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Estimation Of Radon Exhalation Rate In Soil Samples In And Around Oil Field Area Of Dibrugarh District, Assam

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Abstract: An investigation to ascertain the radon level as well as radon exhalation rates from soil samples collected from different locations in Dibrugarh district of Assam with the help of LR115(Type II) detectors using Can technique is presented in this article.Radium concentration observed for soil samples has been found to be varying from 1.39 Bq/Kg to 3.05 Bq/Kg for Duliajan. The Radon exhalation rate in these samples has been found to be varying from 0.81 to 1.97 mBqm^{-2} h^{-1}. A positive correlations with (R^2 =0.947) have been found between radon exhalation rate and radium concentration in the samples for the investigated areas. The obtained results indicate normal levels of indoor radon concentration and effective radium content in all locations of the studied area

***Index Terms* - Can technique, radon exhalation, emanation, effective radium content**

I. INTRODUCTION

The most stable isotope of ^{226}Ra is ^{222}Rn which is produced by the natural radioactive decay of uranium and thorium.Since uranium is essentially ubiquitous in the earth's crust,radium-226 and radon-222 are present in almost all rock,soil and water.The levels of uranium and thorium present depend on local geology. The rate at which radon escapes or emanates from solid into the surrounding air is known as radon exhalation rate of the solid. This may be measured by either per unit mass or per unit surface area of the solid. Measurement of radon exhalation rate of soils and rocks are helpful to study radon health hazards. Radon exhalation is the amount of radon (radon activity) as obtained from a given layer (geological material on the surface/surface exposure) mainly the outer thinner part of the crust. In the deeper material(within a geological strata), due to the attenuation of alpha particles from the uranium rich rock and/or thorium (another isotope of radium) it decreases. It is primarily due to diffusion, advection and convection as modes of radon transport. The presence of fractures, shearing, deformations, tectonic lineaments and faulting aids in the upward migration of radon. On the other hand Radon emanation is dependent on permeability of the rock, other lithological properties like rock alteration, erosion, diagenetic changes, to name a few. It also dependents on the nature of uranium and/or thorium. Radon enters into buildings through the soil or building materials. So radon exhalation rate from the soil or building material is an important parameter for estimating local environmental radon level. The concentration of radon and its decay products changes due to variations in various factors like temperature, pressure, building materials, ventilation conditions, etc. Therefore, it is necessary to have knowledge of the radium concentration and radon exhalation rate in soil and building materials, for accurate assessment of possible radiological hazards and risks to human health. Radon (^{222}Rn), a radioactive inert gas is responsible for about half of the radiation dose received by general population (UNSCEAR, 1994). On the basis of epidemiological studies it has been established that the enhanced levels of indoor radon in dwellings can cause health hazards and may cause serious deceases like lung cancer in human beings (F.Bichichi, R.W.Field). A large number of indoor radon surveys carried out in several countries (UNSCEAR 1977,1988,1993) in the environ of different geological areas.There are also numerous groups to study radium content in soil samples and radon exhalation rates (Sannappa J. et.al.,1999; Azam Amir et.al.,2006; Chauhan R.P. et.al.,2006; Kumar Rajesh et.al.,2006;Singh et.al.,2007). Threfore, it is also necessary to check the correlation between the radium concentration and radon exhalation rate of the source material. In the present study we have applied solid state nuclear track detectors (LR-115,TYPE II) for the analysis of radium and radon exhalation rate measurements in the soil samples taken from wide range of areas of oil field areas of Assam, India.

RESEARCH METHODOLOGY

The 'Can technique' is used for the measurement of radium and radon exhalation rates in some soil samples collected from different study areas. The dried samples collected from different places are finely powdered and sieved through a 200 mesh sieve. The fine powder (250g) of samples from each site is placed in different glass bottles and scaled with thin polyethylene sheets for 30 days so as to attain the equilibrium. After one month, LR-115 (type II) plastic track 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 Fig1. 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 tracks produced by the decay of radon. The exposed detectors are etched in 2.5N, NaOH solution at $(60 \pm 1)^0$C for 90 minutes . The tracks are counted using an (Olympus) optical microscope at 400X magnification.

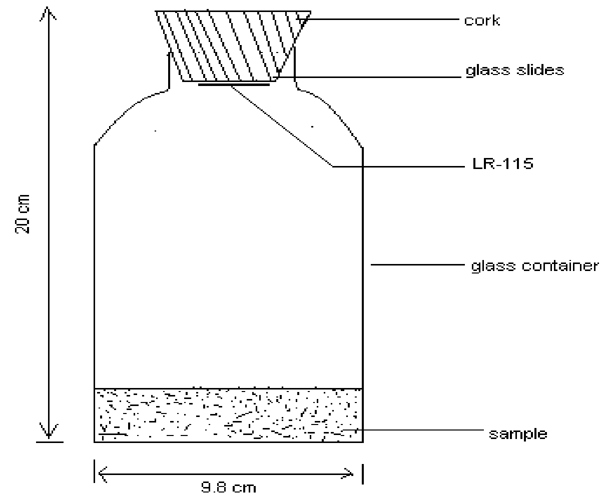


Fig 1: The Can technique used for the study of radium content and radon exhalation rate of soil samples

The track density ρ (tracks.cm^{-2}) so obtained was converted into the units of (Bq m^{-3}) of radon concentration C_{Rn} using the following equation (F.Saad, H.A.Hend, &N.A. Hussein;M.A. Ayman & A.Ali; I.Tayseer & M.A.Ayman):

$$C_{Rn} = \rho / kt \quad (1)$$

where t is the exposure time of distributed LR-115 detector in (days) and k is the calibration factor tracks of CR-39 in (tracks.cm^{-2}. day^{-1}/Bqm^{-3}) (F.Saad; M.A.Ayman &A. Ali; I.Tayseer & M.A.Ayman) The effective radium content C_{Ra} (Bq/Kg) can be calculated from the relation

$$C_{Ra} = \rho hA / kT\ M \quad (2)$$

where ρ.is the counted track density (tracks.cm^{-2}), h is the distance between the detector and the top of the sample (m), A is the area of cross section of the can (m^2), K is the calibration factor of the detector, M is the mass of the sample (Kg) and Te is The effective exposure time (in hour) which can be determined using the following equation.

$$T_e = T - 1 - e^{-\lambda_{Rn} T} / \lambda \quad (3)$$

where T is the exposure time, and λ_{Rn} the decay constant for radon. The radon exhalation rate in terms of area, E_A (mBqm^{-2} h^{-1}) can be calculated from the (F.Saad, M.A. Ayman &A. Ali; I.Tayseer & M.A.Ayman):

$$E_A = C_{Rn} V\lambda / A[T + 1/\lambda\, (e^{-\lambda T} - 1) \quad (4)$$

Where A, V, λ and T are the area of the can in (m^2), the effective volume of the can in (m^3), decay constant for radon in (h^{-1}), and the exposure time in hours, respectively. The radon exhalation rates in terms of mass, E_M (mBqm^{-2} h^{-1}) can be calculated by the following formula

$$E_M = C_{Rn} V\lambda / M[T + 1/\lambda\, (e^{-\lambda T} - 1) \quad (5)$$

Where M is the mass of the sample (250 gm)

The risk of lung cancer from domestic exposure due to radon and its daughters can be computed directly from the equivalent effective dose. The annual effective dose, D (mSvy^{-1}) was computed from the integrated radon concentration using the following formula (Gupta, Mahur, Sonkawade, & Verma, 2010):

$$D = C_{Rn}\ 0.4 \times 3.88 \times 7000 / 170\ 3700 \quad (6)$$

Where D and C_{Rn} are the annual effective dose in (mSvy^{-1}) and the integrated radon concentration in (Bq.m^{-3}) respectively. The equilibrium factor and the ICRP conversion factor (ICRP, 1993) are 0.4 and 3.88 mSv.WLM, respectively. 7000 is the number of hours per year, and 170 is the number of hours per working month.

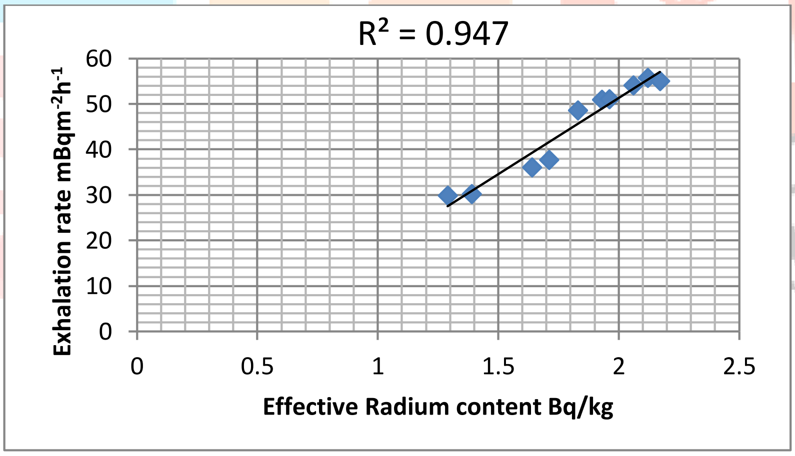
IV. RESULTS AND DISCUSSION

Table 1 represents the activity concentrations of indoor Radon-222, effective Radium content (Bq/kg) and radon exhalation rate (mBqm^{-2} h^{-1}) were measured at different locations in oil field areas of Duliajan, Assam. For these, soil samples are collected from different locations near oil industry within the range 2 – 4 Kms. The values of radium content at Duliajan varies from 1.33 Bq/Kg to 1.6 Bq/Kg and radon exhalation rate varies from 29.37 mBqm^{-2}h^{-1} to 31.18 mBqm^{-2}h^{-1}.From these data, a good positive correlation have been observed between radium content and radon exhalation rate in soil samples. The results show that there is a variation in radon exhalation rate from one location to other which depends on the geological formation. The variation in values of radon exhalation rate may be due to the differences in radium content (T.V.Ramachandran and M.C.Subba Ramu) and porosity (M.Folkerts) of the soil. The values of effective radium content are less than the permissible value of 370 Bq kg^{-1} as recommended by Organization for Economic Cooperation and Development (OECD 1979). Hence, the result shows that these study areas are safe as far as the health hazards of radium are concerned.

Table 4.1:Values of Radon Exhalation Rates and Radium Content in Soil Samples Collected From Different areas of Duliajan

Location	GPS locations	Track Density (Tracks cm^{-2})	Radon Concentration(Bqm^{-3})	Radium content Bq/ kg	Mean Bq/kg	Radon exhalation rates in terms of area(E_A)in $mBqm^{-2}h^{-1}$	Mean (E_A)in $mBqm^{-2}h^{-1}$	Radon exhalation rates in terms of mass,(E_M) $mBqm^{-2}h^{-1}$	Mean ,(E_M) $mBqm^{-2}h^{-1}$
	27°23´41.0´´N &95°36´10.6´´E	129	58.5	1.39		27.12		0.81	
	27°23´41.0´´N &95°36´10.6´´E	135	61.2	1.46		31.16		0.91	
	27°23´40.9´´N &95°36´11.2´´E	146	61.5	1.58		35.62		1.05	
Duliajan	27°24´17.7´´N &95°36´14.4´´E	158	71.9	1.71		41.16	47.70±0.4	1.16	1.36±0.4
	27°36´18.3´´N &95°31´16.5´´E	216	98.0	2.41	2.20±0.3	46.71		1.31	
	27°36´15.4´´N &95°36´17.2´´E	223	101.2	2.43		53.14		1.43	
	27°36´14.16´´N &95°37´03.1´´E	229	103.5	2.48		56.51		1.54	
	26° 90´14.5´´N &94°72´10.6´´E	246	111.60	2.64		58.18		1.64	
	26°90´41.0´´N &94°66´16.1´´E	270	122.56	2.92		62.32		1.82	
	26°90´11.5´´N &94°36´10.6´´E	282	128.00	3.05		65.13		1.97	

Fig2: Co-relation co-efficient between radium content and rad. Exhalation rate in area at Duliajan



CONCLUSION:

Based on the results obtained in this study the following concluding observations may be drawn as follows:

1. With increase of radium content of soil samples the radon exhalation rate also increases in the studied locations.
2. The average values of effective radium content at the locations of the studied area are lower than the OECD recommended value.
3. A good positive correlation have been observed between effective radium content with radon exhalation rate of soil samples.

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