and maximum values as found from this study are 81.26±4.06 Bqm^{-3}and 277.78±13.89 Bqm^{-3}.*
Keywords: *Radon exhalation rate, Indoor radon concentration, LR-115, Plastic detector.*

I. Introduction

Radon (^{222}Rn), Thoron (^{220} Rn) and actinon (^{219}Rn) are the radionuclides that are found in the gaseous form in the decay series of Uranium and Thorium. Due to low abundance of parent nucleus U-235 and short half-life, actinon is believed to be not a significant contributor to the total radiation dose received by the population. Vast difference of half-lives of radon (3.8 d) and thoron (55 sec) is a crucial parameter governing their release from ground and subsequent distribution to free atmosphere. It is believed that inhalation dose to the general population from thoron and its progeny is only about 10% (or little more) of the inhalation dose due to radon [1].

Inhalation of indoor radon (^{222}Rn) and its daughter product contribute a major fraction of total dose to human being from all possible sources of natural radioactivity.

Radon (^{222}Rn) being a daughter product of Uranium-238 series further decays to ^{218}Po (RaA, 3.05 min), ^{214}Pb (RaB, 26.8 min), ^{214}Bi (RaC, 19.7 min), ^{210}Pb (RaD, 22.3 years) etc. Radon is chemically inactive and does not bind to tissues, upon inhalation the radon daughter like ^{218}Po, ^{214}Pb irradiates the lungs tissues by α-particles respectively with energies 6.0 Mev and 8.7 Mev. Such α-exposure is supposed to be one of the serious causes of increased incidence of lung cancer, skin cancer etc. [2].

Due to the existence of pressure difference between the soil and the indoor air, the transportation of radon from the underlying soil into the indoor air takes place by diffusion and / or with gases like CO_2 and CH_4 or water moving into the soil.

The concentration of radon and its progeny in the indoor air depends upon a number of parameter one of which is their exhalation rate, i.e., the amount of activity per unit area of the surface per unit time from soil and building materials to air. The typical values of exhalation rate for radon in soil and building materials are 0.02 and 0.05x10^{-2} Bqm^{-2}s^{-1} respectively.

Karbi Anglong district of Assam is one of the most geographically remote hilly district of Assam that is sharing its boarder with the state of Meghalaya. The global position of Karbi Anglong district is - latitudinal extension 25^{o}32$^{/}$ North - 26^{0}33$^{/}$ North and longitudinal extension 92^{0}09$^{/}$ East - 93^{0}52$^{/}$ East. The district is believed to be situated over zones of structural weakness as is evident from existence of a number of hot fluid channels (hot water springs) at different parts of the district.

In this work we have made an attempt to find indoor radon concentration in the dwellings and the radon exhalation rate of soils of few places of Karbi Anglong District of Assam and hence to find out the possible correlation between the indoor radon level and radon exhalation rate. The result of such studies may also provide some guiding information in regards to the possibility of exploration of uranium in this region.

II. Experimental Procedure

2.1. For the measurement of indoor radon

LR-115 (type-II) plastic detector obtained from Kodak Pathe was exposed for the measurement of indoor radon using plastic twin chamber dosimeter cups (BARC type). The exposure was done in three different modes (i) bare mode (ii) cup with filter paper and (iii) cup with filter paper-Mylar-filter paper [3].

The bare mode registered tracks due to total α-activity, the detector facing the filter paper only registered tracks resulting from the decay of radon and thoron and the detector facing filter paper-Mylar-filter paper had registered the tracks of α-particles due to the decay of radon.

For the present investigation the exposure was done for a period of 90 days (**Jan – Mar**.) in some selected Assam Type (AT) houses of various places of Karbi Anglong district of Assam. The cups were placed at least 1 m above the ground level and 15 cm away from the nearest wall or roof. Two AT houses were selected at each place for indoor Radon studies.

The detectors were retrieved and etched in 2.5 N NaOH solutions at 60^0 C for a period of 90 minutes. For uniform etching, we have used a Remi magnetic stirrer and the tracks were then counted using a Spark counter.

The radon concentration is determined as [4]

$$C_R = T_1/d.K_R \quad (1)$$

Where C_R = concentration of radon in Bq/m^3.

T_1 = Track density recorded in the membrane modes of exposure.

d = No. of exposure days.

K_R = 0.020 Tcm^{-2} / Bq.d.m^{-3} is the sensitivity factor for radon in the membrane compartment.

2.2. For the measurement of Radon exhalation rate in soil samples

For the measurement of radon exhalation rate in soil samples we have used the same "Can technique method" adopted by Abu Jarad and khan et. al. [5, 6].

The collected soil samples were dried, powdered and kept inside the sealed bottles for a period of 30 days to obtain the equilibrium radon concentration inside the chamber. The detectors were then exposed to register α-particle tracks due to decay of radon and left undisturbed for a period of 90 days.

The detectors were then etched and tracks were analyzed under the similar conditions used for indoor radon estimation.

The radon exhalation rate in terms of area is obtained from the expression [7]

$$E_A = \frac{CV\lambda}{A[T + \frac{1}{\lambda}\{EXP(-\lambda T) - 1\}]} \quad (2)$$

Where E_A is radon exhalation rate in terms of area (Bq m^{-2} hr^{-1}); C the integrated radon exposure as measured by LR-115 plastic track detector (Bq m^{-3} .hr), V the effective volume of the can (m^3), λ the decay constant for radon (hr^{-1}), T the exposure time (hr), A the area of the can (m^2). The modified formulas to calculate the radon exhalation rate in terms of mass is [8, 9]

$$E_M = \frac{CV\lambda}{M[T + \frac{1}{\lambda}\{EXP(-\lambda T) - 1\}]} \quad (3)$$

Where E_M is radon exhalation rate in terms of (Bq Kg^{-1} hr^{-1}) and M is the mass the soil sample (250gm).

III. Figures And Tables

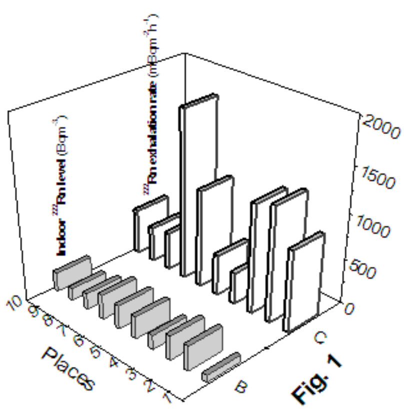

Fig. 1: Variation of ^{222}Rn exhalation rate of soil and indoor ^{222}Rn level of some selective places of Karbi Anglong district of Assam.

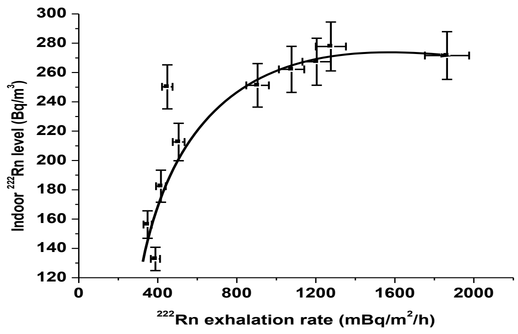

Fig. 2

Fig. 2: Correlation of exhalation rate of soil and indoor ^{222}Rn level

Table – 1: Radon exhalation rate of soil and indoor radon level of different places of Karbi Anglong district of Assam.

Sl. No.	Name of places	Radon Exhalation rate		Avg.Indoor radon level
		E_A (mBqm^{-2}h^{-1})	E_M (mBqkg^{-1}h^{-1})	(Bq/m^3)
1.	Langsoliet	905.33±48.06	27.34±1.45	81.26±4.06
2.	Mongjang	1276±63.95	38.54±1.93	277.78±13.89
3.	P. Taijal	1204.2±60.34	36.36±1.82	267.36±13.36
4.	Manja	348.37±17.4	10.52±0.52	156.28±7.81
5.	Mohendijua	448.05±22.4	13.53±0.67	250.24±12.51
6.	Longnit	1077.26±53.86	32.53±1.62	262.15±13.10
7.	Hojaipur	1864.2±92.7	56.29±2.8	271.60±13.58
8.	Kheroni	415.62±20.8	12.55±0.62	182.45±9.12
9.	Diphu (Mentila)	387.85±19.4	11.76±0.58	132.83±6.64
10.	Chutianala	505.52±25.33	15.26±0.76	212.59±10.62

IV. Results And Discussions

The values of radon exhalation rate of soil samples and indoor radon concentration of different places of Karbi Anglong District of Assam is shown in figure 1. The observed values are also listed in table 1. Figure 1 shows an increased value of indoor radon level at most of the places where the exhalation rates are also found to be relatively large.

Radon exhalation rates are found to vary from 348.37±17.4 mBqm^{-2}h^{-1} (10.52±0.52 mBqkg^{-1}h^{-1}) at Manja to 1864.2±92.7 mBqm^{-2}h^{-1} (56.3±2.8 mBqkg^{-1}h^{-1}) at Hojaipur. The indoor radon concentration, on the other hand, varies from 81.26±4.06 Bq/m^3 at Langsoliet to 277.78±13.89 Bq/m^3 at Mongjang with the average value equal to 209.50±10.20Bqm^{-3}. The observed exhalation rate is much higher than the typical value which is 0.02 Bqm^{-2}s^{-1}[1]. The observed exhalation rates are about 5 - 26 times larger than the typical value of exhalation rate of radon in soil.

When the average value of indoor radon of our case is compared with the indoor radon level in the same type of dwellings (AT Type) of the hilly regions surrounding Guwahati, Assam [10], it is found that average value of the present investigation is about twice the value reported for the dwellings surrounding Guwahati. It is observed that the indoor radon concentrations are higher than the global average value of 40 Bq.m^{-3} in all the studied locations [11].

To find the correlation between the observed exhalation rate and the concentration of indoor radon, in fig.2, we plot indoor radon concentration against exhalation rate. It is readily seen from this figure that with the increase of radon exhalation rate of soil of the studied sites, the indoor radon concentration increases almost linearly and then attains a saturation value. That is, further increase of exhalation rate cannot influence the indoor radon concentration indicating towards a dynamical equilibrium in indoor radon level. However to find an analytical relationship, if any, between the two, we have to increase our sample size in regards to the number of studied sites as well as the number of dwellings studied per site. And also the observation on indoor radon concentration should be made for all the seasons of a year.

V. Conclusion

From the above studies it can be concluded that indoor radon depends upon the radon exhalation rate of soil and with increase in radon exhalation rate of soil, the indoor radon concentration also increases and attains a saturation value. Further, similar observations will have to be done in different locations to come to a final conclusion.

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